

Chapter 8

1 Energy

2 8.1 Introduction

3 This chapter describes the hydroelectric generation facilities and power demands
4 for the Central Valley Project (CVP) and State Water Project (SWP) related to
5 changes that could occur as a result of implementing the alternatives evaluated in
6 this Environmental Impact Statement (EIS). Implementation of the alternatives
7 could affect CVP and SWP power generation and energy demands through
8 potential changes in operation of the CVP and SWP facilities.

9 Changes in CVP and SWP operations are described in more detail in Chapter 5,
10 Surface Water Resources and Water Supplies.

11 8.2 Regulatory Environment and Compliance 12 Requirements

13 Potential actions that could be implemented under the alternatives evaluated in
14 this EIS could affect CVP and/or SWP hydroelectric generation and electricity
15 use. The changes in power production and energy use would need to be
16 compliant with appropriate Federal and state agency policies and regulations, as
17 summarized in Chapter 4, Approach to Environmental Analysis.

18 8.3 Affected Environment

19 This section describes CVP and SWP hydroelectric generation and electricity use
20 of the generated electricity within the study area.

21 The study area includes CVP and SWP hydroelectric generation facilities at the
22 CVP and SWP reservoirs; transmission of the generated electricity; and the CVP
23 and SWP facilities and other users throughout California that rely upon electricity
24 generated by the CVP and SWP hydroelectric facilities. These CVP and SWP
25 energy generation facilities are located in the Trinity River and Central Valley
26 regions. CVP and SWP energy use primarily occurs in the Central Valley,
27 San Francisco Bay Area, Central Coast, and Southern California regions, as
28 defined below.

29 8.3.1 Central Valley Project and State Water Project Electric 30 Generation Facilities

31 Hydroelectric facilities are located at most of the CVP and SWP dams, as shown
32 on Figure 8.1. As water is released from the CVP and SWP reservoirs, the
33 generation facilities produce power that is used by the CVP and SWP pumping
34 plants, respectively. The SWP also generates hydroelectricity along the

1 California Aqueduct at energy recovery plants (California Department of Water
2 Resources [DWR] 2013a, 2013b). Between 1983 and 2013, the DWR owned a
3 portion of the Nevada Power Company's coal-fired Reid Gardner Unit 4
4 Powerplant. However, this agreement was not renewed upon expiration in 2013.

5 Power generated by the CVP is transmitted by Western Area Power
6 Administration (Western) to CVP facilities. Power that is excess to CVP needs is
7 marketed by Western to electric utilities, government and public installations, and
8 commercial "preference" customers who have 20-year contracts (Bureau of
9 Reclamation [Reclamation] 2012a). Power generated by the SWP is transmitted
10 by Pacific Gas & Electric Company, Southern California Edison, and California
11 Independent System Operator through other facilities (DWR 2013a, 2013b). The
12 SWP also markets energy in excess of the SWP demands to a utility and members
13 of the Western Systems Power Pool.

14 Hydropower is an important renewable energy and supplies between 14 and
15 28 percent of electricity used in California depending upon the water year type
16 (The California Energy Commission [CEC] 2014a; Hydropower Working Group
17 [HWG] 2014). In 1992, at the end of the 1987-to-1992 drought, hydropower
18 provided less than 11 percent of the electricity used in California. However,
19 during a wetter year (1995), hydropower provided approximately 28 percent of
20 electricity used in California. Between 1982 and 2012, approximately
21 33,927 gigawatt-hours were generated in California by hydropower, including
22 approximately 4,810 and 2,613 gigawatt-hours generated by the CVP and SWP,
23 respectively.

24 **8.3.1.1 CVP Hydroelectric Generation Facilities**

25 The CVP power facilities include 11 hydroelectric powerplants and have a total
26 maximum generating capacity of 2,076 megawatts, as presented in Table 8.1.
27 Hydrology can vary significantly from year to year, which then affects the
28 hydropower production. Typically, in an average water year, approximately
29 4,500 gigawatt-hours of energy is produced (Reclamation 2012a). Major factors
30 that influence powerplant operations include required downstream water releases,
31 electric system needs, and project use demand. The power generated from CVP
32 powerplants is dedicated to first meeting the requirements of the CVP facilities.
33 The remaining energy is marketed by Western to preferred customers in northern
34 California.

1 **Table 8.1 Central Valley Project Hydroelectric Powerplants**

Facility	Installed Capacity (Megawatts)
Trinity Powerplant	140
Lewiston Powerplant	0.35
Judge Francis Powerplant	154
Shasta Powerplant	710
Spring Creek Powerplant	180
Keswick Powerplant	117
Folsom Powerplant	207
Nimbus Powerplant	17
New Melones Powerplant	383
O'Neill Pump-Generating Plant	14.4
San Luis Powerplant (CVP portion of the William R. Gianelli/San Luis Pump-Generating Plant)	202

2 Sources: Reclamation 2013a, 2013b, 2013c, 2013d, 2013e, 2013f, 2013g, 2013h, 2013i,
3 2013j, 2013k, 2013l

4 **8.3.1.1.1 Trinity Division Powerplants**

5 The Trinity Powerplant is located along the Trinity River (Reclamation 2013b).
6 Primary releases of Trinity Dam are made through the powerplant. Trinity
7 County has first preference to the power from this plant.

8 The Lewiston Powerplant is located at the Lewiston Dam along the Trinity River
9 (Reclamation 2013c). It is operated in conjunction with the spillway gates to
10 maintain the minimum flow in the Trinity River downstream. The turbines are
11 usually set at maximum output with the spillway gates adjusted to regulate river
12 flow. The turbine capacity is less than the Trinity River minimum flow criteria,
13 as described in Chapter 5, Surface Water Resources and Water Supplies. The
14 Lewiston Powerplant provides power to the adjacent fish hatchery.

15 The Judge Francis Carr Powerplant is a peaking powerplant located on the Clear
16 Creek Tunnel (Reclamation 2013d). It generates power from water exported from
17 the Trinity River Basin. Similar to Trinity Powerplant, Trinity County has first
18 preference to the power benefit from this facility.

19 **8.3.1.1.2 Sacramento River Powerplants**

20 The Shasta Powerplant is a peaking powerplant located downstream of Shasta
21 Dam along the Sacramento River (Reclamation 2013a, 2013e). Until early 1990s,
22 concerns with downstream temperatures resulted in the bypasses of outflows
23 around the powerplant and lost hydropower generation. Installation of the Shasta
24 Temperature Control Device enabled operators to decide the depth of the
25 reservoir from which the water feeding into the penstocks originates. The system
26 has shown significant success in controlling the water temperature of powerplant

1 releases through Shasta Dam. The Shasta Powerplant also provides water supply
2 for the Livingston Stone National Fish Hatchery.

3 The Spring Creek Powerplant is a peaking plant located along Spring Creek, at
4 the foot of Spring Creek Debris Dam (Reclamation 2013f). Water discharged via
5 the Judge Francis Carr Powerplant flows into the Whiskeytown Reservoir and
6 then provides the source of water for the Spring Creek Powerplant generation.
7 Trinity County has first preference to the power benefits from Spring Creek
8 Powerplant. Water from Spring Creek Powerplant is discharged into Keswick
9 Reservoir. Releases from Spring Creek Powerplant also are operated to maintain
10 water quality in the Spring Creek arm of Keswick Reservoir.

11 The Keswick Powerplant is located at Keswick Dam along the Sacramento River
12 downstream of Shasta Dam and regulates the flows into the Sacramento River
13 from both Shasta Lake and Spring Creek releases and can be considered as a run-
14 of-the-river powerplant (Reclamation 2013g).

15 **8.3.1.1.3 American River Powerplants**

16 The Folsom Powerplant is a peaking powerplant located at Folsom Dam along the
17 American River (Reclamation 2013h). The Folsom Powerplant is operated in an
18 integrated manner with flood control operations at Folsom Lake. One of the
19 integrated operations is related to coordinating early flood control releases with
20 power generation. It also provides power for the pumping plant that supplies the
21 local domestic water supply. Folsom Powerplant supports voltage support for the
22 Sacramento Region during summer heavy load times.

23 The Nimbus Powerplant is located at Nimbus Dam along the American River,
24 downstream of Folsom Dam (Reclamation 2013i). The Nimbus Powerplant
25 regulates releases from Folsom Dam into the American River and can be
26 considered as a run-of-the river powerplant.

27 **8.3.1.1.4 Stanislaus River Powerplants**

28 The New Melones Powerplant is a peaking powerplant located along the
29 Stanislaus River (Reclamation 2013j). Primary reservoir releases are made
30 through the powerplant. This plant provides significant voltage support to the
31 Pacific Gas and Electric Company system during summer heavy load periods.

32 **8.3.1.1.5 San Luis Reservoir Powerplants**

33 The O'Neill Pump-Generating Plant is located on a channel that conveys water
34 between the Delta-Mendota Canal and the O'Neill Forebay (Reclamation 2013k).
35 This pump-generating plant only generates power when water is released from the
36 O'Neill Reservoir to the Delta-Mendota Canal. When water is conveyed from the
37 Delta-Mendota Canal to O'Neill Forebay, the units serve as pumps, not
38 hydroelectric generators. The generated power is used to support CVP pumping
39 and irrigation actions of the CVP.

40 The William R. Gianelli (San Luis) Pump-Generating Plant is located along the
41 along the western boundary of the O'Neill Forebay at the San Luis Dam

1 (Reclamation 2013l). This pump-generating plant is owned by the Federal
 2 government but is operated as a joint Federal-State facility that is shared by the
 3 CVP and SWP. Energy is generated when water is needed to be conveyed from
 4 San Luis Reservoir back into O’Neill Forebay for continued conveyance to the
 5 Delta-Mendota Canal. The plant is operated in pumping mode when water is
 6 moved from O’Neill Forebay to San Luis Reservoir for storage until heavier water
 7 demands develop. The generated power is used to offset CVP and SWP pumping
 8 loads. The powerplant can generate up to 424 megawatts, with the CVP share of
 9 the total capacity being 202 megawatts. This facility is operated and maintained
 10 by the State of California under an operation and maintenance agreement with
 11 Reclamation.

12 **8.3.1.2 SWP Electric Generation Facilities**

13 The SWP power facilities are operated primarily to provide power for the SWP
 14 facilities (DWR 2013b). The SWP power facilities and capacities are summarized
 15 in Table 8.2. The SWP has power contracts with electric utilities and the
 16 California Independent System Operator that act as exchange agreements with
 17 utility companies for transmission and power sales/purchases. In all years, the
 18 SWP must purchase additional power to meet pumping requirements.

19 **Table 8.2 State Water Project Hydroelectric Powerplants**

Facility	Installed Capacity (Megawatts)
Oroville Facilities	–
Hyatt Pumping-Generating Plant	645
Thermalito Diversion Dam Powerplant	3
Thermalito Pumping-Generating Plant	114
William R. Gianelli (San Luis) Pumping-Generating Plant (SWP share)	222
Alamo Powerplant	17
Mojave Siphon Powerplant	30
Devil Canyon Powerplant	276
Warne Powerplant	74

20 Source: DWR 2012

21 **8.3.1.2.1 Feather River Powerplants**

22 The Hyatt Pumping-Generating Plant is located on the channel between Lake
 23 Oroville and the Thermalito Diversion Pool (DWR 2007). Water in the
 24 Thermalito Diversion Pool can be pumped back to Lake Oroville to be released
 25 through the Hyatt Pumping-Generating Plant and generate more electricity;
 26 released through the Thermalito Diversion Dam Powerplant for delivery to the
 27 low flow channel upstream of Thermalito Forebay; or conveyed to Thermalito
 28 Forebay for subsequent release through the Thermalito Pumping-Generating
 29 Plant. The combined Hyatt Pumping-Generating Plant and Thermalito Pumping-
 30 Generating Plant generate approximately 2,200 gigawatt-hours of energy in a

1 median water year, while the 3 megawatts generated by Thermalito Diversion
2 Dam Powerplant adds another 24 gigawatt-hours per year (DWR 2013).

3 **8.3.1.2.2 San Luis Reservoir Powerplant**

4 As described above, the William R. Gianelli (San Luis) Pump-Generating Plant is
5 owned by the Federal government and is operated as a joint Federal-state facility
6 that is shared by the CVP and SWP. The SWP water flows from the California
7 Aqueduct into O'Neill Forebay downstream of the CVP's O'Neill Pump-
8 Generating Plant. The pump-generating plant is located along the western
9 boundary of the O'Neill Forebay at the San Luis Dam (DWR 2013a, 2013b,
10 Reclamation 2013l). Electricity is generated when water is transferred from
11 San Luis Reservoir back to O'Neill Forebay for continued conveyance in the
12 California Aqueduct. The plant acts as a pumping plant when water is transferred
13 from O'Neill Forebay to San Luis Reservoir. The generated power is used to
14 offset CVP and SWP pumping loads. The powerplant can generate up to
15 424 megawatts, with the SWP share of the total capacity being 222 megawatts.
16 This facility is operated and maintained by the State of California under an
17 operation and maintenance agreement with Reclamation.

18 **8.3.1.2.3 East Branch and West Branch Powerplants**

19 Downstream of the Antelope Valley, the California Aqueduct divides into the
20 East Branch and West Branch. The Alamo Powerplant, Mojave Powerplant, and
21 Devil Canyon Powerplant are located along the East Branch which conveys water
22 into San Bernardino County (DWR 2013a, 2013b). The Warne Powerplant is
23 located along the West Branch which conveys water into Los Angeles County.
24 The generation rates vary at these powerplants depending upon the amount of
25 water conveyed.

26 **8.3.1.2.4 Other Energy Resources for the State Water Project**

27 Other energy supplies have been obtained by DWR from other utilities and energy
28 marketers under agreements that allow DWR to buy, sell, or exchange energy on
29 a short-term hourly basis or a long-term multi-year basis (DWR 2013a, 2013b).

30 For example, DWR jointly developed the 1,254-megawatt Castaic Powerplant on
31 the West Branch with the Los Angeles Department of Water and Power (DWR
32 2012, 2013). The power is available to DWR at the Sylmar Substation.

33 DWR has a long-term purchase agreement with the Kings River Conservation
34 District for the approximately 400 million kilowatt-hours of energy from the
35 165-megawatt hydroelectric Pine Flat Powerplant (DWR 2012, 2013). DWR also
36 purchases energy from five hydroelectric plants with 30 megawatts of installed
37 capacity that are owned and operated by Metropolitan Water District of Southern
38 California (DWR 2012, 2013).

39 DWR also purchases energy under short-term purchase agreements from utilities
40 and energy marketers of the Western Systems Power Pool (DWR 2012, 2013). In
41 addition, the 1988 Coordination Agreement between DWR and Metropolitan

1 Water District of Southern Californian enables DWR to purchase and exchange
2 energy (DWR 2012, 2013).

3 **8.3.2 Other Hydroelectric Generation Facilities**

4 Hydroelectric facilities in addition to CVP and SWP hydroelectric facilities in the
5 study area are owned by investor-owned utility companies, such as Pacific Gas &
6 Electric Company and Southern California Edison; municipal agencies, such as
7 Sacramento Municipal Utility District; and by local and regional water agencies.
8 Some of the larger facilities outside the CVP and SWP systems and within or
9 adjacent to the study area include (DWR 2013d; 2013e; YCWA 2012):

- 10 • Pacific Gas and Electric Company
 - 11 – Helms Pumped Storage (1,200 megawatts) in Fresno County.
 - 12 – Pit System (320 megawatts) and McCloud-Pit System (370 megawatts,
13 total) in Shasta County.
 - 14 – Upper North Fork Feather River System (360 megawatts) in Plumas
15 County.
- 16 • Sacramento Municipal Utility District Upper American River Project System
17 (688 megawatts) in El Dorado County.
- 18 • City and County of San Francisco Hetch Hetchy Power System
19 (390 megawatts) in Tuolumne County.
- 20 • Southern California Edison
 - 21 – Big Creek System and Eastwood Pump Storage (approximately
22 1,000 megawatts) in Fresno and Madera counties.
 - 23 – Mammoth Pool Project (187 megawatts) in Fresno and Madera counties.
- 24 • Turlock Irrigation District and Modesto Irrigation District New Don Pedro
25 Project (203 megawatts) in Tuolumne County.
- 26 • Yuba County Water Agency Yuba River Development Project
27 (390 megawatts) in Yuba County.

28 **8.3.3 CVP and SWP System Energy Demands**

29 Power generation at CVP and SWP hydropower facilities fluctuates in response to
30 reservoir releases and conveyance flows. Reservoir releases are significantly
31 affected by hydrologic conditions, minimum stream flow requirements, flow
32 fluctuation restrictions, water quality requirements, and non-CVP and non-SWP
33 water rights which must be met prior to releases for CVP water service
34 contractors and SWP entitlement holders.

35 **8.3.3.1 CVP Power Generation and Energy Use**

36 The CVP power generation facilities were developed to meet CVP energy use
37 loads.

1 The majority of the energy used by the CVP is needed for pumping plants located
 2 in the Delta, at San Luis Reservoir, and along the Delta-Mendota Canal and San
 3 Luis Canal portion of the California Aqueduct. Table 8.3 presents historical
 4 average annual CVP hydropower generation and use. Monthly power generation
 5 pattern follows seasonal reservoir releases, with peaks during the irrigation
 6 season, as shown on Figure 8.2. The hydropower generation between January and
 7 June decreases after 2007 because the potential to convey CVP water across the
 8 Delta during this period was reduced after 2007 to reduce reverse flows in Old
 9 and Middle River, in accordance with legal decisions and subsequently through
 10 implementation of the biological opinions.

11 **Table 8.3 Hydropower Generation and Energy Use by the CVP**

Calendar Year	Water Year Type ^a	Net CVP Hydropower Generation (Gigawatt-hours)	Energy Used CVP Facilities (Gigawatt-hours)
2000	AN	5,667	–
2001	D	4,107	957
2002	D	4,322	1,090
2003	AN	5,483	1,170
2004	BN	5,186	1,172
2005	AN	4,599	1,150
2006	W	7,284	1,037
2007	D	4,276	1,064
2008	C	3,659	923
2009	D	3,560	803
2010	BN	3,624	1,001
2011	W	5,469	1,276
2012	BN	4,849	990

12 Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008a-l, 2009a-l,
 13 2010a-l, 2011a-l, 2012b-m.

14 Note:

15 a. Water Year Type based on Sacramento Valley 40-30-30 Index, as described in
 16 Chapter 5, Surface Water Resources and Water Supplies.

17 Recently, the California Public Utilities Commission (CPUC) evaluated the
 18 “energy intensity” of several types of water supplies (CPUC 2010). The energy
 19 intensity is defined as the average amount of energy required to convey and/or
 20 treat water on a unit basis, such as per 1 acre-foot. Substantial quantities of
 21 energy are required by the CVP pumping plants to convey large amounts of water
 22 over long distances with significant changes in elevation. The study indicated
 23 that the energy intensity of CVP water delivered to users downstream of San Luis
 24 Reservoir ranged from 0.292 megawatt-hours/acre-foot for users along the Delta-
 25 Mendota Canal; to 0.428 megawatt-hours/acre-foot for users along the San Luis

1 Canal/California Aqueduct; to 0.870 megawatt-hours/acre-foot in San Benito and
2 Santa Clara counties.

3 **8.3.3.2 SWP Power Generation and Energy Use**

4 The SWP power generation facilities also were developed to meet SWP energy
5 use loads. The majority of the energy used by the SWP is needed for pumping
6 plants located in the Delta, at the San Luis Reservoir, and along the California
7 Aqueduct. Table 8.4 presents historical average annual SWP hydropower
8 generation and use. Monthly power generation pattern follows seasonal reservoir
9 releases, with peaks during the irrigation season, as shown on Figure 8.3.
10 Table 8.4 presents SWP power use and generation values for the period 2001
11 through 2012 that indicate the SWP generates approximately 63 percent of the
12 energy needed for deliveries (DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008,
13 2012a, 2012b, 2013). The energy generation and purchases and energy use
14 decreases after 2007 because the potential to convey SWP water across the Delta
15 was reduced in accordance with legal decisions and subsequently through
16 implementation of the biological opinions.

17 **Table 8.4 Hydropower Generation and Energy Use by the State Water Project**

Calendar Year	Water Year Type ^a	SWP Hydropower Generation (Gigawatt-hour)	Energy Acquired through Long-term Agreements and Purchases (Gigawatt-hour)	Energy Used by SWP Facilities (Gigawatt-hour)
2000	AN	6,372	5,741	9,190
2001	D	4,295	4,660	6,656
2002	D	4,953	4,610	8,394
2003	AN	5,511	4,668	9,175
2004	BN	6,056	4,429	9,868
2005	AN	5,151	5,367	8,308
2006	W	7,056	5,811	9,158
2007	D	5,577	6,642	9,773
2008	C	3,541	4,603	5,745
2009	D	4,295	4,660	6,656
2010	BN	4,953	4,610	8,394
2011	W	5,511	4,668	9,175
2012	BN	6,056	4,429	9,868

18 Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013

19 Note:

20 a. Water Year Type based on Sacramento Valley 40-30-30 Index, as described in
21 Chapter 5, Surface Water Resources and Water Supplies.

1 The energy intensity values calculated by the California Public Utilities
2 Commission for the SWP ranged from 1.128 megawatt-hours/acre-foot for water
3 users along the South Bay Aqueduct; to 1.157 megawatt-hours/acre-foot for water
4 users in Kern County; to 4,644 megawatt-hours/acre-foot for water users at the
5 terminal end of the East Branch Extension of the California Aqueduct (CPUC
6 2010).

7 **8.3.4 Energy Demands for Groundwater Pumping**

8 Groundwater provided approximately 37 percent of the state’s agricultural,
9 municipal, and industrial water supply of the average water needs between 1998
10 and 2010, or approximately 16 million acre-feet/year of groundwater (DWR
11 2013). The use of groundwater varies regionally throughout the State. For
12 example in some areas, groundwater provides less than 10 percent to more than
13 90 percent, as described in Chapter 7, Groundwater Resources and Groundwater
14 Quality.

15 The amount of energy used statewide to pump groundwater is not well quantified
16 (CPUC 2010). The California Public Utilities Commission estimated
17 groundwater energy use by hydrologic region and by type of use to evaluate the
18 water and energy relationships. Groundwater pumping estimates were calculated
19 in each DWR Planning Areas for agricultural and municipal water demands.
20 Groundwater energy use was estimated based upon assumptions of well depths
21 and pump efficiencies. Some wells use natural gas for individual engines instead
22 of electricity; however, the amount of natural gas pumping versus electric
23 pumping is generally unknown. In 2010, average groundwater use in the state
24 was approximately 14.7 million acre-feet, or 36 percent of total agricultural,
25 municipal, and industrial water supplies (DWR 2013). The California Public
26 Utilities Commission estimated that in 2010, statewide groundwater pumping
27 accounted for more electricity use between May and August than the total
28 electricity use by the CVP and SWP during that time period (CPUC 2010). Over
29 the entire year, it was estimated that groundwater pumping used approximately
30 10 percent more electricity than the SWP and approximately 5 percent less than
31 the CVP and SWP combined.

32 **8.4 Impact Analysis**

33 This section describes the potential mechanisms for change in energy generation
34 and analytical methods; results of the impact analyses; potential mitigation
35 measures; and cumulative effects.

36 **8.4.1 Potential Mechanisms for Change and Analytical Tools**

37 The environmental consequences assessment considers changes in energy
38 resources conditions related to changes in CVP and SWP operations under the
39 alternatives as compared to the No Action Alternative and Second Basis of
40 Comparison.

1 **8.4.1.1 Changes in Energy Resources Related to CVP and SWP Water**
 2 **Users**

3 Energy generation is limited on a monthly bases by the average power capacity of
 4 each generation facility based upon reservoir elevations and water release
 5 patterns. The majority of the CVP and SWP energy use is for the conveyance
 6 facilities located in the Delta and south of the Delta. Energy use would change
 7 with changes in CVP and SWP deliveries.

8 Reservoir elevations and flow patterns through pumping facilities output from the
 9 CalSim II model (see Chapter 5, Surface Water Resources and Water Supplies)
 10 are used with LTGen and SWP Power tools, as described in Appendix 8A, Power
 11 Model Documentation. These tools estimate average annual peaking power
 12 capacity, energy use, and energy generation at CVP and SWP facilities,
 13 respectively. The tools estimate average annual energy generation and use and
 14 net generation. When net generation values are negative, the CVP or SWP would
 15 purchase power from other generation facilities. When net generation values are
 16 positive, power would be available for use by non-CVP and SWP electricity
 17 users.

18 When CVP and SWP water deliveries change, water users would be anticipated
 19 do change their use of groundwater, recycled water, and/or desalinated water, as
 20 described in Chapter 5, Surface Water Resources and Water Supplies, Chapter 12,
 21 Agricultural Resources, and Chapter 19, Socioeconomics. Specific responses by
 22 water users to changes in CVP and SWP water deliveries are not known; and
 23 therefore, energy use for the alternate water supplies cannot be quantified in this
 24 analysis. It is not known whether the net change in energy use for the CVP and
 25 SWP would or would not be similar to the net change in energy use for alternate
 26 water supplies (e.g., groundwater pumping, water treatment, water conveyance).

27 **8.4.1.2 Effect Related to Cross Delta Water Transfers**

28 Historically water transfer programs have been developed on an annual basis.
 29 The demand for water transfers is dependent upon the availability of water
 30 supplies to meet water demands. Water transfer transactions have increased over
 31 time as CVP and SWP water supply availability has decreased, especially during
 32 drier water years. Water transfers using CVP and SWP Delta pumping plants and
 33 south of Delta canals generally occur when there is unused capacity in these
 34 facilities, especially in drier years.

35 Parties seeking water transfers generally acquire water from sellers who have
 36 available surface water who can make the water available through releasing
 37 previously stored water, pump groundwater instead of using surface water
 38 (groundwater substitution); idle crops; or substitute crops that uses less water in
 39 order to reduce normal consumptive use of surface water.

40 Changes in net energy generation could occur statewide during cross Delta water
 41 transfers due to following reasons:

- 42 • Changed reservoir release patterns at CVP and SWP reservoirs
- 43 • Changed conveyance patterns at the CVP and SWP pumping plants

- 1 • Increased groundwater pumping in the seller’s service area if groundwater
2 substitution is used to make the transferred water available
- 3 • Reductions in groundwater pumping in the purchaser’s service area if less
4 groundwater would be used due to the water transfer

5 Reclamation recently prepared a long-term regional water transfer environmental
6 document which evaluated potential changes in surface water conditions related to
7 water transfer actions (Reclamation 2014c). Results from this analysis were used
8 to inform the impact assessment of potential effects of water transfers under the
9 alternatives as compared to the No Action Alternative and the Second Basis of
10 Comparison.

11 **8.4.2 Conditions in Year 2030 without Implementation of** 12 **Alternatives 1 through 5**

13 The impact analysis in this EIS is based upon the comparison of the alternatives to
14 the No Action Alternative and the Second Basis of Comparison in the Year 2030.
15 Changes that would occur over the next 15 years without implementation of the
16 alternatives are not analyzed in this EIS. However, the changes that are assumed
17 to occur by 2030 under the No Action Alternative and the Second Basis of
18 Comparison are summarized in this section.

19 Many of the changed conditions would occur in the same manner under both the
20 No Action Alternative and the Second Basis of Comparison. Other future
21 conditions would be different under the No Action Alternative as compared to the
22 Second Basis of Comparison due to the implementation of the 2008 U.S. Fish and
23 Wildlife Service (USFWS) Biological Opinion (BO) and 2009 National Marine
24 Fisheries Service (NMFS) BO under the No Action Alternative.

25 This section of Chapter 8 provides qualitative projections of the No Action
26 Alternative as compared to existing conditions described under the Affected
27 Environment; and qualitative projections of the Second Basis of Comparison as
28 compared to “recent historical conditions.” Recent historical conditions are not
29 the same as existing conditions which include implementation of the 2008
30 USFWS BO and 2009 NMFS BO; and consider changes that would have occurred
31 without implementation of the 2008 USFWS BO and the 2009 NMFS BO.

32 **8.4.2.1 Common Changes in Conditions under the No Action Alternative** 33 **and Second Basis of Comparison**

34 Conditions in 2030 would be different than existing conditions due to:

- 35 • Climate change and sea-level rise
- 36 • General plan development throughout California, including increased water
37 demands in portions of Sacramento Valley
- 38 • Implementation of reasonable and foreseeable water resources management
39 projects to provide water supplies

40 These changes would result in a decline of the long-term average CVP and SWP
41 water supply deliveries by 2030 as compared to recent historical long-term

1 average deliveries, as described in Chapter 5, Surface Water Resources and Water
2 Supplies.

3 **8.4.2.1.1 Changes in Conditions due to Climate Change and Sea Level Rise**

4 It is anticipated that climate change would result in more short-duration high-
5 rainfall events and less snowpack in the winter and early spring months. The
6 reservoirs would be full more frequently by the end of April or May by 2030 than
7 in recent historical conditions. However, as the water is released in the spring,
8 there would be less snowpack to refill the reservoirs. This condition would
9 reduce reservoir storage and potential hydropower generation in the summer.
10 These conditions would occur for all reservoirs in the California foothills and
11 mountains, including non-CVP and SWP reservoirs.

12 **8.4.2.1.2 General Plan Development in California**

13 Counties and cities throughout California have adopted general plans which
14 identify land use classifications including those for municipal and industrial uses
15 and those for agricultural uses. Population projections from those general plan
16 evaluations are provided to the State Department of Finance and are used to
17 project future water needs and the potential for conversion of existing
18 undeveloped lands and agricultural lands. Many of the existing general plans for
19 counties with municipal areas recently have been modified to include land use and
20 population projections through 2030. The No Action Alternative and the Second
21 Basis of Comparison assume that land uses will develop through 2030 in
22 accordance with existing general plans.

23 Statewide the increased population would result in increased energy demands.
24 Under the No Action Alternative and Second Basis of Comparison, it is assumed
25 that energy demands would be met on a long-term basis and in dry and critical dry
26 years using a combination of conservation, increased efficiency in energy
27 generation and transmission, and renewable energy sources.

28 **8.4.2.1.3 Reasonable and Foreseeable Water Resources Management** 29 **Projects**

30 The No Action Alternative and the Second Basis of Comparison assumes
31 completion of water resources management and environmental restoration
32 projects that would have occurred without implementation of the 2008 USFWS
33 BO and 2009 NMFS BO by 2030, as described in Chapter 3, Description of
34 Alternatives. Many of these future actions involve additional water treatment and
35 conveyance facilities that would change statewide energy demands.

36 **8.4.2.2 Changes in Conditions under the No Action Alternative**

37 Due to the climate change and sea level rise and increased water demands in the
38 Sacramento Valley, CVP and SWP energy generation would be less in the
39 summer months when energy demand is high for water conveyance and air
40 conditioning equipment throughout the state. It is also anticipated that water
41 deliveries would be less in 2030 than under recent historical conditions; and,

1 therefore, energy use for CVP and SWP water conveyance facilities would be
2 less.

3 **8.4.2.3 Changes in Conditions under the Second Basis of Comparison**

4 Due to the climate change and sea level rise and increased water demands in the
5 Sacramento Valley, CVP and SWP energy generation would be less in the
6 summer months when energy demand is high for water conveyance and air
7 conditioning equipment throughout the State. It is also anticipated that water
8 deliveries would be less in 2030 than under recent historical conditions; and,
9 therefore, energy use for CVP and SWP water conveyance facilities would be
10 less.

11 As described in Chapter 5, Surface Water Resources and Water Supplies, the
12 availability of CVP and SWP water supplies would be greater under the Second
13 Basis of Comparison as compared to the No Action Alternative because CVP and
14 SWP water operations would not include requirements of the 2008 USFWS BO
15 and 2009 NMFS BO. Therefore, CVP and SWP energy use would be greater, and
16 possibly groundwater pumping use would be less, under the Second Basis of
17 Comparison as compared to the No Action Alternative.

18 **8.4.3 Evaluation of Alternatives**

19 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1
20 through 5 have been compared to the No Action Alternative; and the No Action
21 Alternative and Alternatives 1 through 5 have been compared to the Second Basis
22 of Comparison.

23 During review of the numerical modeling analyses used in this EIS, an error was
24 determined in the CalSim II model assumptions related to the Stanislaus River
25 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
26 model runs. Appendix 5C includes a comparison of the CalSim II model run
27 results presented in this chapter and CalSim II model run results with the error
28 corrected. Appendix 5C also includes a discussion of changes in the comparison
29 of groundwater conditions for the following alternative analyses.

- 30 • No Action Alternative compared to the Second Basis of Comparison
- 31 • Alternative 1 compared to the No Action Alternative
- 32 • Alternative 3 compared to the Second Basis of Comparison
- 33 • Alternative 5 compared to the Second Basis of Comparison

34 **8.4.3.1 No Action Alternative**

35 The No Action Alternative is compared to the Second Basis of Comparison.

36 **8.4.3.1.1 Potential Changes in Energy Resources Related to CVP and SWP**
37 **Water Users**

38 Changes in CVP and SWP operations under the No Action Alternative as
39 compared to the Second Basis of Comparison would result in a reduction of CVP
40 and SWP water deliveries to areas located south of the Delta; and therefore,

1 annual energy use would result in changes in CVP and SWP energy resources, as
 2 summarized in Table 8.5. The CVP net generation over the long-term conditions
 3 (averaged over the 81-year model simulation period, as described in Chapter 5)
 4 and in dry and critical dry years would be similar (within 5 percent) under the
 5 No Action Alternative and the Second Basis of Comparison. The SWP net
 6 generation would be reduced by 29 percent over the long-term condition and by
 7 37 percent in dry and critical dry years. Changes in monthly energy use are
 8 presented in Appendix 8A, Power Model Documentation.

9 **Table 8.5 Energy Generation, Energy Use, and Net Generation under the No Action**
 10 **Alternative as Compared to the Second Basis of Comparison**

Project	Water Year	Energy (Gigawatt-hours)	No Action Alternative (NAA)	Second Basis of Comparison (SBC)	Changes between NAA and SBC
CVP Facilities	Long-term Average	Energy Generation	4,558	4,604	-46
		Energy Use	1,113	1,289	-177
		Net Generation	3,445	3,315	131
	Dry and Critical Water Years	Energy Generation	2,696	2,773	-77
		Energy Use	699	773	-75
		Net Generation	1,997	2,000	-2
SWP Facilities	Long-term Average	Energy Generation	4,202	4,721	-520
		Energy Use	7,798	9,802	-2,004
		Net Generation	-3,597	-5,081	1,484
	Dry and Critical Water Years	Energy Generation	1,914	2,494	-579
		Energy Use	3,929	5,686	-1,757
		Net Generation	-2,015	-3,192	1,177

11 Under the No Action Alternative as compared to the Second Basis of
 12 Comparison, CVP and SWP water deliveries would be less and it is anticipated

1 that CVP and SWP water users would use more alternate water supplies. These
2 alternate water supplies would require energy. Specific changes in energy use
3 would depend upon specific responses by water users, and are not known at this
4 time. Therefore, it is uncertain whether the increased regional and local water
5 supply energy requirements would be similar to the reduced energy use by the
6 CVP and SWP operations in 2030 under the No Action Alternative as compared
7 to the Second Basis of Comparison. For the purposes of this analysis, a worse-
8 case scenario is assumed, and that total energy use by CVP and SWP water users
9 could be higher under the No Action Alternative than under the Second Basis of
10 Comparison.

11 **8.4.3.1.2 Effects Related to Cross Delta Water Transfers**

12 Potential effects to energy resources could be similar to those identified in a
13 recent environmental analysis conducted by Reclamation for long-term water
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).
15 Potential effects to energy resources were identified as changes in power
16 generation patterns at the reservoirs due to changes in reservoir release patterns
17 and surface water elevation patterns. These potential changes were not
18 considered to be substantial because the total amount of electricity generated
19 would be similar and the power loss would be minimal due to changes in release
20 patterns. For the purposes of this EIS, it is anticipated that similar conditions
21 would occur during implementation of cross Delta water transfers under the
22 No Action Alternative and the Second Basis of Comparison.

23 Groundwater pumping in areas that purchase the transferred water could be
24 reduced if additional surface water is provided. However, if the transferred water
25 is used to meet water demands that would not have been met (e.g., crops that had
26 been idled), groundwater pumping would be similar with or without water
27 transfers.

28 Under the No Action Alternative, the timing of cross Delta water transfers would
29 be limited to July through September and include annual volumetric limits, in
30 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second
31 Basis of Comparison, water could be transferred throughout the year without an
32 annual volumetric limit. Overall, the potential for cross Delta water transfers
33 would be less under the No Action Alternative than under the Second Basis of
34 Comparison; however, energy resources conditions would be similar.

35 **8.4.3.2 Alternative 1**

36 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is
37 compared to the No Action Alternative and the Second Basis of Comparison.
38 However, because energy resource conditions under Alternative 1 are identical to
39 energy resource conditions under the Second Basis of Comparison; Alternative 1
40 is only compared to the No Action Alternative.

1 **8.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

2 *Potential Changes in Energy Resources Related to CVP and SWP Water Users*

3 Changes in CVP and SWP operations under Alternative 1 as compared to the No
 4 Action Alternative would result in an increase of CVP and SWP water deliveries
 5 to areas located south of the Delta; and therefore, annual energy use would result
 6 in changes in CVP and SWP energy resources, as summarized in Table 8.6. The
 7 CVP net generation over the long-term conditions and in dry and critical dry years
 8 would be similar under Alternative 1 as compared to the No Action Alternative.
 9 The SWP net generation would be increased by 41 percent over the long-term
 10 condition and by 58 percent in dry and critical dry years. Changes in monthly
 11 energy use are presented in Appendix 8A, Power Model Documentation.

12 **Table 8.6 Energy Generation, Energy Use, and Net Generation under Alternative 1**
 13 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 1	No Action Alternative (NAA)	Changes between Alternative 1 and NAA
CVP Facilities	Long-term Average	Energy Generation	4,604	4,558	46
		Energy Use	1,289	1,113	177
		Net Generation	3,315	3,445	-131
	Dry and Critical Water Years	Energy Generation	2,773	2,696	77
		Energy Use	773	699	75
		Net Generation	2,000	1,997	2
SWP Facilities	Long-term Average	Energy Generation	4,721	4,202	520
		Energy Use	9,802	7,798	2,004
		Net Generation	-5,081	-3,597	-1,484
	Dry and Critical Water Years	Energy Generation	2,494	1,914	579
		Energy Use	5,686	3,929	1,757
		Net Generation	-3,192	-2,015	-1,177

1 Under Alternative 1 as compared to the No Action Alternative, CVP and SWP
2 water deliveries would be increased and it is anticipated that CVP and SWP water
3 users would use less alternate water supplies. Specific changes in energy use
4 would depend upon specific responses by water users, and are not known at this
5 time. Therefore, it is uncertain whether the decreased regional and local water
6 supply energy requirements would be similar to the increased energy use by the
7 CVP and SWP operations in 2030 under Alternative 1 as compared to the No
8 Action Alternative. For the purposes of this analysis, a worse-case scenario is
9 assumed, and that total energy use by CVP and SWP water users could be lower
10 under Alternative 1 as compared to the No Action Alternative.

11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a
13 recent environmental analysis conducted by Reclamation for long-term water
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
15 described above under the No Action Alternative compared to the Second Basis
16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy
17 conditions would occur during implementation of cross Delta water transfers
18 under Alternative 1 and the No Action Alternative.

19 Under Alternative 1, water could be transferred throughout the year without an
20 annual volumetric limit. Under the No Action Alternative, the timing of cross
21 Delta water transfers would be limited to July through September and include
22 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
23 NMFS BO. Overall, the potential for cross Delta water transfers would be
24 increased under Alternative 1 as compared to the No Action Alternative; however,
25 energy resources conditions would be similar.

26 **8.4.3.2 Alternative 1 Compared to the Second Basis of Comparison**

27 Alternative 1 is identical to the Second Basis of Comparison.

28 **8.4.3.3 Alternative 2**

29 The CVP and SWP operations under Alternative 2 are identical to the CVP and
30 SWP operations under the No Action Alternative; therefore, the energy resources
31 conditions under Alternative 2 is only compared to the Second Basis of
32 Comparison.

33 **8.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

34 Changes to energy resources under Alternatives 2 as compared to the Second
35 Basis of Comparison would be the same as the impacts described in
36 Section 8.4.3.1, No Action Alternative.

37 **8.4.3.4 Alternative 3**

38 CVP and SWP operations under Alternative 3 are similar to the Second Basis of
39 Comparison with modified Old and Middle River flow criteria and New Melones
40 Reservoir operations. Alternative 3 would include changed water demands for
41 American River water supplies as compared to the No Action Alternative or

1 Second Basis of Comparison. Alternative 3 would provide water supplies of up to
 2 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and
 3 15 TAF/year under a Warren Act Contract for El Dorado County Water Agency.
 4 These demands are not included in the analysis presented in this section of the
 5 EIS. A sensitivity analysis comparing the results of the analysis with and without
 6 these demands is presented in Appendix 5B of this EIS.

7 **8.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

8 *Potential Changes in Energy Resources to CVP and SWP Water Users*

9 Changes in CVP and SWP operations under Alternative 3 as compared to the No
 10 Action Alternative would result in changes in CVP and SWP energy resources, as
 11 summarized in Table 8.7. The CVP net generation over the long-term conditions
 12 and in dry and critical dry years would be similar under Alternative 3 as compared
 13 to the No Action Alternative. The SWP net generation would be increased by
 14 27 percent over the long-term condition and by 16 percent in dry and critical dry
 15 years. Changes in monthly energy use are presented in Appendix 8A, Power
 16 Model Documentation.

17 **Table 8.7 Energy Generation, Energy Use, and Net Generation under Alternative 3**
 18 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	No Action Alternative (NAA)	Changes between Alternative 3 and NAA
CVP Facilities	Long-term Average	Energy Generation	4,582	4,558	24
		Energy Use	1,238	1,113	125
		Net Generation	3,344	3,445	-102
	Dry and Critical Water Years	Energy Generation	2,798	2,696	102
		Energy Use	715	699	16
		Net Generation	2,084	1,997	86
SWP Facilities	Long-term Average	Energy Generation	4,537	4,202	335
		Energy Use	9,115	7,798	1,317
		Net Generation	-4,578	-3,597	-981

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	No Action Alternative (NAA)	Changes between Alternative 3 and NAA
	Dry and Critical Water Years	Energy Generation	2,128	1,914	214
		Energy Use	4,455	3,929	526
		Net Generation	-2,327	-2,015	-312

1 Under Alternative 3 as compared to the No Action Alternative, CVP and SWP
 2 water deliveries would be increased and it is anticipated that CVP and SWP water
 3 users would use less alternate water supplies. Specific changes in energy use
 4 would depend upon specific responses by water users, and are not known at this
 5 time. Therefore, it is uncertain whether the decreased regional and local water
 6 supply energy requirements would be similar to the increased energy use by the
 7 CVP and SWP operations in 2030 under Alternative 3 as compared to the No
 8 Action Alternative. For the purposes of this analysis, a worse-case scenario is
 9 assumed, and that total energy use by CVP and SWP water users could be lower
 10 under Alternative 3 as compared to the No Action Alternative.

11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a
 13 recent environmental analysis conducted by Reclamation for long-term water
 14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
 15 described above under the No Action Alternative compared to the Second Basis
 16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy
 17 conditions would occur during implementation of cross Delta water transfers
 18 under Alternative 3 and the No Action Alternative.

19 Under Alternative 3, water could be transferred throughout the year without an
 20 annual volumetric limit. Under the No Action Alternative, the timing of cross
 21 Delta water transfers would be limited to July through September and include
 22 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
 23 NMFS BO. Overall, the potential for cross Delta water transfers would be
 24 increased under Alternative 3 as compared to the No Action Alternative; however,
 25 energy resources conditions would be similar.

26 **8.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

27 *Potential Changes in Energy Resources to CVP and SWP Water Users*

28 Changes in CVP and SWP operations under Alternative 3 as compared to the
 29 Second Basis of Comparison would result in changes in CVP and SWP energy
 30 resources, as summarized in Table 8.8. The CVP net generation over the long-

1 term conditions and in dry and critical dry years would be similar under
 2 Alternative 3 as compared to the Second Basis of Comparison. The SWP net
 3 generation would be reduced by 10 percent over the long-term condition and by
 4 58 percent in dry and critical dry years. Changes in monthly energy use are
 5 presented in Appendix 8A, Power Model Documentation.

6 **Table 8.8 Energy Generation, Energy Use, and Net Generation under Alternative 3**
 7 **as Compared to the Second Basis of Comparison**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	Second Basis of Comparison (SBC)	Changes between Alternative 3 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,582	4,604	-22
		Energy Use	1,238	1,289	-51
		Net Generation	3,344	3,315	29
	Dry and Critical Water Years	Energy Generation	2,798	2,773	25
		Energy Use	715	773	-59
		Net Generation	2,084	2,000	84
SWP Facilities	Long-term Average	Energy Generation	4,537	4,721	-184
		Energy Use	9,115	9,802	-687
		Net Generation	-4,578	-5,081	503
	Dry and Critical Water Years	Energy Generation	2,128	2,494	-366
		Energy Use	4,455	5,686	-1,230
		Net Generation	-2,327	-3,192	865

8 Under Alternative 3 as compared to the Second Basis of Comparison, CVP and
 9 SWP water deliveries would be decreased and it is anticipated that CVP and SWP
 10 water users would use more alternate water supplies. Specific changes in energy
 11 use would depend upon specific responses by water users, and are not known at
 12 this time. Therefore, it is uncertain whether the increased regional and local water
 13 supply energy requirements would be similar to the decreased energy use by the
 14 CVP and SWP operations in 2030 under Alternative 3 as compared to the Second
 15 Basis of Comparison. For the purposes of this analysis, a worse-case scenario is

1 assumed, and that total energy use by CVP and SWP water users could be higher
2 under Alternative 3 as compared to the Second Basis of Comparison.

3 *Effects Related to Cross Delta Water Transfers*

4 Potential effects to energy resources could be similar to those identified in a
5 recent environmental analysis conducted by Reclamation for long-term water
6 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
7 described above under the No Action Alternative compared to the Second Basis
8 of Comparison. For the purposes of this EIS, it is anticipated that similar energy
9 conditions would occur during implementation of cross Delta water transfers
10 under Alternative 3 as compared to the Second Basis of Comparison.

11 Under Alternative 3 and the Second Basis of Comparison, water could be
12 transferred throughout the year without an annual volumetric limit. Overall, the
13 potential for cross Delta water transfers would be similar under Alternative 3 as
14 compared to the Second Basis of Comparison; and energy resources conditions
15 would be similar.

16 **8.4.3.5 Alternative 4**

17 Energy resources under Alternative 4 would be identical to the conditions under
18 the Second Basis of Comparison. Alternative 4 is only compared to the No
19 Action Alternative.

20 **8.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

21 Changes in energy resources under Alternative 4 as compared to the No Action
22 Alternative would be the same as the impacts described in Section 8.4.3.2.1,
23 Alternative 1 Compared to the No Action Alternative.

24 **8.4.3.6 Alternative 5**

25 The CVP and SWP operations under Alternative 5 are similar to the No Action
26 Alternative with modified Old and Middle River flow criteria and New Melones
27 Reservoir operations. Alternative 5 would include changed water demands for
28 American River water supplies as compared to the No Action Alternative or
29 Second Basis of Comparison. Alternative 5 would provide water supplies of up to
30 17 TAF/year under a Warren Act Contract for El Dorado Irrigation District and
31 15 TAF/year under a Warren Act Contract for El Dorado County Water Agency.
32 These demands are not included in the analysis presented in this section of the
33 EIS. A sensitivity analysis comparing the results of the analysis with and without
34 these demands is presented in Appendix 5B of this EIS.

35 **8.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

36 *Potential Changes in Energy Resources to CVP and SWP Water Users*

37 Changes in CVP and SWP operations under Alternative 5 as compared to the No
38 Action Alternative would result in changes in CVP and SWP energy resources, as
39 summarized in Table 8.9. The CVP and SWP net generation over the long-term
40 conditions and in dry and critical dry years would be similar under Alternative 5

1 as compared to the No Action Alternative. Changes in monthly energy use are
 2 presented in Appendix 8A, Power Model Documentation.

3 **Table 8.9 Energy Generation, Energy Use, and Net Generation under Alternative 5**
 4 **as Compared to the No Action Alternative**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 3	Second Basis of Comparison (SBC)	Changes between Alternative 3 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,552	4,558	-6
		Energy Use	1,110	1,113	-3
		Net Generation	3,442	3,445	-4
	Dry and Critical Water Years	Energy Generation	2,684	2,696	-12
		Energy Use	699	699	0
		Net Generation	1,986	1,997	-11
SWP Facilities	Long-term Average	Energy Generation	4,191	4,202	-11
		Energy Use	7,732	7,798	-66
		Net Generation	-3,541	-3,597	56
	Dry and Critical Water Years	Energy Generation	1,904	1,914	-10
		Energy Use	3,841	3,929	-88
		Net Generation	-1,937	-2,015	78

5 Under Alternative 5 as compared to the No Action Alternative, CVP and SWP
 6 water deliveries would be similar, and it is anticipated that CVP and SWP water
 7 users would use similar alternate water supplies. Therefore, for the purposes of
 8 this analysis, it is assumed that total energy use by CVP and SWP water users
 9 could be similar under Alternative 5 as compared to the No Action Alternative.

10 *Effects Related to Cross Delta Water Transfers*

11 Potential effects to energy resources could be similar to those identified in a
 12 recent environmental analysis conducted by Reclamation for long-term water
 13 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
 14 described above under the No Action Alternative compared to the Second Basis

1 of Comparison. For the purposes of this EIS, it is anticipated that similar energy
 2 conditions would occur during implementation of cross Delta water transfers
 3 under Alternative 5 and the No Action Alternative.

4 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
 5 water transfers would be limited to July through September and include annual
 6 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
 7 Overall, the potential for cross Delta water transfers would be similar under
 8 Alternative 5 as compared to the No Action Alternative; and energy resources
 9 conditions would be similar.

10 **8.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

11 *Potential Changes in Energy Resources to CVP and SWP Water Users*

12 Changes in CVP and SWP operations under Alternative 5 as compared to the
 13 Second Basis of Comparison would result in changes in CVP and SWP energy
 14 resources, as summarized in Table 8.10. The CVP net generation over the long-
 15 term conditions and in dry and critical dry years would be similar under
 16 Alternative 3 as compared to the Second Basis of Comparison. The SWP net
 17 generation would be reduced by 30 percent over the long-term condition and by
 18 39 percent in dry and critical dry years. Changes in monthly energy use are
 19 presented in Appendix 8A, Power Model Documentation.

20 **Table 8.10 Energy Generation, Energy Use, and Net Generation under Alternative 5**
 21 **as Compared to the Second Basis of Comparison**

Project	Water Year	Energy (Gigawatt-hours)	Alternative 5	Second Basis of Comparison (SBC)	Changes between Alternative 5 and SBC
CVP Facilities	Long-term Average	Energy Generation	4,552	4,604	-52
		Energy Use	1,110	1,289	-179
		Net Generation	3,442	3,315	127
	Dry and Critical Water Years	Energy Generation	2,684	2,773	-89
		Energy Use	699	773	-75
		Net Generation	1,986	2,000	-14
SWP Facilities	Long-term Average	Energy Generation	4,191	4,721	-530
		Energy Use	7,732	9,802	-2,070
		Net Generation	-3,541	-5,081	1,540

Project	Water Year	Energy (Gigawatt-hours)	Alternative 5	Second Basis of Comparison (SBC)	Changes between Alternative 5 and SBC
	Dry and Critical Water Years	Energy Generation	1,904	2,494	-590
		Energy Use	3,841	5,686	-1,845

1 Under Alternative 5 as compared to the Second Basis of Comparison, CVP and
2 SWP water deliveries would be decreased and it is anticipated that CVP and SWP
3 water users would use more alternate water supplies. Specific changes in energy
4 use would depend upon specific responses by water users, and are not known at
5 this time. Therefore, it is uncertain whether the increased regional and local water
6 supply energy requirements would be similar to the decreased energy use by the
7 CVP and SWP operations in 2030 under Alternative 5 as compared to the Second
8 Basis of Comparison. For the purposes of this analysis, a worse-case scenario is
9 assumed, and that total energy use by CVP and SWP water users could be higher
10 under Alternative 5 as compared to the Second Basis of Comparison.

11 *Effects Related to Cross Delta Water Transfers*

12 Potential effects to energy resources could be similar to those identified in a
13 recent environmental analysis conducted by Reclamation for long-term water
14 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c), as
15 described above under the No Action Alternative compared to the Second Basis
16 of Comparison. For the purposes of this EIS, it is anticipated that similar energy
17 conditions would occur during implementation of cross Delta water transfers
18 under Alternative 5 as compared to the Second Basis of Comparison.

19 Under Alternative 5, the timing of cross Delta water transfers would be limited to
20 July through September and include annual volumetric limits, in accordance with
21 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,
22 water could be transferred throughout the year without an annual volumetric limit.
23 Overall, the potential for cross Delta water transfers would be reduced under
24 Alternative 5 as compared to the Second Basis of Comparison; however, energy
25 resources conditions would be similar.

26 **8.4.3.7 Summary of Impact Analysis**

27 The results of the environmental consequences of implementation of Alternatives
28 1 through 5 as compared to the No Action Alternative and the Second Basis of
29 Comparison are presented in Tables 8.11 and 8.12.

1 **Table 8.11 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>CVP annual net generation would be similar.</p> <p>SWP annual net generation would be increased by 41 percent over the long-term condition; and by 58 percent in dry and critical dry years.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to decrease.</p>	None needed.
Alternative 2	No effects on energy resources.	None needed.
Alternative 3	<p>CVP annual net generation would be similar.</p> <p>SWP annual net generation would be increased by 27 percent over the long-term condition and by 16 percent in dry and critical dry years.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to decrease.</p>	None needed.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	<p>CVP and SWP annual net generation would be similar.</p> <p>Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to be similar.</p>	None needed.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **Table 8.12 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	CVP annual net generation would be similar. SWP annual net generation would be reduced by 29 percent over the long-term condition and by 37 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.
Alternative 1	No effects on energy resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	CVP annual net generation would be similar. SWP annual net generation would be reduced by 10 percent over the long-term condition and by 58 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.
Alternative 4	No effects on energy resources.	Not considered for this comparison.
Alternative 5	CVP annual net generation would be similar. SWP annual net generation would be reduced by 30 percent over the long-term condition and by 39 percent in dry and critical dry years. Total energy use by CVP and SWP water users, including energy for alternate water supplies, is assumed to increase.	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be "similar."

3 **8.4.3.8 Potential Mitigation Measures**

4 Mitigation measures are presented in this section to avoid, minimize, rectify,
 5 reduce, eliminate, or compensate for adverse environmental effects of
 6 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation
 7 measures were not included to address adverse impacts under the alternatives as

1 compared to the Second Basis of Comparison because this analysis was included
 2 in this EIS for information purposes only.

3 Changes under Alternatives 1 through 5 as compared to the No Action Alternative
 4 would result in similar or increased net energy generation, and reduced potential
 5 energy use by CVP and SWP water users for alternate water supplies. Therefore,
 6 there would be no adverse impacts to energy resources as compared to the No
 7 Action Alternative; and no mitigation measures are needed.

8 **8.4.3.9 Cumulative Effects Analysis**

9 As described in Chapter 3, the cumulative effects analysis considers projects,
 10 programs, and policies that are not speculative; and are based upon known or
 11 reasonably foreseeable long-range plans, regulations, operating agreements, or
 12 other information that establishes them as reasonably foreseeable.

13 The cumulative effects analysis Alternatives 1 through 5 for Energy Resources
 14 are summarized in Table 8.13.

15 **Table 8.13 Summary of Cumulative Effects on Energy Resources of Alternatives 1**
 16 **through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that Would Have Occurred without Implementation of the Biological Opinions, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): <ul style="list-style-type: none"> - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs 	These effects would be the same in all alternatives. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that could reduce hydroelectric generation in the summer and fall months. Reduced CVP and SWP water deliveries south of the Delta would also reduce CVP and SWP electricity use. Future water supply projects are anticipated to both improve water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects.

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents) 	<p>However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.</p> <p>Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.</p>
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program 	<p>These effects would be the same in all alternatives.</p> <p>Most of the future reasonably foreseeable actions are anticipated to improve water supplies in California to reduce impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth. If CVP and SWP water supply reliability increases, energy use for conveyance of CVP and SWP water supplies also would increase.</p> <p>Some of the future reasonably foreseeable actions are anticipated to potentially reduce CVP and SWP water supply reliability (e.g., Water Quality Control Plan Update and FERC Relicensing Projects).</p> <p>Future water supply projects are anticipated to both improve water supply reliability due to reduced</p>

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> - San Luis Reservoir Low Point Improvement Project - Westlands Water District v. United States Settlement - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS) 	<p>surface water supplies and to accommodate planned growth in the general plans. It is anticipated that some of these projects could increase energy use, such as implementation of desalination projects. However, other projects, such as water recycling, would not substantially increase energy use because most of the energy use was previously required for wastewater treatment. It is anticipated that energy required for water treatment of alternative water supplies would be similar as treatment for CVP and SWP water supplies. Increased use of groundwater pumps would increase energy use; however, this energy use would be similar or less than the energy used for CVP and SWP water conveyance.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP</p>	<p>Implementation of No Action Alternative future reasonably foreseeable actions would result in changes stream flows and related changes in hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs.</p> <p>If CVP and SWP water supply reliability decreases, energy use for conveyance of CVP and SWP water supplies also would decrease and energy use for alternative water supplies could increase.</p>
<p>Alternatives 1 and 4 with Associated Cumulative Effects Actions Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternatives 1 and 4 future reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP</p>

Scenarios	Actions	Cumulative Effects of Actions
		<p>water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p>
Alternative 2 with Associated Cumulative Effects Actions Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 future reasonably foreseeable actions with future reasonably foreseeable actions for energy resources would be the same as for the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	<p>Implementation of Alternative 3 future reasonably foreseeable actions would result in changes in stream flows and related hydroelectric generation patterns, and increased CVP and SWP water supplies as compared to the No Action Alternative with the added actions.</p> <p>Increased CVP and SWP water supply reliability would increase energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would decrease as compared to the No Action Alternative with the added actions.</p>
Alternative 5 with Associated Cumulative Effects Actions Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 would result in changes in stream flows and related hydroelectric generation patterns, and reduced CVP and SWP water supplies as compared to the No Action

Scenarios	Actions	Cumulative Effects of Actions
		<p>Alternative with the added actions.</p> <p>Reduced CVP and SWP water supply reliability would decrease energy use for conveyance of CVP and SWP water supplies; and it is anticipated that energy use for alternative water supplies would increase as compared to the No Action Alternative with the added actions.</p>

1 **8.5 References**

2 CEC (The California Energy Commission). 2014a. Hydroelectric Power in
3 California. Site accessed June 8,
4 2014. <http://www.energy.ca.gov/hydroelectric/>.

5 _____. 2014b. *How the Drought Affects California’s Energy, Economy, and*
6 *Emission Goals*. Site accessed June 8, 2014.
7 [http://www.energy.ca.gov/drought /](http://www.energy.ca.gov/drought/)

8 CPUC (California Public Utilities Commission). 2010. *Embedded Energy in*
9 *Water Studies, Study 1: Statewide and Regional Water-Energy*
10 *Relationship*. August 31.

11 DWR (California Department of Water Resources). 2002. *Management of the*
12 *California State Water Project. Bulletin 132-01*. December.

13 _____. 2004a. *Management of the California State Water Project. Bulletin 132-*
14 *02*. January.

15 _____. 2004b. *Management of the California State Water Project. Bulletin 132-*
16 *03*. December.

17 _____. 2005. *Management of the California State Water Project. Bulletin 132-*
18 *04*. September.

19 _____. 2006. *Management of the California State Water Project. Bulletin 132-*
20 *05*. December.

21 _____. 2007. *Management of the California State Water Project. Bulletin 132-*
22 *06*. December.

23 _____. 2008. *Management of the California State Water Project. Bulletin 132-*
24 *07*. December.

25 _____. 2012a. *Management of the California State Water Project. Bulletin 132-*
26 *08*. June.

- 1 _____. 2012b. *Management of the California State Water Project. Bulletin 132-*
2 *09*. December.
- 3 _____. 2013a. *Management of the California State Water Project. Bulletin 132-*
4 *10*. June.
- 5 _____. 2013b. *Management of the California State Water Project. Bulletin 132-*
6 *11*. December.
- 7 _____. 2013c. *California Water Plan Update 2013 – Public Review Draft*.
- 8 _____. 2013d. *California Hydroelectric Statistics & Data*. Site accessed June 17,
9 2014. <http://energyalmanac.ca.gov/renewables/hydro/>.
- 10 _____. 2013e. Excel spreadsheet from *California Hydroelectric Statistics & Data*.
11 Site accessed June 17,
12 2014. <http://energyalmanac.ca.gov/renewables/hydro/>.
- 13 _____. 2013f. *North-of-the-Delta Offstream Storage Preliminary Administrative*
14 *Draft Environmental Impact Report*. December.
- 15 DWR, Reclamation, USFWS and NMFS (California Department of Water
16 Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and
17 National Marine Fisheries Service). 2013. *Draft Environmental Impact*
18 *Report/Environmental Impact Statement for the Bay Delta Conservation*
19 *Plan*. November.
- 20 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
21 *General Information – Licensing*. Site accessed April 29,
22 2015. <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>.
- 23 HWG (Hydropower Working Group, California Energy Commission, California
24 Public Utilities Commission, Department of Water Resources, State Water
25 Resources Control Board, and California Independent System Operator).
26 2014. *Hydropower Working Group*. February 27.
- 27 Reclamation (Bureau of Reclamation). 2001. *Central Valley Operations Office*
28 *Report of Operations*. December.
- 29 _____. 2002. *Central Valley Operations Office Report of Operations*. December.
- 30 _____. 2003. *Central Valley Operations Office Report of Operations*. December.
- 31 _____. 2004. *Central Valley Operations Office Report of Operations*. December.
- 32 _____. 2005. *Central Valley Operations Office Report of Operations*. December.
- 33 _____. 2006. *Central Valley Operations Office Report of Operations*. December.
- 34 _____. 2007. *Central Valley Operations Office Report of Operations*. December.
- 35 _____. 2008a. *Central Valley Project-California Monthly Power System*
36 *Generation Summary*. January.
- 37 _____. 2008b. *Central Valley Project-California Monthly Power System*
38 *Generation Summary*. February.

Chapter 8: Energy

- 1 _____. 2008c. *Central Valley Project-California Monthly Power System*
2 *Generation Summary*. March.
- 3 _____. 2008d. *Central Valley Project-California Monthly Power System*
4 *Generation Summary*. April.
- 5 _____. 2008e. *Central Valley Project-California Monthly Power System*
6 *Generation Summary*. May.
- 7 _____. 2008f. *Central Valley Project-California Monthly Power System*
8 *Generation Summary*. June.
- 9 _____. 2008g. *Central Valley Project-California Monthly Power System*
10 *Generation Summary*. July.
- 11 _____. 2008h. *Central Valley Project-California Monthly Power System*
12 *Generation Summary*. August.
- 13 _____. 2008i. *Central Valley Project-California Monthly Power System*
14 *Generation Summary*. September.
- 15 _____. 2008j. *Central Valley Project-California Monthly Power System*
16 *Generation Summary*. October.
- 17 _____. 2008k. *Central Valley Project-California Monthly Power System*
18 *Generation Summary*. November.
- 19 _____. 2008l. *Central Valley Project-California Monthly Power System*
20 *Generation Summary*. December.
- 21 _____. 2009a. *Central Valley Project-California Monthly Power System*
22 *Generation Summary*. January.
- 23 _____. 2009b. *Central Valley Project-California Monthly Power System*
24 *Generation Summary*. February.
- 25 _____. 2009c. *Central Valley Project-California Monthly Power System*
26 *Generation Summary*. March.
- 27 _____. 2009d. *Central Valley Project-California Monthly Power System*
28 *Generation Summary*. April.
- 29 _____. 2009e. *Central Valley Project-California Monthly Power System*
30 *Generation Summary*. May.
- 31 _____. 2009f. *Central Valley Project-California Monthly Power System*
32 *Generation Summary*. June.
- 33 _____. 2009g. *Central Valley Project-California Monthly Power System*
34 *Generation Summary*. July.
- 35 _____. 2009h. *Central Valley Project-California Monthly Power System*
36 *Generation Summary*. August.
- 37 _____. 2009i. *Central Valley Project-California Monthly Power System*
38 *Generation Summary*. September.

- 1 _____. 2009j. *Central Valley Project-California Monthly Power System*
2 *Generation Summary*. October.
- 3 _____. 2009k. *Central Valley Project-California Monthly Power System*
4 *Generation Summary*. November.
- 5 _____. 2009l. *Central Valley Project-California Monthly Power System*
6 *Generation Summary*. December.
- 7 _____. 2010a. *Central Valley Project-California Monthly Power System*
8 *Generation Summary*. January.
- 9 _____. 2010b. *Central Valley Project-California Monthly Power System*
10 *Generation Summary*. February.
- 11 _____. 2010c. *Central Valley Project-California Monthly Power System*
12 *Generation Summary*. March.
- 13 _____. 2010d. *Central Valley Project-California Monthly Power System*
14 *Generation Summary*. April.
- 15 _____. 2010e. *Central Valley Project-California Monthly Power System*
16 *Generation Summary*. May.
- 17 _____. 2010f. *Central Valley Project-California Monthly Power System*
18 *Generation Summary*. June.
- 19 _____. 2010g. *Central Valley Project-California Monthly Power System*
20 *Generation Summary*. July.
- 21 _____. 2010h. *Central Valley Project-California Monthly Power System*
22 *Generation Summary*. August.
- 23 _____. 2010i. *Central Valley Project-California Monthly Power System*
24 *Generation Summary*. September.
- 25 _____. 2010j. *Central Valley Project-California Monthly Power System*
26 *Generation Summary*. October.
- 27 _____. 2010k. *Central Valley Project-California Monthly Power System*
28 *Generation Summary*. November.
- 29 _____. 2010l. *Central Valley Project-California Monthly Power System*
30 *Generation Summary*. December.
- 31 _____. 2011a. *Central Valley Project-California Monthly Power System*
32 *Generation Summary*. January.
- 33 _____. 2011b. *Central Valley Project-California Monthly Power System*
34 *Generation Summary*. February.
- 35 _____. 2011c. *Central Valley Project-California Monthly Power System*
36 *Generation Summary*. March.
- 37 _____. 2011d. *Central Valley Project-California Monthly Power System*
38 *Generation Summary*. April.

Chapter 8: Energy

- 1 _____. 2011e. *Central Valley Project-California Monthly Power System*
2 *Generation Summary*. May.
- 3 _____. 2011f. *Central Valley Project-California Monthly Power System*
4 *Generation Summary*. June.
- 5 _____. 2011g. *Central Valley Project-California Monthly Power System*
6 *Generation Summary*. July.
- 7 _____. 2011h. *Central Valley Project-California Monthly Power System*
8 *Generation Summary*. August.
- 9 _____. 2011i. *Central Valley Project-California Monthly Power System*
10 *Generation Summary*. September.
- 11 _____. 2011j. *Central Valley Project-California Monthly Power System*
12 *Generation Summary*. October.
- 13 _____. 2011k. *Central Valley Project-California Monthly Power System*
14 *Generation Summary*. November.
- 15 _____. 2011l. *Central Valley Project-California Monthly Power System*
16 *Generation Summary*. December.
- 17 _____. 2012a. *Central Valley Project Hydropower Production*. September.
- 18 _____. 2012b. *Central Valley Project-California Monthly Power System*
19 *Generation Summary*. January.
- 20 _____. 2012c. *Central Valley Project-California Monthly Power System*
21 *Generation Summary*. February.
- 22 _____. 2012d. *Central Valley Project-California Monthly Power System*
23 *Generation Summary*. March.
- 24 _____. 2012e. *Central Valley Project-California Monthly Power System*
25 *Generation Summary*. April.
- 26 _____. 2012f. *Central Valley Project-California Monthly Power System*
27 *Generation Summary*. May.
- 28 _____. 2012g. *Central Valley Project-California Monthly Power System*
29 *Generation Summary*. June.
- 30 _____. 2012h. *Central Valley Project-California Monthly Power System*
31 *Generation Summary*. July.
- 32 _____. 2012i. *Central Valley Project-California Monthly Power System*
33 *Generation Summary*. August.
- 34 _____. 2012j. *Central Valley Project-California Monthly Power System*
35 *Generation Summary*. September.
- 36 _____. 2012k. *Central Valley Project-California Monthly Power System*
37 *Generation Summary*. October.

- 1 _____. 2012l. *Central Valley Project-California Monthly Power System*
2 *Generation Summary*. November.
- 3 _____. 2012m. *Central Valley Project-California Monthly Power System*
4 *Generation Summary*. December.
- 5 _____. 2013a. *Mid-Pacific Region, Central Valley Project Hydropower*
6 *Production*. July.
- 7 _____. 2013b. Trinity River Powerplant. Site accessed September 24, 2013.
8 [http://www.usbr.gov/projects/Powerplant.jsp?fac_Name=Trinity+Powerpl](http://www.usbr.gov/projects/Powerplant.jsp?fac_Name=Trinity+Powerplant)
9 [ant](http://www.usbr.gov/projects/Powerplant.jsp?fac_Name=Trinity+Powerplant).
- 10 _____. 2013c. Lewiston Powerplant. Site accessed September 24,
11 2013. http://www.usbr.gov/projects/Powerplant.jsp?fac_Name=Lewiston
12 [+Powerplant](http://www.usbr.gov/projects/Powerplant.jsp?fac_Name=Lewiston).
- 13 _____. 2013d. Judge Francis Carr Powerplant. Site accessed September 24,
14 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Judge) [jsp?fac_Name=Judge](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Judge)
15 [Francis Carr Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Judge).
- 16 _____. 2013e. Shasta Powerplant. Site accessed September 24,
17 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Shasta) [jsp?fac_Name=Shasta](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Shasta)
18 [Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Shasta).
- 19 _____. 2013f. Spring Creek Powerplant. Site accessed September 24,
20 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Spring) [jsp?fac_Name=Spring](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Spring)
21 [Creek Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Spring).
- 22 _____. 2013g. Keswick Powerplant. Site accessed September 24,
23 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Keswick)
24 [jsp?fac_Name=Keswick](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Keswick) Powerplant.
- 25 _____. 2013h. Folsom Powerplant. Site accessed September 24,
26 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Folsom) [jsp?fac_Name=Folsom](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Folsom)
27 [Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Folsom).
- 28 _____. 2013i. Nimbus Powerplant. Site accessed September 24,
29 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Nimbus) [jsp?fac_Name=Nimbus](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Nimbus)
30 [Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=Nimbus).
- 31 _____. 2013j. New Melones Powerplant. Site accessed September 24, 2013.
32 [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=New+Melones+Powerplant)
33 [jsp?fac_Name=New+Melones+Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=New+Melones+Powerplant).
- 34 _____. 2013k. O'Neill Powerplant. Site accessed September 24, 2013.
35 [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=O%20Neill+) [Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=O%20Neill+
36 <a href=)
- 37 _____. 2013l. San Luis (William R. Gianelli) Powerplant. Site accessed
38 September 24, 2013. [http://www.usbr.gov/projects/powerplants.](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=San+Luis+(William+R.+Gianelli)+Powerplant)
39 [jsp?fac_Name=San Luis \(William R. Gianelli\) Powerplant](http://www.usbr.gov/projects/powerplants.jsp?fac_Name=San+Luis+(William+R.+Gianelli)+Powerplant).

Chapter 8: Energy

- 1 _____. 2013m. *Record of Decision, Water Transfer Program for the San Joaquin*
2 *River Exchange Contractors Water Authority, 2014-2038*. July 30.
- 3 _____. 2013n. *Shasta Lake Water Resources Investigation Draft Environmental*
4 *Impact Statement*. June.
- 5 _____. 2014a. *Findings of No Significant Impact, 2014 Tehama-Colusa Canal*
6 *Authority Water Transfers*. April 22.
- 7 _____. 2014b. *Findings of No Significant Impact, 2014 San Luis & Delta-*
8 *Mendota Water Authority Water Transfers*. April 22.
- 9 _____. 2014c. *Long-Term Water Transfers Environmental Impact*
10 *Statement/Environmental Impact Report, Public Draft*. September.
- 11 _____. 2014d. *Upper San Joaquin River Basin Storage Investigation, Draft*
12 *Environmental Impact Statement*. August.
- 13 Reclamation, CCWD, and Western (Bureau of Reclamation, Contra Costa Water
14 District, and Western Area Power Administration). 2010. *Los Vaqueros*
15 *Expansion Project, Environmental Impact Statement/Environmental*
16 *Impact Report*. March.
- 17 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
18 Game [now known as Department of Fish and Wildlife], and U.S. Fish
19 and Wildlife Service). 2011. *Suisun Marsh Habitat Management,*
20 *Preservation, and Restoration Plan Final Environmental Impact*
21 *Statement/Environmental Impact Report*. November.
- 22 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control*
23 *Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.
24 December 13.
- 25 _____. 2013. *Comprehensive (Phase 2) Review and Update to the Bay-Delta*
26 *Plan, DRAFT Bay-Delta Plan Workshops Summary Report*. January
- 27 SWSD (Semitropic Water Storage District). 2011. *Delta Wetlands Project Place*
28 *of Use, Final Environmental Impact Report*. August.
- 29 YCWA (Yuba County Water Agency). 2012. *Yuba River Development Project*
30 *Relicensing*.

Chapter 8

1 **Energy Figures**

2 The following figures are included in Chapter 8, Energy.

- 3 • 8.1 Central Valley Project and State Water Project Hydroelectric Generation
4 Facilities
- 5 • 8.2 Central Valley Project Energy Generation and Energy Use
- 6 • 8.3 State Water Project Energy Generation and Energy Use



Figure 8.1 Central Valley Project and State Water Project Hydroelectric Generation Facilities

Sources: Reclamation 2013a, 2013b, 2013c, 2013d, 2013e, 2013f, 2013g, 2013h, 2013i, 2013j, 2013k, 2013l; DWR 2012

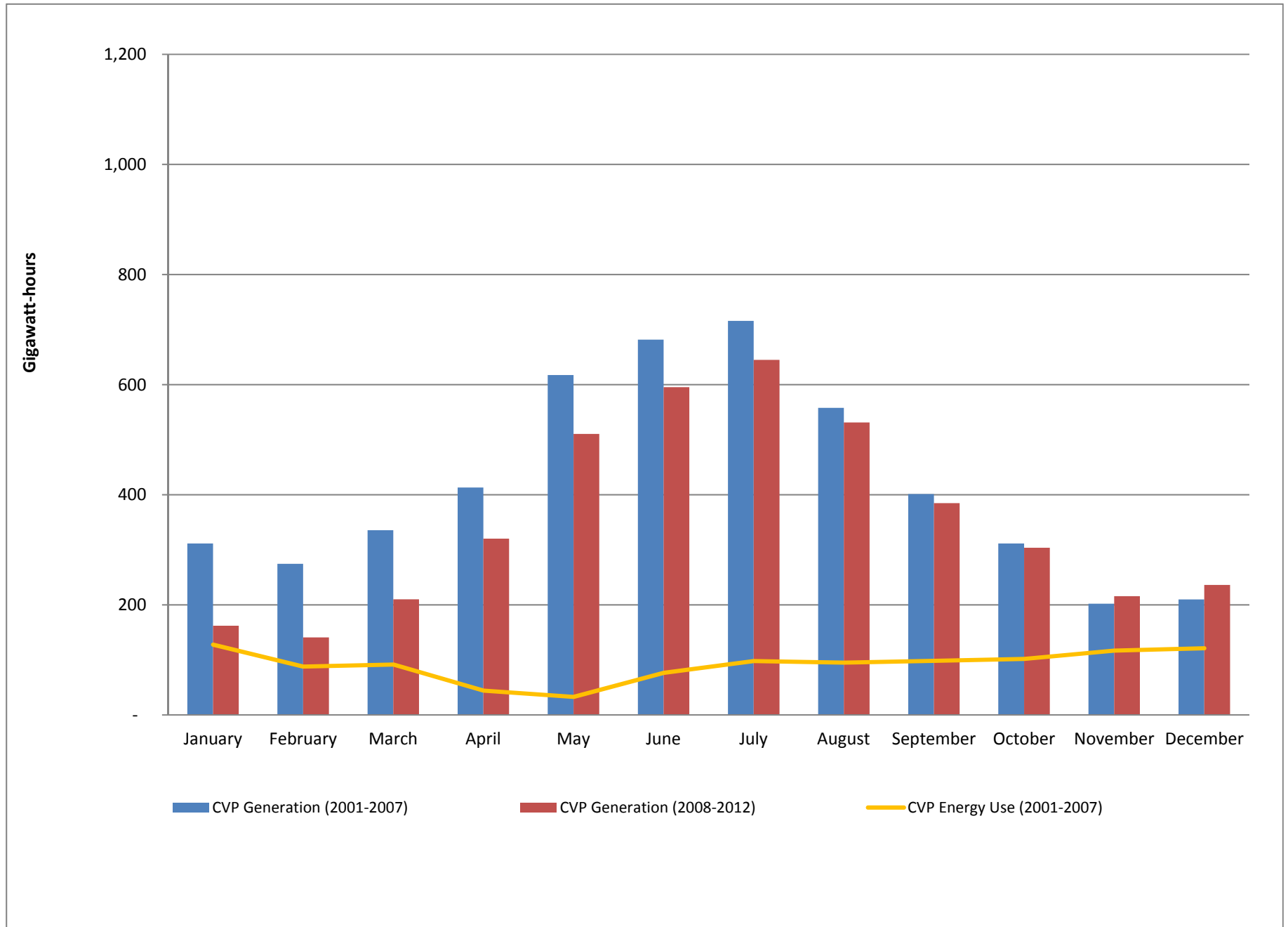


Figure 8.2 Central Valley Project Energy Generation and Energy Use

Sources: Reclamation 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008 a-l, 2009a-l, 2010a-l, 2011a-l, 2012a-l

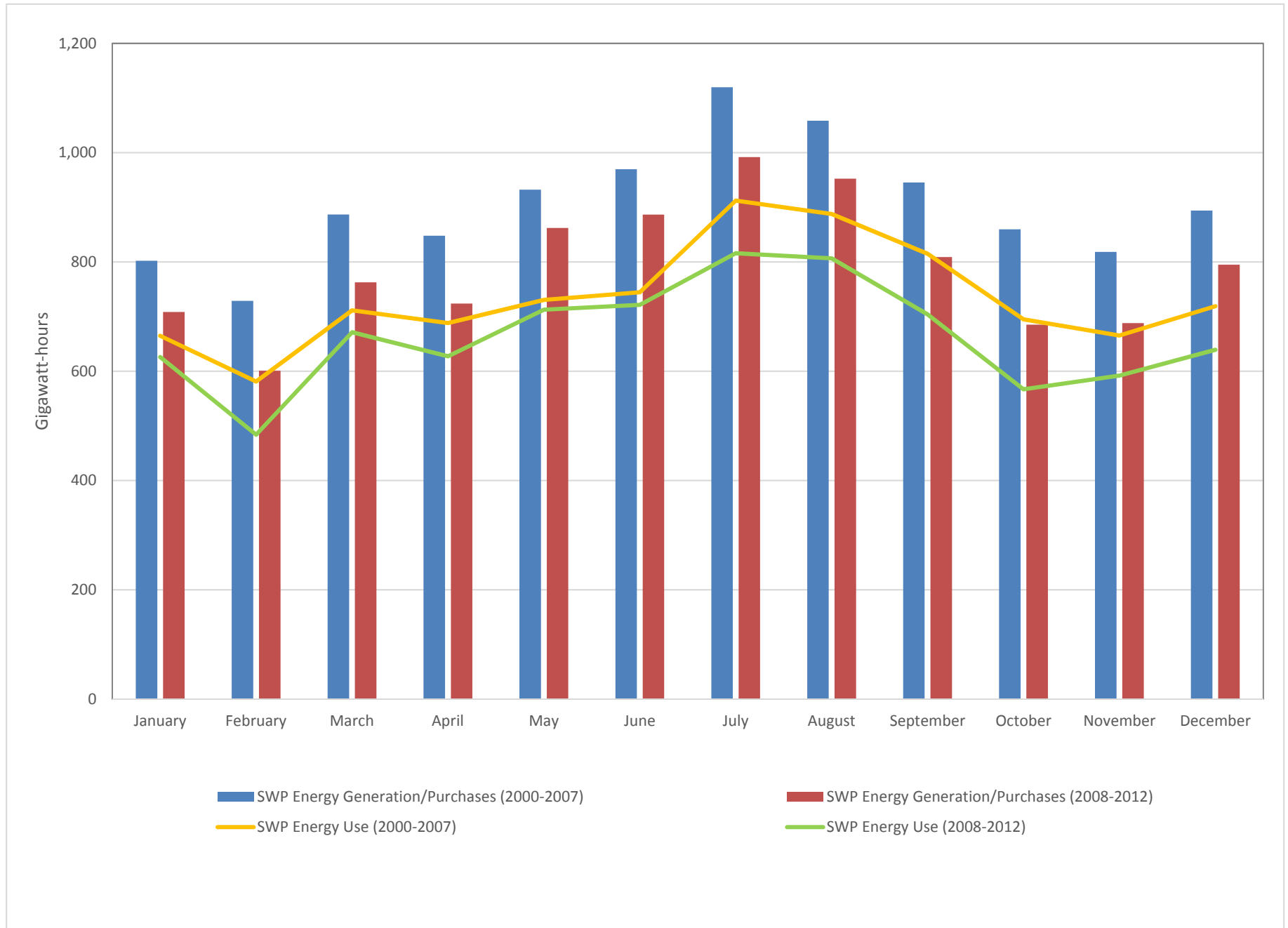


Figure 8.3 State Water Project Energy Generation and Energy Use

Sources: DWR 2002, 2004a, 2004b, 2005, 2006, 2007, 2008, 2012a, 2012b, 2013

Chapter 9

1 Fish and Aquatic Resources

2 9.1 Introduction

3 This chapter describes the fish and aquatic resources that occur in the portions of
 4 the project area that could be affected as a result of implementing the alternatives
 5 evaluated in this Environmental Impact Statement (EIS). Implementation of the
 6 alternatives could affect aquatic resources through changes in ecological attributes
 7 as a result of potential changes in long-term operation of the Central Valley
 8 Project (CVP) and State Water Project (SWP) and ecosystem restoration.

9 9.2 Regulatory Environment and Compliance 10 Requirements

11 Potential actions implemented under the alternatives evaluated in this EIS could
 12 affect fish and aquatic resources. Actions located on public agency lands, or
 13 implemented, funded, or approved by Federal and state agencies, would need to
 14 be compliant with appropriate Federal and state agency policies and regulations,
 15 as summarized in Chapter 4, Approach to Environmental Analyses.

16 9.3 Affected Environment

17 This section describes fish and aquatic resources that could be affected by the
 18 implementation of the alternatives considered in this EIS. Changes in aquatic
 19 resources due to changes in CVP and SWP operations may occur in the Trinity
 20 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern
 21 California regions.

22 The following description of the affected environment focuses on CVP and SWP
 23 reservoirs, rivers downstream of CVP and SWP reservoirs, the Sacramento-San
 24 Joaquin Rivers Delta Estuary (Delta), and conditions downstream of the Delta that
 25 are affected by operation of the CVP and SWP.

26 This section is organized by geographic area, generally in an upstream to
 27 downstream direction. This format does not necessarily coincide with the use by
 28 fish and aquatic species, which can move among geographic areas either
 29 seasonally or during different phases of their life history.

30 The descriptions of species and biological and hydrodynamic processes in this
 31 chapter frequently use the terms “Delta” and “San Francisco Estuary.” The Delta
 32 refers to the Sacramento-San Joaquin Delta, as legally defined in the Delta
 33 Protection Act. The San Francisco Estuary refers to the portion of the
 34 Sacramento-San Joaquin Rivers watershed downstream of Chipps Island that is

1 influenced by tidal action and where fresh water and salt water mix, which
 2 includes the following waterbodies: Suisun, San Pablo, and San Francisco bays.

3 **9.3.1 Fish and Aquatic Species Evaluated**

4 Many fish and aquatic species use the project area during all or some portion of
 5 their lives; however, certain fish and aquatic species were selected to be the focus
 6 of the analysis of alternatives considered in this EIS based on their sensitivity and
 7 their potential to be affected by changes in the operation of the CVP and SWP
 8 implemented under the alternatives considered in this EIS, as summarized in
 9 Table 9.1. While many of the species identified in Table 9.1 also occur in
 10 tributaries to the major rivers, the focus of this EIS is on the waterbodies
 11 influenced by operations of the CVP and SWP. Operation of the CVP and SWP
 12 would not directly affect ocean conditions; however, operations have the potential
 13 to affect Southern Resident Killer Whales indirectly by influencing the number of
 14 Chinook Salmon (produced in the Sacramento-San Joaquin River and associated
 15 tributaries) that enter the Pacific Ocean and become available as a food supply for
 16 the whales.

17 These focal species are fish and marine mammal species listed as threatened or
 18 endangered or at risk of being listed as endangered or threatened, legally
 19 protected, or are otherwise considered sensitive by the U.S. Fish and Wildlife
 20 Service (USFWS), National Marine Fisheries Service (NMFS), or California
 21 Department of Fish and Wildlife (CDFW) (previously known as Department of
 22 Fish and Game [DFG]) and fish that have tribal, commercial or recreational
 23 importance. In addition, salmon, steelhead, sturgeon, Striped Bass, and American
 24 Shad are managed in accordance with Section 3406of the Central Valley Project
 25 Improvement Act. Details on the status, life history, habitat requirements, and
 26 population trends for each of the aquatic focal species are provided in
 27 Appendix 9B.

28 **Table 9.1 Focal Fish Species by Region of Occurrence**

Species or Population ^a	Federal Status	State Status ^b	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
Trinity River Region				
Coho Salmon <i>Southern Oregon/Northern California Coast ESU</i>	Threatened	Threatened	Yes	Trinity River, Klamath River
Eulachon <i>Southern DPS</i>	Threatened	None	Yes	Klamath River
Green Sturgeon <i>Southern DPS</i>	Threatened	Species of Special Concern	Yes	Trinity River, Klamath River
Spring-run Chinook Salmon <i>Upper Klamath-Trinity River ESU</i>	None	Species of Special Concern	Yes	Trinity River, Klamath River
Steelhead (winter- and summer-run) <i>Klamath Mountains Province DPS</i>	None	Species of Special Concern ^c	Yes	Trinity River, Klamath River
American Shad	None	None	Yes	Trinity River
Pacific Lamprey	None	None	Yes	Trinity River, Klamath River

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Species or Population ^a	Federal Status	State Status ^b	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
White Sturgeon	None	None	Yes	Trinity River, Klamath River
Black Bass (Largemouth, Smallmouth, Spotted)	None	None	Yes	Trinity River
Central Valley Region				
Winter-run Chinook Salmon <i>Sacramento River ESU</i>	Endangered	Endangered	Yes	Sacramento River ^d , Delta, and Suisun Marsh
Spring-run Chinook Salmon <i>Central Valley ESU</i>	Threatened	Threatened	Yes	Clear Creek, Sacramento River, Feather River, American River, Delta, and Suisun Marsh
Steelhead <i>Central Valley DPS</i>	Threatened	None	Yes	Clear Creek, Feather River, Sacramento River; American River, Stanislaus River, San Joaquin River, Delta and Suisun Marsh
Green Sturgeon <i>Southern DPS</i>	Threatened	Species of Special Concern	Yes	Feather River, Sacramento River, Delta and Suisun Marsh
Delta Smelt	Threatened	Endangered	No	Delta and Suisun Marsh
Longfin Smelt <i>Bay Delta DPS</i>	Candidate	Threatened	No	Delta and Suisun Marsh
Fall-/late Fall-run Chinook Salmon <i>Central Valley ESU</i>	None	Species of Special Concern	Yes	Clear Creek, Feather River, Sacramento River, American River, Stanislaus River, San Joaquin River, Delta and Suisun Marsh
Sacramento Splittail	None	Species of Special Concern	No	Feather River, American River, Sacramento River, Delta and Suisun Marsh, San Joaquin River
Hardhead	None	Species of Special Concern	No	Clear Creek, Feather River, Sacramento River, American River, Delta, Stanislaus River, San Joaquin River
Sacramento-San Joaquin Roach	None	Species of Special Concern	No	Clear Creek, Feather River, American River, Sacramento River, Delta, Stanislaus River, San Joaquin River

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Species or <i>Population</i> ^a	Federal Status	State Status ^b	Tribal, Commercial, or Recreational Importance	Occurrence within Area of Analysis
River Lamprey	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Pacific Lamprey	None	None	Yes	Clear Creek, Feather River, Sacramento River, American River, Delta, Stanislaus River, San Joaquin River
White Sturgeon	None	None	Yes	Feather River, Sacramento River, American River, San Joaquin River, Delta and Suisun Marsh
American Shad	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Black Bass (Largemouth, Smallmouth, Spotted)	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
Striped Bass	None	None	Yes	Feather River, American River, Sacramento River, Delta and Suisun Marsh, Stanislaus River, San Joaquin River
San Francisco Bay and Pacific Ocean Waters				
Steelhead Central California Coast DPS	Threatened	None	Yes	San Francisco Bay region
Killer Whale <i>Southern Resident DPS</i>	Endangered	None	Yes	Pacific Coast

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Notes:

- a. The term *population* refers to the listed Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS) for that species.
- b. Includes species listed by the State of California as threatened, endangered, or considered a Species of Special Concern.
- c. The California Species of Special Concern designation refers only to the summer-run of the Klamath Mountains Province DPS steelhead population
- d. Also includes lower reaches of tributaries (e.g., American River) used for nonnatal rearing areas by juvenile salmon.

10 The life history attributes (e.g., timing of juvenile outmigration) for most of the
11 species listed above, along with the ecological attributes important to the species
12 and potentially influenced by the alternatives, are discussed in this chapter

1 according to the geographic areas (regions/subregions) where the species occurs;
 2 Pacific Lamprey, Green Sturgeon, White Sturgeon, American Shad, and Striped
 3 Bass are discussed in detail only in those regions where they spend the majority of
 4 their life cycle such that geographic information is available. There are also
 5 several species (i.e., River Lamprey, Sacramento-San Joaquin Roach, and
 6 Hardhead) for which little geographic information is available; therefore, they are
 7 not discussed in detail in this chapter, but are described in the species accounts
 8 presented in Appendix 9B. Additionally, these species are only generally
 9 addressed in the analysis of impacts presented in the Environmental
 10 Consequences section of this chapter.

11 The level of detail presented in the Affected Environment section is tailored to
 12 correspond the level of resolution of the analysis, which relies on modeling tools
 13 that broadly characterize the changes in CVP and SWP operations on reservoir
 14 storage and flows. This level of detail is intended to support an understanding of
 15 the resources potentially affected and the context within which the project is
 16 evaluated. The inclusion of unnecessary detail is avoided.

17 **9.3.2 Critical Habitat**

18 Critical habitat refers to areas designated by USFWS or NMFS for the
 19 conservation of their jurisdictional species listed as threatened or endangered
 20 under the Endangered Species Act (ESA). When a species is proposed for listing
 21 under the ESA, USFWS or NMFS considers whether there are certain areas
 22 essential to the conservation of the species. Critical habitat is defined in
 23 Section 3, Provision 5 of the ESA as follows.

24 *(5)(A) The term “critical habitat” for a threatened or endangered species*
 25 *means—*

26 *(i) the specific areas within the geographical area occupied by a species*
 27 *at the time it is listed in accordance with the Act, on which are found those*
 28 *physical or biological features (I) essential to the conservation of the*
 29 *species, and (II) which may require special management considerations or*
 30 *protection; and*

31 *(ii) specific areas outside the geographical area occupied by a species at*
 32 *the time it is listed in accordance with the provisions of section 4 of this*
 33 *Act, upon a determination by the Secretary that such areas are essential*
 34 *for the conservation of the species.*

35 Any Federal action (permit, license, or funding) in critical habitat requires that the
 36 Federal agency consult with USFWS or NMFS where the action has potential to
 37 adversely modify the habitat for the listed species.

38 ESA regulations state that the physical and biological features essential to the
 39 conservation of the species include space for individual and population growth
 40 and for normal behavior; food, water, air, light, minerals, or other nutritional or
 41 physiological requirements; cover or shelter; sites for breeding, reproduction, and
 42 rearing of offspring; and habitats that are protected from disturbance or are
 43 representative of the historical geographical and ecological distribution of a

1 species. These principal biological and physical features are known as Primary
2 Constituent Elements (PCEs)¹. Specific PCEs identified for salmonids, Green
3 Sturgeon, Delta Smelt, and Eulachon are described below.

4 **9.3.2.1 Anadromous Salmonids**

5 In designating critical habitat for anadromous salmonids (70 Federal Register
6 [FR] 52536), NMFS identified the following PCEs as essential to the conservation
7 of the listed populations:

- 8 • Freshwater spawning sites with water quantity and quality conditions and
9 substrate that support spawning, incubation, and larval development.
- 10 • Freshwater rearing sites with:
 - 11 – Water quantity and floodplain connectivity to form and maintain physical
12 habitat conditions and support juvenile growth and mobility
 - 13 – Water quality and forage supporting juvenile development
 - 14 – Natural cover such as shade, submerged and overhanging large wood, log
15 jams and beaver dams, aquatic vegetation, large rocks and boulders, side
16 channels, and undercut banks
- 17 • Freshwater migration corridors free of obstruction and excessive predation
18 with water quantity and quality conditions and natural cover such as
19 submerged and overhanging large wood, aquatic vegetation, large rocks and
20 boulders, side channels, and undercut banks supporting juvenile and adult
21 mobility and survival.
- 22 • Estuarine areas free of obstruction and excessive predation with:
 - 23 – Water quality, water quantity, and salinity conditions supporting juvenile
24 and adult physiological transitions between fresh water and salt water
 - 25 – Natural cover such as submerged and overhanging large wood, aquatic
26 vegetation, large rocks and boulders, and side channels
 - 27 – Juvenile and adult forage, including aquatic invertebrates and fishes,
28 supporting growth and maturation

29 Critical habitat in nontidal waters includes the stream channels in the designated
30 stream reaches, the lateral extent of which generally defined by the ordinary
31 high-water line.

32 **9.3.2.1.1 Central Valley Spring-run Chinook Salmon ESU**

33 This ESU consists of spring-run Chinook Salmon in the Sacramento River Basin,
34 including spring-run Chinook Salmon from the Feather River Hatchery.
35 Designated critical habitat for Central Valley spring-run Chinook Salmon
36 includes stream reaches of the American, Feather, Yuba, and Bear rivers;

¹ The U.S. Fish and Wildlife Service and National Marine Fisheries Service have proposed discontinuing the use of the term "Primary Constituent Elements" to simplify and clarify the critical habitat process and to provide consistency with the language contained in the Endangered Species Act, which uses the term "physical or biological features."

1 tributaries of the Sacramento River, including Big Chico, Butte, Deer, Mill,
 2 Battle, Antelope, and Clear creeks; and the main stem of the Sacramento River
 3 from Keswick Dam through the Delta. Designated critical habitat in the Delta
 4 includes portions of the Delta Cross Channel (DCC); Yolo Bypass; and portions
 5 of the network of channels in the northern Delta. Critical habitat for spring-run
 6 Chinook Salmon was not designated for the Stanislaus or San Joaquin River.

7 The spring-run Chinook Salmon critical habitat potentially affected by operation
 8 of the CVP and SWP includes the network of channels in the northern Delta,
 9 Sacramento River up to Keswick Dam, Clear Creek up to Whiskeytown Dam, the
 10 Feather River up to the Fish Barrier Dam, and the American River up to Watt
 11 Avenue in the Sacramento Valley subregion. The section of the American River
 12 denoted as critical habitat serves only as juvenile nonnatal rearing habitat;
 13 spring-run Chinook Salmon do not spawn in the American River. Operation of
 14 the CVP and SWP would have no effect on designated critical habitat for spring-
 15 run Chinook Salmon in the Yuba River and Big Chico, Butte, Deer, Mill, Battle,
 16 and Antelope creeks or other tributaries of the Sacramento River. Operation of
 17 the CVP and SWP could affect designated critical habitat in the Delta subregion.
 18 There is no designated critical habitat for spring-run Chinook Salmon in the San
 19 Joaquin Valley subregion.

20 **9.3.2.1.2 Sacramento River Winter-run Chinook Salmon ESU**

21 The Sacramento River winter-run Chinook Salmon ESU consists of only one
 22 population confined to the upper Sacramento River. This ESU includes all fish
 23 spawning naturally in the Sacramento River and its tributaries, as well as fish that
 24 are propagated at the Livingston Stone National Fish Hatchery (NFH), operated
 25 by USFWS (NMFS 2005a). Critical habitat was delineated as the Sacramento
 26 River from Keswick Dam to Chipps Island at the westward margin of the Delta;
 27 all waters from Chipps Island westward to the Carquinez Bridge, including
 28 Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San
 29 Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco
 30 Bay (north of the San Francisco-Oakland Bay Bridge) to the Golden Gate Bridge
 31 (NMFS 1993).

32 **9.3.2.1.3 Central Valley Steelhead DPS**

33 The California Central Valley Steelhead DPS includes all naturally spawned
 34 populations of steelhead in the Sacramento and San Joaquin rivers and their
 35 tributaries, excluding steelhead from San Francisco and San Pablo bays and their
 36 tributaries. Two artificial propagation programs, the Coleman NFH and Feather
 37 River Hatchery steelhead hatchery programs, are considered to be part of the
 38 DPS. Critical habitat for Central Valley Steelhead includes stream reaches of the
 39 American, Feather, Yuba, and Bear rivers and their tributaries, and tributaries of
 40 the Sacramento River including Deer, Mill, Battle, Antelope, and Clear creeks in
 41 the Sacramento River Basin; the Mokelumne, Calaveras, Stanislaus, Tuolumne,
 42 and Merced rivers in the San Joaquin River Basin; and portions of the Sacramento
 43 and San Joaquin rivers. Designated critical habitat in the Delta includes portions
 44 of the DCC, Yolo Bypass, Ulatis Creek, and portions of the network of channels

1 in the Sacramento River portion of the Delta; and portions of the San Joaquin,
2 Cosumnes, and Mokelumne rivers and portions of the network of channels in the
3 San Joaquin portion of the Delta.

4 The Central Valley Steelhead critical habitat potentially affected by operation of
5 the CVP and SWP includes the Sacramento River up to Keswick Dam, Clear
6 Creek up to Whiskeytown Dam, the Feather River up to the Fish Barrier Dam,
7 and the American River up to Nimbus Dam in the Sacramento Valley subregion.
8 Operation of the CVP and SWP would have no effect on designated critical
9 habitat for steelhead in the Yuba River and Big Chico, Butte, Deer, Mill, Battle,
10 and Antelope creeks or other tributaries of the Sacramento River.

11 **9.3.2.1.4 Central California Coast Steelhead DPS**

12 The Central California Coast Steelhead DPS includes all naturally spawned
13 populations of steelhead in streams from the Russian River to Aptos Creek, Santa
14 Cruz County (inclusive). It also includes the drainages of San Francisco and San
15 Pablo bays. Critical habitat for Central California Coast Steelhead includes
16 stream reaches in the Russian River, Bodega, Marin Coastal, San Mateo, Bay
17 Bridge, Santa Clara, San Pablo, and Big Basin Hydrologic Units. Operation of
18 the CVP and SWP would not affect designated critical habitat for this DPS of
19 Central California Coast Steelhead, and NMFS (2009a) concluded that operation
20 would not likely adversely affect individual fish; therefore, this species is not
21 addressed in this EIS.

22 **9.3.2.1.5 Southern Oregon/Northern California Coastal Coho Salmon ESU**

23 The Southern Oregon/Northern California Coast Coho Salmon ESU consists of
24 populations from Cape Blanco, Oregon, to Punta Gorda, California, including
25 Coho Salmon in the Trinity River. In the Trinity River Region, all Trinity River
26 reaches downstream of Lewiston Dam, the south fork of the Trinity River, and the
27 entire lower Klamath River are designated as critical habitat with the exception of
28 tribal lands (NMFS 1999).

29 **9.3.2.2 North American Green Sturgeon Southern DPS**

30 The North American Green Sturgeon Southern DPS consists of coastal and
31 Central Valley populations south of the Eel River, with the only known spawning
32 population in the Sacramento River. In designating critical habitat for the North
33 American Green Sturgeon Southern DPS, NMFS (74 FR 52345) identified PCEs
34 as essential to the conservation of this species in freshwater riverine systems,
35 estuarine areas, and nearshore marine waters. The PCEs for each area largely
36 overlap and include the following items:

- 37 • **Food Resources.** Abundant prey items for larval, juvenile, subadult, and
38 adult life stages.
- 39 • **Substrate Type or Size (i.e., structural features of substrates).** Substrates
40 suitable for egg deposition and development (e.g., bedrock sills and shelves,
41 cobble and gravel, or hard clean sand, with interstices or irregular surfaces to
42 “collect” eggs and provide protection from predators, and free of excessive silt

- 1 and debris that could smother eggs during incubation), larval development
 2 (e.g., substrates with interstices or voids providing refuge from predators and
 3 from high-flow conditions), and subadults and adults (e.g., substrates for
 4 holding and spawning).
- 5 • **Water Flow.** A flow regime (i.e., the magnitude, frequency, duration,
 6 seasonality, and rate-of-change of fresh water discharge over time) necessary
 7 for normal behavior, growth, and survival of all life stages.
 - 8 • **Water Quality.** Water quality, including temperature, salinity, oxygen
 9 content, and other chemical characteristics, necessary for normal behavior,
 10 growth, and viability of all life stages.
 - 11 • **Migratory Corridor.** A migratory pathway necessary for the safe and timely
 12 passage of Southern DPS fish within riverine habitats and between riverine
 13 and estuarine habitats (e.g., an unobstructed river or dammed river that still
 14 allows for safe and timely passage).
 - 15 • **Water Depth.** Deep (greater than 5 meters [m]) holding pools for both
 16 upstream and downstream holding of adult or subadult fish, with adequate
 17 water quality and flow to maintain the physiological needs of the holding
 18 adult or subadult fish.
 - 19 • **Sediment Quality.** Sediment quality (i.e., chemical characteristics) necessary
 20 for normal behavior, growth, and viability of all life stages.

21 Critical habitat in freshwater riverine habitats includes the stream channels in the
 22 designated stream reaches with the lateral extent defined by the ordinary high-
 23 water line. The ordinary high-water line on nontidal rivers is defined as “the line
 24 on the shore established by the fluctuations of water and indicated by physical
 25 characteristics such as a clear, natural line impressed on the bank; shelving;
 26 changes in the character of soil; destruction of terrestrial vegetation; the presence
 27 of litter and debris, or other appropriate means that consider the characteristics of
 28 the surrounding areas” [33 Code of Federal Regulations 329.11(a)(1)].

29 Within the study area, critical habitat includes the Sacramento River from the
 30 I-Street Bridge upstream to Keswick Dam, including areas in the Yolo Bypass
 31 and the Sutter Bypass and the lower American River from the confluence with the
 32 Sacramento River upstream to the State Route 160 bridge over the American
 33 River; the lower Feather River from the confluence with the Sacramento River
 34 upstream to the Fish Barrier Dam; and the lower Yuba River from the confluence
 35 with the Feather River upstream to Daguerre Dam. Critical habitat also includes
 36 all waterways of the Delta up to the elevation of mean higher high water except
 37 for certain excluded areas and all tidally influenced areas of San Francisco Bay,
 38 San Pablo Bay, and Suisun Bay up to the elevation of mean higher high water
 39 (NMFS 2009b).

1 **9.3.2.3 Delta Smelt**

2 In designating critical habitat for Delta Smelt (59 FR 65256), USFWS identified
3 the following PCEs essential to the conservation of the species: (1) suitable
4 substrate for spawning; (2) water of suitable quality and depth to support survival
5 and reproduction (e.g., temperature, turbidity, lack of contaminants); (3) sufficient
6 Delta flow to facilitate spawning migrations and transport of larval Delta Smelt to
7 appropriate rearing habitats; and (4) salinity, which influences the extent and
8 location of the low salinity zone where Delta Smelt rear. The location of the low
9 salinity zone (or X2) is described in terms of the average distance of the two
10 practical salinity units isohaline from the Golden Gate Bridge. Critical habitat for
11 Delta Smelt includes all water and submerged lands below ordinary high water
12 and the entire water column bounded by and contained in Suisun Bay (including
13 the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff,
14 First Mallard (Spring Branch), and Montezuma sloughs; and the existing
15 contiguous waters contained in the legal Delta (as defined in Section 12220 of the
16 California Water Code) (USFWS 1994a).

17 **9.3.2.4 Eulachon Southern DPS**

18 In designating critical habitat for Eulachon, NMFS (76 FR 65323) identified the
19 following physical or biological features essential to the conservation of the
20 Eulachon Southern DPS fall reflecting key life history phases of Eulachon:
21 (1) freshwater spawning and incubation sites with water flow, quality and
22 temperature conditions and substrate supporting spawning and incubation, and
23 with migratory access for adults and juveniles; (2) freshwater and estuarine
24 migration corridors associated with spawning and incubation sites that are free of
25 obstruction and with water flow, quality and temperature conditions supporting
26 larval and adult mobility, and with abundant prey items supporting larval feeding
27 after the yolk sac is depleted; and (3) nearshore and offshore marine foraging
28 habitat with water quality and available prey, supporting juveniles and adult
29 survival.

30 Within the study area, critical habitat for Eulachon includes the Klamath River
31 from the mouth upstream to the confluence with Omogar Creek. The critical
32 habitat designation specifically excludes all lands of the Yurok Tribe and
33 Reshigini Rancheria, based upon a determination that the benefits of exclusion
34 outweigh the benefits of designation (NMFS 2011b). Exclusion of these areas
35 will not result in the extinction of the Southern DPS because the
36 overall percentage of critical habitat on Indian lands is so small (approximately
37 5 percent of the total are designated), and it is likely that Eulachon production on
38 these lands represents a small percent of the total annual production for the DPS
39 (NMFS 2011a, 2011b).

40 **9.3.3 Trinity River Region**

41 The Trinity River Region includes Trinity Lake, Lewiston Reservoir and the
42 Trinity River from Lewiston Reservoir to the confluence with the Klamath River;
43 and the portion of the lower Klamath River watershed in Humboldt and Del Norte
44 counties from the confluence with the Trinity River to the Pacific Ocean. The

1 CVP Trinity Lake and Lewiston Reservoir are located upstream of the
 2 confluences of several Trinity River tributaries (i.e., north fork, south fork, and
 3 New River) and flows on these tributaries are not affected by CVP facilities. The
 4 Trinity River flows approximately 112 miles from Lewiston Reservoir to its
 5 confluence with the Klamath River, traversing through Trinity and Humboldt
 6 counties and the Hoopa Indian Reservation within Trinity and Humboldt counties.
 7 The Trinity River is the largest tributary to the Klamath River (DOI and
 8 DFG 2012).

9 The lower Klamath River flows 43.5 miles from the confluence with the Trinity
 10 River to the Pacific Ocean (USFWS et al. 1999). Downstream of the Trinity
 11 River confluence, the Klamath River flows through Humboldt and Del Norte
 12 counties and through the Hoopa Indian Reservation, Yurok Indian Reservation,
 13 and Resighini Indian Reservation within Humboldt and Del Norte counties (DOI
 14 and DFG 2012). There are no dams located in the Klamath River watershed
 15 downstream of the confluence with the Trinity River. The Klamath River estuary
 16 extends from approximately 5 miles upstream of the Pacific Ocean. This area is
 17 generally under tidal effects, and salt water can occur up to 4 miles from the
 18 coastline during high tides in summer and fall when Klamath River flows are low.

19 **9.3.3.1 Trinity Lake and Lewiston Reservoir**

20 Trinity Lake is created by Trinity Dam and is considered relatively unproductive,
 21 with low-standing crops of phytoplankton and zooplankton (USFWS et al. 2004).
 22 The fish in Trinity Lake include cold-water and warm-water species. Trinity
 23 Lake supports a trophy Smallmouth Bass fishery and provides substantial sport
 24 fishing for Largemouth Bass, Rainbow and Brown Trout, and Kokanee Salmon
 25 (landlocked Sockeye Salmon). Other fish species in Trinity Lake include
 26 Speckled Dace, Klamath Smallscale Sucker, Coast Range Sculpin, and the
 27 nonnative Green Sunfish and Brown Bullhead.

28 Lewiston Reservoir is a re-regulating reservoir for Trinity Lake. The water
 29 surface elevation is relatively constant. The reservoir contains Rainbow, Brown,
 30 and Brook Trout and Kokanee Salmon. Other fish species present include Pacific
 31 Lamprey, Speckled Dace, Klamath Smallscale Sucker, Coast Range Sculpin, and
 32 Smallmouth Bass (USFWS et al. 2004).

33 **9.3.3.2 Trinity River from Lewiston Reservoir to Klamath River**

34 The Trinity River flows out of Trinity Lake and Lewiston Reservoir. Native
 35 anadromous salmonids in the mainstem Trinity River and its tributaries
 36 downstream of Lewiston Dam are spring- and fall-run Chinook Salmon, Coho
 37 Salmon, and steelhead (NCRWQCB et al. 2009). Native non-salmonid
 38 anadromous species that inhabit the Trinity River Basin include Green Sturgeon,
 39 White Sturgeon, Pacific Lamprey, and Eulachon.

40 The hydrologic and geomorphic changes following construction of the Trinity and
 41 Lewiston dams changed the character of the river channel substantially and
 42 altered the quantity and quality of aquatic habitat. Riparian vegetation was
 43 allowed to encroach on areas that had previously been scoured by flood flows,

1 resulting in the formation of a riparian berm that armored and anchored the river
2 banks and prevented meandering of the river channel (USFWS et al. 1999). The
3 berm reduced the potential for encroachment and maturation of woody vegetation
4 along the stabilized channel.

5 The ongoing Trinity River Restoration Program includes specific minimum
6 instream flows (as described in Chapter 5, Surface Water Resources and Water
7 Supplies); mechanical channel rehabilitation; fine and coarse sediment
8 management; watershed restoration; infrastructure improvement; and adaptive
9 management components (NCRWQCB et al. 2009, USFWS et al. 1999). The
10 mechanical channel rehabilitation includes removal of fossilized riparian berms
11 that had been anchored by extensive woody vegetation root systems and had
12 confined the river. Following removal of the berms, the areas have been
13 re-vegetated to support native vegetation, re-establish alternate point bars, and
14 re-establish complex fish habitat similar to conditions prior to construction of the
15 dams. Sediment management activities include introduction of coarse sediment at
16 locations to support spawning and other aquatic life stages; and relocation of sand
17 outside of the floodway. In areas closer to Lewiston Dam with limited gravel
18 supply, gravel/cobble point bars are being rebuilt to increase gravel storage and
19 improve channel dynamics. Riparian vegetation planted on the restored
20 floodplains and flows will be managed to encourage natural riparian growth on
21 the floodplain and limit encroachment on the newly formed gravel bars.
22 Improvement projects have been completed and others are under construction or
23 in the planning phases. These restoration actions are occurring in the 40-mile
24 restoration reach between Lewiston Dam and the confluence with north fork of
25 the Trinity River (TRRP 2014).

26 **9.3.3.2.1 Fish in the Trinity River**

27 The following focal fish species that occur in the Trinity River are considered in
28 this EIS.

- 29 • Coho Salmon
- 30 • Chinook Salmon (spring- and fall-run)
- 31 • Steelhead (winter-and summer-run)
- 32 • Green Sturgeon
- 33 • White Sturgeon
- 34 • Pacific Lamprey
- 35 • American Shad

36 *Coho Salmon*

37 Coho Salmon in the Trinity River are thought to be exclusively 3-year lifecycle
38 fish, living a full year in the river as juveniles before migrating to the ocean.
39 Most returning adult Coho Salmon enter rivers between August and January.
40 Spawning in the Trinity River and tributaries occurs primarily in November and
41 December. Most of the spawning by Coho Salmon in the mainstem Trinity River
42 occurs from Lewiston Dam downstream to the North Fork Trinity confluence
43 (NMFS 2014a). Coho Salmon eggs incubate from 35 to more than 100 days,

1 depending on water temperature, and emerge from the gravel 2 weeks to 7 weeks
2 after hatching. Because juvenile Coho Salmon remain in their spawning stream
3 for a full year after emerging from the gravel, they are exposed to a broad range
4 of freshwater conditions. Coho Salmon smolts typically migrate to the ocean
5 between March and June, with most leaving in April and May (the term “smolt”
6 refers to young salmon prior to entering the ocean that have undergone the
7 physiological changes necessary for life in salt water).

8 Coho Salmon were not likely the dominant species of salmon in the Trinity River
9 before dam construction. However, the species was widespread in the Trinity
10 River Basin, ranging as far upstream as Stuarts Fork above present-day Trinity
11 Dam. Passage for Coho Salmon and other anadromous salmonids is now blocked
12 at Lewiston Dam, which prevents access to roughly 109 miles of upstream habitat
13 for Coho Salmon (DOI 2000). The Trinity River Salmon and Steelhead Hatchery
14 (Trinity River Hatchery) produces Coho Salmon with an annual production goal
15 of 500,000 yearlings to mitigate the upstream habitat loss (CHSRG 2012).

16 Several interrelated factors affect Coho Salmon abundance and distribution in the
17 Trinity River. These factors include degradation of spawning and rearing habitat,
18 sparse spawning gravel recruitment, lack of deep pools, stressful late summer
19 water temperatures, water diversions, channelization and confinement, irregular
20 timing of flows, fragmentation of populations, genetic and ecological interactions
21 with hatchery salmonids, migration barriers, water quality problems, and
22 unscreened diversions (NMFS 2014a). Current CVP operations primarily affect
23 water temperature, water flow, and habitat suitability in the Trinity River
24 (Reclamation 2008a). Currently accessible habitat downstream of Lewiston Dam
25 represents about 50 percent of historically available habitat (USFWS 1999).

26 Habitat in the Trinity River has changed since flow regulation that began with the
27 completion of Trinity and Lewiston dams, with the encroachment of riparian
28 vegetation restricting channel movement and limiting fry rearing habitat (Trush
29 et al. 2000). The Trinity River Restoration Program is implemented to provide
30 higher peak flows to restore attributes of a fully functioning alluvial river, such as
31 alternating bar features and additional off-channel habitat, and to provide better
32 rearing habitat for Coho Salmon (Reclamation 2008a, TRRP 2013). Several
33 restoration actions have been completed to reconnect the river with the floodplain,
34 including selective removal of terraces and riparian berms and physical alteration
35 of the adjacent floodplain to increase inundation frequency. Releases from
36 Trinity Lake occur on a variable flow schedule with higher spring releases to
37 promote the restored geomorphic processes and habitat.

38 An estimated 21,906 adult Coho Salmon migrated into the Trinity River Basin
39 upstream of Willow Creek (about 88 miles downstream of Lewiston Dam) in
40 2013, of which 6,631 entered Trinity River Hatchery (located near Lewiston
41 Dam) and 15,275 were estimated to have spawned in the river (CDFW 2014).
42 The run-size estimates have ranged from 852 fish in 1994 to 59,079 fish in 1987.
43 The 2011 run was ranked 10th of the 37 years on record and is 27.6 percent of the
44 17,161 average (CDFW 2014). Both intra- and inter-specific redd
45 superimposition on the spawning grounds can affect salmon reproductive success

1 and the spawning areas downstream of Lewiston Dam are likely near carrying
2 capacity (NMFS 2014a).

3 *Spring-run Chinook Salmon*

4 Adult spring-run Chinook Salmon migrate upstream in the Trinity River from
5 April through September, with most fish arriving at the mouth of the North Fork
6 Trinity by the end of July. These fish remain in deep pools until the onset of the
7 spawning season, which typically begins the third week of September, peaks in
8 October, and continues through November. The distribution of spawning extends
9 upstream to Lewiston Dam, and is concentrated in the reaches immediately
10 downstream of the dam to the mouth of the North Fork Trinity River. Williams
11 et al. (2011) concluded that although abundance is low compared with historical
12 abundance, the current spring-run Chinook Salmon population (which includes
13 hatchery fish) appears to have been fairly stable for the past 30 years. In 2013, an
14 estimated 8,961 spring-run Chinook Salmon entered the Trinity River upstream of
15 Junction City, including the 2,578 fish that entered the Trinity River Hatchery and
16 6,129 natural area spawners (CDFW 2014). This run-size estimate is
17 approximately 51 percent of the 34-year average spring-run Chinook Salmon run-
18 size of 17,402, which has ranged from 2,381 fish in 1991 to 62,692 fish in 1988
19 (CDFW 2014).

20 Emergence of spring-run Chinook Salmon fry in the Trinity River begins in
21 December and continues into mid-April. Juvenile spring-run Chinook Salmon
22 typically outmigrate after a year of growth in the Trinity River. Outmigration
23 from the lower Trinity River, as indicated by monitoring near Willow Creek,
24 peaks in May and June.

25 *Fall-run Chinook Salmon*

26 The adult fall-run Chinook Salmon migration in the Trinity River begins in
27 August and continues into December, with spawning beginning in mid-October.
28 Spawning activity peaks in November, and continues through December.
29 Spawning of fall-run Chinook Salmon occurs throughout the mainstem Trinity
30 River from Lewiston Dam to the Hoopa Valley (Myers et al. 1998). The first
31 spawning activity usually occurs just downstream from Lewiston Dam and
32 extends farther downstream as the spawning season progresses.

33 Like spring-run Chinook Salmon, emergence of fall-run Chinook Salmon fry
34 begins in December and continues into mid-April. Juvenile fall-run Chinook
35 Salmon typically outmigrate after a few months of growth in the Trinity River.
36 Outmigration from the upper river, as indicated by monitoring near Junction City,
37 begins in March and peaks in early May, ending by late May or early June.
38 Outmigration of fall-run Chinook Salmon fry in the lower Trinity River occurs
39 over approximately the same time period described above for the spring run.

40 An estimated 36,989 fall-run Chinook Salmon migrated into the Trinity River
41 upstream of Willow Creek in 2013, of which 3,852 entered Trinity River
42 Hatchery and 32,257 spawned naturally (CDFW 2014). This estimate is
43 approximately 84.5 percent of the 43,762 mean run-size for the years since 1977,
44 which has ranged from 9,207 fish in 1991 to 147,888 fish in 1986 (CDFW 2014).

1 *Steelhead*

2 Steelhead in the Trinity River exhibit two primary life history strategies: a
3 summer-run that is stream maturing and a winter-run that is ocean maturing. The
4 winter-run is considered by some to be composed of a fall-run and a winter-run
5 based upon the timing of the adult migration. Summer-run steelhead have been
6 observed in the north and south forks of the Trinity River and in the tributaries of
7 New River and Canyon Creek (BLM 1995).

8 Adult summer-run steelhead enter the Trinity River from April through
9 September and over-summer in deep pools within the mainstem. Some enter the
10 smaller tributary streams of the Trinity River during the first November rains
11 (Hill 2010), with most fish spawning in both the mainstem and tributaries from
12 February through April (USFWS et al. 2004). Summer-run steelhead spawner
13 escapements for the Trinity River upstream of Lewiston Dam prior to its
14 construction were estimated to average 8,000 adults annually. Post-dam survey
15 (reported in 2004) ranged from 20 to 1,037 adult summer steelhead in the
16 tributaries and Trinity River (USFWS et al. 2004).

17 Juvenile summer-run steelhead may rear in fresh water for up to three years
18 before outmigrating. Rearing in the Trinity River is highly variable, but most
19 summer-run steelhead either outmigrate as young-of-the-year (YOY) or at age 1+
20 (Scheiff et al. 2001, Pinnix and Quinn 2009, Pinnix et al. 2013). For juveniles
21 that rear at least a year in fresh water, survival appears to be higher for those that
22 outmigrate to the ocean at age 2+ (DFG 1998a). Juveniles outmigrating from the
23 tributaries as 0+ or age 1+ may rear in the mainstem or in nonnatal tributaries
24 (particularly during periods of poor water quality) for one or more years before
25 smolting. Juvenile outmigration can occur from spring through fall, with three
26 peak migration periods including March, May/June, and October/November
27 (USFWS et al. 2004).

28 Fall-run and winter-run steelhead also are widely distributed throughout the
29 Trinity River. Adult fall-run steelhead enter the Klamath River system in
30 September and October (Hill 2010) and likely spawn in tributaries such as the
31 Trinity River from January through April. Adult winter-run steelhead begin their
32 upstream migration in the Klamath River from November through March
33 (USFWS 1997). Winter-run steelhead primarily spawn in Klamath River
34 tributaries (including the Trinity River) from January through April (USFWS
35 1997), with peak spawn timing in February and March (NRC 2004).

36 An estimated run-size of 16,594 adult fall-run steelhead migrated into the Trinity
37 River upstream of Willow Creek in 2013, including the 2,375 fish (80 natural-
38 origin and 2,295 hatchery-origin) that entered the Trinity River Hatchery and
39 13,560 natural area spawners (9,039 of natural origin and 4,521 of hatchery
40 origin) (CDFW 2014). Since 1980, run-size estimates have ranged from 2,972 in
41 1998 to 53,885 in 2007. The estimated abundance of steelhead in 2013 was
42 8.4 percent above the average since 1980 (CDFW 2014).

1 *Green Sturgeon*

2 Limited Green Sturgeon data has been collected in the Trinity River, so most
3 information on life history characteristics for Green Sturgeon in the Trinity River
4 is based on data from the Klamath River. Green Sturgeon in the Klamath River
5 sampled during their spawning migration ranged in age from 16 to 40 years (Van
6 Eenennaam et al. 2006). Green Sturgeon are generally believed to have a life
7 span of at least 50 years and spawn every four years on average after around
8 age 16 (Klimley et al. 2007). Green Sturgeon enter the Trinity and Klamath rivers
9 to spawn from February through July, and most spawning occurs from the middle
10 of April to the middle of June (NRC 2004). After spawning, around 25 percent of
11 Green Sturgeon migrate directly back to the ocean (Benson et al. 2007), and the
12 remainder hold in mainstem pools through November. During the onset of fall
13 rainstorms and increased river flow, adult sturgeon move downstream and leave
14 the river system (Benson et al. 2007). Juvenile Green Sturgeon may rear for one
15 to three years in the Klamath River system before they migrate to the estuary and
16 Pacific Ocean (NRC 2004, FERC 2007a, CALFED 2007), usually during summer
17 and fall (Emmett et al. 1991, Hardy and Addley 2001).

18 In the Trinity River Basin, Green Sturgeon are known to spawn in the mainstem
19 from the confluence with the Klamath to as far upstream as Gray's Falls near
20 Burnt Ranch. Juveniles are captured in rotary screw traps at Willow Creek on the
21 Trinity River (Scheiff et al. 2001, Pinnix and Quinn 2009).

22 *White Sturgeon*

23 White Sturgeon are uncommon in the Klamath and Trinity rivers and spawning
24 may not occur (NRC 2004). Historically there may have been small spawning
25 runs in these rivers; almost all of the sturgeon occurring above the Klamath
26 estuary are Green Sturgeon (Moyle 2002).

27 *Pacific Lamprey*

28 Pacific Lamprey are the only anadromous lamprey species in the Trinity River
29 Basin. This species is important to local tribes and supports a subsistence fishery
30 on the lower Trinity River. Although no systematic distribution surveys are
31 available for the Trinity River Basin, they are expected to have a distribution
32 similar to anadromous salmonids that use the mainstem Trinity River and
33 accessible reaches of larger tributaries. No current status assessments are
34 available for Pacific Lamprey in the Trinity River, but information from tribal
35 fishermen who catch lampreys in the lower Klamath River suggests a decline that
36 mirrors that observed across the species' range (Petersen Lewis 2009).

37 Adult Pacific Lampreys have been documented entering the Klamath River from
38 the ocean during all months of the year, with peak upstream migration to holding
39 areas from December through June (Larson and Belchik 1998, Petersen Lewis
40 2009). Migration up the Trinity River is expected to begin slightly later. After
41 entering fresh water as sexually immature adults and undergoing an initial
42 migration, Pacific Lampreys hold through summer and most of winter before
43 spawning the following spring when they reach sexual maturity (Robinson and
44 Bayer 2005, Clemens et al. 2012). After the holding period, individuals undergo

1 a secondary migration in the late winter or early spring from holding areas to
2 spawning grounds (Robinson and Bayer 2005, Clemens et al. 2012, Lampman
3 2011). Thus, adult Pacific Lampreys with varying levels of sexual maturity may
4 be in the Trinity River throughout the year. Ammocoetes (the larval stage of
5 lamprey) inhabit fine substrates in depositional areas, rearing in the Trinity River
6 and tributaries year-round for up to 7 years before outmigrating to the ocean
7 (Moyle 2002, Reclamation and Trinity County 2006).

8 Little information is available on factors that influence populations of Pacific
9 Lamprey in the Trinity River, but they are affected by many of the same factors as
10 salmon and steelhead, because of parallels in their life cycles. Lack of access to
11 historical spawning habitats caused by the mainstem dams and other migration
12 barriers, modification of spawning and rearing habitat because of downstream
13 impacts from dams, altered hydrology, and predation by nonnative invasive
14 species such as Brown Trout have likely contributed to adverse effects on the
15 Trinity River Pacific Lamprey population.

16 *American Shad*

17 American Shad, an introduced, anadromous fish, has become established in the
18 Klamath and Trinity rivers. American Shad occur in the lowermost portions of
19 the Trinity River, but are primarily found in the lower Klamath River. Adult fish
20 enter estuaries or streams in late spring or early summer and spawn soon
21 afterward in fresh water. Juvenile shad have been captured regularly in the
22 rotary-screw traps at the Pear Tree and Willow Creek sites during salmonid
23 outmigrant monitoring (Scheiff et al. 2001, Pinnix and Quinn 2009, Pinnix et al.
24 2013). Sport fishing for American Shad occurs seasonally throughout the lower
25 Trinity River.

26 **9.3.3.2.2 Hatcheries on the Trinity River**

27 The Trinity River Hatchery is located immediately downstream of Lewiston Dam,
28 and is operated by CDFW and funded by Reclamation to mitigate the loss of
29 salmonid production upstream of Lewiston Dam resulting from the Trinity Dam
30 (Reclamation 2008a). The hatchery produces Coho Salmon, fall-run Chinook
31 Salmon, spring-run Chinook Salmon, and steelhead. The hatchery's Coho
32 Salmon program currently uses only endemic Coho Salmon broodstock and
33 releases approximately 500,000 yearlings annually from March 15 to May 15.
34 The fall-run Chinook Salmon program has a goal of releasing two million sub-
35 yearlings in June and 900,000 yearlings in October from in-river broodstock, and
36 the spring-run Chinook Salmon program has a goal of releasing one million
37 subyearlings in June and 400,000 yearlings in October from in-river broodstock.
38 The steelhead program currently uses only in-river broodstock with a goal to
39 release 800,000 steelhead smolts (approximately six inches) from March 15 to
40 May 1.

1 **9.3.3.3 Lower Klamath River from Trinity River to Pacific Ocean**

2 The Lower Klamath River begins where the Trinity River flows into it near
3 Weitchpec, which is located about 43 miles upstream from the Pacific Ocean.
4 The Trinity River is the largest tributary of the Klamath River and makes a
5 substantial contribution to the flows in the lower Klamath River. This section of
6 the Klamath River serves primarily as a migration corridor for salmonids, with
7 most spawning and rearing upstream of the confluence with the Trinity River or
8 in the larger tributaries (e.g., Blue Creek) to the mainstem Klamath River.

9 **9.3.3.3.1 Fish in the Lower Klamath River**

10 Focal fish species that occur in the lower Klamath River downstream of the
11 Trinity River confluence are included for analysis in this EIS and include all those
12 found in the Trinity River, as described above, with the exception of Eulachon.

13 Eulachon is a smelt species in the Klamath River system found upstream of the
14 estuary. Eulachon are anadromous broadcast spawners that spawn in the lower
15 reaches of rivers and tributaries and usually die after spawning. Eulachon are
16 sexually mature at 2 years and spawn at ages 3, 4, and/or 5 (Scott and Crossman
17 1973). Timing of the spawning migration in the Klamath River is similar to other
18 known runs of Eulachon, beginning in December and continuing until May, with
19 a peak in March and April (YTFP 1998, Larson and Belchik 1998).

20 In the Klamath River, adult Eulachon generally migrate as high as Brooks Riffle,
21 about 40 kilometers (about 24 miles) upstream of the mouth, but have been
22 observed as high as Pecwan Creek and even Weitchpec during exceptional years
23 (YTFP 1998); specific spawning areas are unknown. Eggs hatch in 20 to 40 days
24 depending on water temperature, taking longer at cooler temperatures. After
25 hatching, the larvae are passively carried from spawning grounds to the ocean via
26 river currents (Scott and Crossman 1973).

27 This species was historically important to local tribes and supported a subsistence
28 fishery on the lower Klamath River. According to accounts of Yurok Tribal
29 elders, there were annual runs so great that one had no problem catching “as many
30 as you wanted;” however, the last noticeable runs of Eulachon were observed in
31 1988 and 1989 by Tribal fishers (Larson and Belchik 1998). In 1996, YTFP
32 sampling efforts to capture Eulachon were unsuccessful, although a Yurok Tribal
33 member gave the YTFP a Eulachon he had caught while fishing for lamprey at the
34 mouth of the river (Larson and Belchik 1998). However, it is likely that the
35 Eulachon has been extirpated or nearly so on the lower Klamath River
36 (NMFS 2015).

37 **9.3.4 Central Valley Region**

38 Fish and aquatic resources in the Central Valley Region are described in this
39 section in accordance with the following major waterbodies.

- 40 • Shasta Lake and Keswick Reservoir
- 41 • Whiskeytown Lake
- 42 • Clear Creek

- 1 • Sacramento River from Keswick Reservoir to the Delta (near Freeport)
- 2 • Battle Creek
- 3 • Feather River
- 4 • Yuba and Bear Rivers
- 5 • American River
- 6 • Delta
- 7 • Yolo Bypass
- 8 • Millerton Lake
- 9 • San Joaquin River from the Stanislaus River confluence to the Delta (near
- 10 Vernalis)
- 11 • New Melones Reservoir, Tulloch Reservoir, and the reservoir formed by
- 12 Goodwin Dam
- 13 • Stanislaus River
- 14 • San Luis Reservoir

15 **9.3.4.1 Shasta Lake and Keswick Reservoir**

16 Shasta Lake is formed by Shasta Dam, which is located on the Sacramento River
 17 just downstream of the confluence of the Sacramento, McCloud, and Pit rivers.
 18 Shasta Dam has no fish passage facilities; however, the dam has a fish trapping
 19 facility that operates in conjunction with Livingston Stone National Fish Hatchery
 20 below Shasta Dam.

21 **9.3.4.1.1 Shasta Lake**

22 Shasta Lake fish species include native and introduced warm-water and cold-
 23 water species. Major nonfish aquatic animal species assemblages in Shasta Lake
 24 include benthic macroinvertebrates and zooplankton (Reclamation 2013b).
 25 Shasta Lake is typically thermally stratified from April through November, during
 26 which time the upper layer (epilimnion) can reach a peak water temperature of
 27 80 degrees Fahrenheit (°F) (Reclamation 2003). The upper layer of Shasta Lake
 28 supports warm-water game fish, and the lower layers (metalimnion and
 29 hypolimnion) support cold-water fishes. Nonnative, warm-water fish species in
 30 Shasta Lake include Smallmouth Bass, Largemouth Bass, Spotted Bass, Black
 31 Crappie, Bluegill, Green Sunfish, Channel Catfish, White Catfish, and Brown
 32 Bullhead (DWR et al. 2013). Cold-water species include Rainbow Trout, Brown
 33 Trout, landlocked White Sturgeon, landlocked Coho Salmon (Reclamation et al.
 34 2003), and landlocked Chinook Salmon (Reclamation 2013). Other fish species
 35 in Shasta Lake include Golden Shiner, Threadfin Shad, Common Carp, and the
 36 native Hardhead, Sacramento Sucker, and Sacramento Pikeminnow (DWR et al.
 37 2013, Reclamation 2013).

1 Water quality in Shasta Lake is generally considered good, largely because of the
2 continual inflow of cool, high-quality water from the major tributaries to the lake.
3 The primary water quality concerns in the lake is turbidity, typically associated
4 with heavy rainfall events that move soils and runoff from abandoned mines in
5 the area into the lake.

6 Warm-water fish habitat in Shasta Lake is influenced primarily by fluctuations in
7 the lake level and the availability of shoreline cover (Reclamation 2003). Water
8 surface elevations in Shasta Lake can fluctuate approximately 55 feet annually as
9 a result of operation of Shasta and Sacramento River diversions (Reclamation
10 2003). Reservoir surface elevation fluctuations can disturb shallow, nearshore
11 habitats, including spawning and rearing habitat for warm-water fish species. The
12 shoreline of Shasta Lake is generally steep, which limits shallow, warm-water fish
13 habitat, and is not conducive to the establishment of vegetation or other shoreline
14 cover (Reclamation 2003).

15 **9.3.4.1.2 Keswick Reservoir**

16 Keswick Reservoir is a re-regulating reservoir for Shasta Lake. The water surface
17 elevation is relatively constant. Residence time for water in Keswick Reservoir is
18 about a day, compared with a residence time of about a year for water in Shasta
19 Lake. Consequently, water temperatures tend to be controlled by releases from
20 Shasta Dam and average less than 55°F. Despite the cool temperatures, the
21 reservoir supports warm-water and cold-water fishes, including Largemouth Bass,
22 crappie and catfish, and Rainbow Trout (Reclamation 2003).

23 **9.3.4.2 Whiskeytown Lake**

24 Water is diverted from the Trinity River at Lewiston Dam and discharged via the
25 Clear Creek Tunnel into Whiskeytown Lake on Clear Creek. From Whiskeytown
26 Lake, water is released into the lower portion of Clear Creek via Whiskeytown
27 Dam and into Keswick Reservoir through the Spring Creek Tunnel. There are
28 two temperature control curtains in Whiskeytown Lake: Oak Bottom and Spring
29 Creek (Reclamation 2008a). The Oak Bottom temperature control curtain serves
30 as a barrier to prevent warm water in the reservoir from mixing with cold water
31 from Lewiston Lake entering through the Carr Powerhouse. The Oak Bottom
32 curtain is damaged and cannot be fully deployed; it is scheduled to be repaired in
33 2015. The Spring Creek temperature control curtain was replaced in 2011 and
34 aids cold-water movement into the underwater intake for the Spring Creek
35 Tunnel.

36 The fish assemblage in Whiskeytown Lake includes cold-water and warm-water
37 species. Common fishes known to occur in Whiskeytown Lake include Rainbow
38 Trout, Brown Trout, Kokanee Salmon, Largemouth Bass, crappie, sunfish,
39 catfish, and bullhead (USFWS et al. 2004).

40 **9.3.4.3 Clear Creek**

41 The project area includes the reach of Clear Creek extending from Whiskeytown
42 Dam to the confluence with the Sacramento River. Since 1995, extensive habitat
43 and flow restoration in Clear Creek has occurred under the Central Valley Project

1 Improvement Act (CVPIA) and CALFED programs and in accordance with the
2 NMFS 2009 BO. The Clear Creek Technical Team has been working since 1996
3 to facilitate implementation of CVPIA anadromous salmonid restoration actions
4 (Brown et al. 2012). Restoration efforts have resulted in increased stocks of
5 fall-run Chinook Salmon and re-established populations of spring-run Chinook
6 Salmon and steelhead.

7 **9.3.4.3.1 Fish in Clear Creek**

8 This analysis is focused on Chinook Salmon, steelhead, and Pacific Lamprey in
9 Clear Creek.

10 *Spring-run Chinook Salmon*

11 Clear Creek currently supports a modest run of spring-run Chinook Salmon,
12 which since 1998 has ranged from 0 in 2001 to an estimated high of 659 fish in
13 2013 (CDFW 2014). Adult spring-run Chinook Salmon migrate into Clear Creek
14 from April through September. Adult fish tend to move as far upstream as
15 possible to access cooler temperatures downstream of Whiskeytown Dam and
16 hold over in summer until spawning in September through October. In the NMFS
17 2009 BO, NMFS expressed concern that spring-run Chinook Salmon unable to
18 enter Clear Creek for spawning could hybridize with fall-run Chinook Salmon
19 spawning in the Sacramento River (NMFS 2009a).

20 NMFS (2009a) reported that insufficient instream flows could fail to attract adult
21 spring-run holding in the Sacramento River mainstem into Clear Creek. Adult
22 spring-run Chinook Salmon tend to spread downstream of their holding areas
23 prior to spawning (from Whiskeytown Dam downstream to the Clear Creek Road
24 Bridge) from September through October. Egg incubation occurs from
25 September through December, and juveniles rear from October through April
26 (NMFS 2009a).

27 Spawning gravel is annually augmented in Clear Creek downstream of
28 Whiskeytown Dam under the CVPIA Clear Creek Restoration Program and in
29 accordance with the 2009 NMFS BO (Reclamation 2013a). Additionally, water
30 temperature criteria to protect spring-run Chinook Salmon during spawning and
31 incubation are generally met; however, in recent years, water temperatures in
32 Clear Creek during the spawning and incubation period (i.e., September 15 to
33 October 31) have exceeded the temperature targets at times (Brown et al. 2012).

34 Based on rotary screw trap captures, juvenile spring-run Chinook Salmon
35 outmigrate from Clear Creek from May through February. Peak outmigration
36 occurs over a 9-week period from early December 2008 through early February
37 2009 (Earley et al. 2010). Trap data indicate that the majority of juveniles
38 identified as spring-run (based on length-at-date size criteria) leave as age-0 fish,
39 less than 40 millimeter (mm) in fork length (USFWS 2008b, Earley et al. 2010).

40 *Fall-/Late Fall-run Chinook Salmon*

41 Since 1995, restoration activities implemented in accordance with programs
42 implemented under the CVPIA, CALFED, and the 2009 NMFS BO have
43 increased stocks of fall-run Chinook Salmon by more than 400 percent (Brown

1 2011). In 2014, fall-run Chinook Salmon estimated escapement was 15,794
2 compared to the average baseline (1967-1991) estimated escapement of 1,689.

3 Fall/late fall-run Chinook Salmon primarily use the lower reaches of Clear Creek
4 for all life history phases. Fall-run Chinook migrate into Clear Creek between the
5 spring- and late fall-runs and spawn in October through December (USFWS
6 2015). A picket weir installed about 7.4 miles upstream of the confluence with
7 the Sacramento River from August 1 to November 1 is used to prevent fall-run
8 Chinook Salmon from spawning in the upper reaches with spring-run.

9 Late-fall-run Chinook Salmon migrate into Clear Creek from November through
10 April, with peak migration in December; peak spawning occurs in January.

11 Based on rotary screw trap captures and length-at-date size criteria, fall-run
12 Chinook Salmon make up the vast majority of all Chinook Salmon outmigrating
13 from lower Clear Creek. Late fall-run juveniles constitute a small percentage of
14 juvenile Chinook Salmon leaving Clear Creek. Juvenile fall-/late fall-run
15 Chinook Salmon primarily outmigrate from Clear Creek as age-0 fish less than
16 40 mm in fork length (USFWS 2008b, Earley et al. 2010). Peak age-0
17 outmigration in 2008/2009 was from January and February for fall-run Chinook
18 Salmon and during April to May for late fall-run Chinook Salmon (Earley et al.
19 2010).

20 *Steelhead*

21 Operation of Whiskeytown Dam supports cold-water habitat for steelhead in
22 Clear Creek, the amount of which depends on flow releases which range from
23 30 to 200 cubic feet per second (cfs) depending on water year type (Reclamation
24 2008a). Steelhead have recolonized the habitat that became accessible with the
25 removal of the McCormick-Saeltzer Dam in 2000. Redd surveys conducted since
26 2003 indicate that a small, but increasing population of steelhead resides in Clear
27 Creek, with the highest density in the first mile below Whiskeytown Dam
28 (USFWS 2007).

29 Adult steelhead immigration into Clear Creek usually occurs from August through
30 March, with a peak occurring from September to November (USFWS 2008b).
31 Adult steelhead tend to hold in the upper reaches of Clear Creek from September
32 to December.

33 Spawning typically begins in December and continues through early March. Peak
34 spawning occurs from late January to early February (USFWS 2007). The
35 embryo incubation life stage begins with the onset of spawning in late December
36 and generally extends through April.

37 Spawning distribution has recently expanded from the upper 4 miles of lower
38 Clear Creek to the entire 17 miles of lower Clear Creek, although it appears to be
39 concentrated in areas of newly added spawning gravels. Recently, more steelhead
40 were observed spawning in the lowest reach of the creek where resulting juveniles
41 can be subject to warmer water temperatures during summer (Brown 2011).

1 Summertime water temperatures are often critical for steelhead rearing and limit
2 rearing habitat quality in many streams. Instream flow releases are intended to
3 maintain suitable water temperatures throughout most of Clear Creek during
4 summer. Snorkel surveys from 1999 to 2002 indicate that rearing steelhead may
5 be present throughout all of lower Clear Creek (Good et al. 2005). Based on
6 rotary screw trap captures, fry make up the vast majority of all steelhead/Rainbow
7 Trout captured in lower Clear Creek. Peak outmigration of juvenile steelhead fry
8 occurred from mid-March through April of 2009 (Earley et al. 2010).

9 *Pacific Lamprey*

10 Pacific Lamprey is expected to inhabit all reaches in Clear Creek upstream to
11 Whiskeytown Dam. The loss of access to historical habitat and apparent
12 population declines throughout California and the Sacramento and San Joaquin
13 River basins indicate the population is likely reduced compared with historical
14 levels (Moyle et al. 2009). Little information is available on factors influencing
15 populations of Pacific Lamprey in Clear Creek, but they are likely affected by
16 many of the same factors as salmon and steelhead because of parallels in their
17 life cycles.

18 Ocean stage adult Pacific Lampreys likely migrate into Clear Creek in summer,
19 where they hold for approximately 1 year before spawning (Hanni et al. 2006).
20 No information is available on spawning in Clear Creek; however, spawning
21 period documented by Hannon and Deason (2008) for Pacific Lampreys in the
22 American River of early January to late May, with peak spawning typically in
23 early April, may also apply to Clear Creek. Pacific Lamprey ammocoetes rear in
24 Clear Creek for all or part of their 5- to 7-year freshwater residence. Data from
25 rotary screw trapping in Clear Creek suggest that some outmigration of Pacific
26 Lampreys may occur year-round, but peak outmigration occurs from early winter
27 through spring (Hanni et al. 2006).

28 **9.3.4.3.2 Extent and Status of Aquatic Habitat**

29 Whiskeytown Dam limits the contribution of coarse sediment for transport
30 downstream in Clear Creek, which NMFS (2009a) reported has resulted in riffle
31 coarsening, fossilization of alluvial features, loss of fine sediments available for
32 overbank deposition, and considerable loss of spawning gravels. These
33 conditions affect spawning and rearing habitat on Clear Creek. Water flows and
34 temperatures conditions on Clear Creek are presented in Chapter 5, Surface Water
35 Resources and Water Supplies, and Chapter 6, Surface Water Quality,
36 respectively.

37 *Spawning Habitat*

38 An unpublished study conducted by USFWS (as cited in Brown 2011) suggested
39 that gravel transport blocked by the construction of Whiskeytown Dam reduced
40 spawning habitat in Clear Creek by 92 percent. Plans developed under CVPIA
41 implementation included a goal to create and maintain 347,288 square feet of
42 usable spawning habitat between Whiskeytown Dam to the former
43 McCormick-Saeltzer Dam by 2020. This area is equivalent to the spawning
44 habitat that existed before construction of Whiskeytown Dam (CVPIA 2014).

1 Brown (2011) noted that much of the degraded habitat has been restored by gravel
2 augmentation, but continued augmentation will be required. Spawning gravel is
3 annually augmented in Clear Creek downstream of Whiskeytown Dam, pursuant
4 to CVPIA implementation and Action of I.1.3 of the 2009 NMFS BO Reasonable
5 and Prudent Alternative (RPA). The CVPIA annual spawning gravel target is
6 25,000 tons per year; however, an average of 9,574 tons has been placed annually
7 since 1996. In 2012, a total of 9,974 tons of gravel was placed at four sites:
8 Guardian Rock site, Placer Bridge, Clear Creek Road Crossing, and at Tule
9 Backwater. A gravel injection project did not occur in 2013 (CVPIA 2014).

10 Most supplemental spawning gravel is placed into Clear Creek at long-term
11 injection sites awaiting high flows to move gravel into the creek. These gravel
12 addition projects have successfully created habitat suitable for spring-run Chinook
13 Salmon spawning as evidenced by the number of redds directly observed in
14 supplemental gravel or in supplemental gravel integrated into native gravel
15 (USFWS 2007, 2008b). Spawning area mapping performed annually since 2000
16 indicates the overall amount of area used by spawning fall-run Chinook Salmon
17 has been increasing, despite the adult population abundance remaining stable.
18 The amount of area used in 2008 was the highest measured and more than double
19 the amount used in 2000, suggesting that the gravel augmentation program has
20 been successful in creating new spawning habitat. Gravel augmentation also has
21 increased the amount of steelhead spawning habitat available in the lower reaches
22 of Clear Creek, and NMFS (2009a) has indicated that this directly relates to
23 higher fish abundance in recent years. In most locations, gravel additions created
24 spawning habitat that did not exist or had limited prior use.

25 Studies to determine the availability of fish habitat, expressed as Weighted
26 Useable Area (WUA), have been conducted by USFWS for Clear Creek
27 (USFWS 2006). For spring-run Chinook Salmon, it was determined that
28 spawning WUA peaked at the highest modeled flow (900 cfs) in the upstream
29 alluvial segment from Whiskeytown Dam to the NEED Camp Bridge. In the
30 canyon segment downstream (NEED Camp Bridge to the Clear Creek Road
31 Bridge) spawning habitat peaked at 650 cfs. The WUA for steelhead/Rainbow
32 Trout spawning habitat peaked at 350 cfs and 600 cfs in these segments,
33 respectively (USFWS 2007). In the lower reach downstream of the Clear Creek
34 Road Bridge, WUA for both fall-run Chinook Salmon and steelhead/Rainbow
35 Trout spawning habitat peaked at 300 cfs (USFWS 2011a).

36 At all flows, the amount of spawning habitat present in Clear Creek is less than
37 the amount needed to achieve the abundance recovery goal of spring-run Chinook
38 Salmon spawning (based on the original USFWS [2007] estimates). However,
39 the increased spawning habitat availability due to gravel additions since 2003
40 suggests that spawning habitat for spring-run Chinook Salmon is now more than
41 sufficient to support the recovery goal at all flows. At flows greater than 50 cfs,
42 the amount of spawning habitat present in Clear Creek is greater than the amount
43 of spawning habitat needed to achieve the abundance recovery goal for steelhead.
44 In contrast, the amount of spawning habitat present in Clear Creek is less than the

1 amount of spawning habitat needed to support 7,920 adult fall-run Chinook
2 Salmon in Clear Creek (USFWS 2015).

3 *Rearing Habitat*

4 The WUA for spring-run Chinook Salmon fry rearing peaked at 600 cfs in the
5 upstream alluvial segment from Whiskeytown Dam to the NEED Camp Bridge.
6 In the canyon segment downstream (NEED Camp Bridge to Clear Creek Road
7 Bridge), fry rearing habitat peaked at the highest modeled flow (900 cfs). The
8 WUA for steelhead/Rainbow Trout fry rearing habitat peaked at 700 cfs and
9 900 cfs (the maximum flow modeled) in these segments, respectively (USFWS
10 2011b). The WUA for spring-run Chinook Salmon and steelhead/Rainbow Trout
11 juvenile rearing habitat peaked at the highest modeled flow (900 cfs) in the upper
12 alluvial segment and 650 cfs in the canyon segment downstream. In the lower
13 reach downstream of the Clear Creek Road Bridge, WUA for both fall-run
14 Chinook Salmon and steelhead/Rainbow Trout fry rearing habitat peaked at
15 50 cfs; fry rearing habitat for spring-run Chinook Salmon peaked at 900 cfs.
16 Spring-run Chinook Salmon and steelhead/Rainbow Trout juvenile rearing habitat
17 peaked at 850 cfs, while fall-run Chinook Salmon juvenile rearing habitat peaked
18 at 350 cfs (USFWS 2013a).

19 As described above for spawning habitat, USFWS (2015) compared the total
20 amount or rearing habitat available for spring-run Chinook Salmon and
21 steelhead/Rainbow Trout to the amount of rearing habitat needed to support an
22 annual escapement of 833 adults for each species. The total amount of rearing
23 habitat available for fall-run Chinook Salmon was compared to the amount of
24 habitat needed to support an average escapement of 7,920 fall-run Chinook
25 Salmon. At all flows, the amount of rearing habitat present in Clear Creek is
26 greater than the amount needed to achieve the abundance recovery goal for
27 spring-run Chinook Salmon and steelhead. In contrast, the amount of rearing
28 habitat present in Clear Creek is less than the amount needed to support
29 7,920 adult fall-run Chinook Salmon in Clear Creek.

30 **9.3.4.3.3 Fish Passage**

31 Whiskeytown Dam blocks access to 25 miles of historical spring-run Chinook
32 Salmon and steelhead spawning and rearing habitat (Yoshiyama et al. 1996).
33 Until 2000, the McCormick-Saeltzer Dam was a barrier to upstream migration for
34 anadromous salmonids. After its removal, anadromous salmonids recolonized an
35 additional 12 miles of habitat upstream to Whiskeytown Dam. With the removal
36 of McCormick-Saeltzer Dam, passage of spring-run Chinook Salmon has
37 increased. Stream surveys and juvenile monitoring results also suggest that dam
38 removal has allowed reestablishment of spring-run Chinook Salmon and
39 steelhead. NMFS (2009a) reported that compared to fall-run Chinook Salmon,
40 spring-run Chinook Salmon historically spawned earlier and at locations farther
41 upstream in Clear Creek. However, NMFS (2009a) concluded that the
42 construction of Whiskeytown Dam likely caused a high degree of spatial overlap
43 between the fall-run and spring-run fish during spawning, resulting in a higher
44 probability of hybridization. To address this concern, USFWS has been

1 separating adult fall-run fish from the spring-run fish holding in the upper reaches
2 of Clear Creek with a segregation weir that is operated from August 1 to
3 November 1. After November 1, fall-run Chinook Salmon have access to the
4 entire river for spawning.

5 **9.3.4.4 Sacramento River from Keswick Reservoir to the Delta near**
6 **Freeport**

7 Aquatic resources in the Sacramento River are affected by the habitat along the
8 river and along the tributaries that connect to the river. Habitat along the river
9 ranges from artificial structures used for water supply and flood management to
10 open spaces that provide more natural types of habitat. The flow regime in the
11 Sacramento River is managed for water supply and flood management, as
12 described in Chapter 5, Surface Water Resources and Water Supplies. The
13 following discussion focuses on the fish in the Sacramento River and aquatic
14 habitat conditions.

15 **9.3.4.4.1 Fish in the Sacramento River**

16 The analysis is focused on the following species:

- 17 • Chinook Salmon (winter-, spring-, and fall/late fall-run)
- 18 • Steelhead
- 19 • Green Sturgeon
- 20 • White Sturgeon
- 21 • Sacramento Splittail
- 22 • Pacific Lamprey
- 23 • Striped Bass
- 24 • American Shad

25 *Winter-run Chinook Salmon*

26 Adult winter-run Chinook Salmon return to fresh water during winter but delay
27 spawning until spring and summer. Adults enter fresh water in an immature
28 reproductive state, similar to spring-run Chinook, but winter-run Chinook move
29 upstream much more quickly and then hold in the cool waters downstream of
30 Keswick Dam for an extended period before spawning. Juveniles spend about
31 5 to 9 months in the river and estuary systems before entering the ocean. This
32 life-history pattern differentiates the winter-run Chinook from other Sacramento
33 River Chinook runs and from all other populations within the range of Chinook
34 Salmon (DFG 1985, 1998b).

35 Access to approximately 58 percent of the original winter-run Chinook Salmon
36 habitat has been blocked by dam construction (Reclamation 2008a). The
37 remaining accessible habitat occurs in the Sacramento River downstream of
38 Keswick Dam and in Battle Creek. The number of winter-run Chinook Salmon in
39 Battle Creek is unknown, but if they do occur, they are scarce (Reclamation and
40 SWRCB 2003).

1 Escapement data indicate that the winter-run Chinook Salmon population
2 declined from its levels in the 1970s to relatively low levels through the 1980s
3 and 1990s, with a small rebound in the early 2000s (Azat 2012).

4 Adult winter-run Chinook Salmon migrate upstream past the location of the Red
5 Bluff Diversion Dam (RBDD) beginning in mid-December and continuing into
6 early August. Most of the run passes RBDD between January and May, with the
7 peak in mid-March (DFG 1985). Winter-run Chinook Salmon spawn only in the
8 Sacramento River, almost exclusively above RBDD, with the majority spawning
9 upstream of Balls Ferry, based on aerial redd survey data collected after passage
10 was provided past the Anderson-Cottonwood Irrigation District (ACID) diversion.
11 Aerial redd surveys have indicated that the winter-run Chinook Salmon spawning
12 distribution has shifted upstream since gravel introductions began in the upper
13 river near Keswick Dam; a high proportion of winter run Chinook spawn on the
14 recently placed gravel (USFWS and Reclamation 2008). Spawning occurs May
15 through July, with the peak in early June. Fry emergence occurs from mid-June
16 through mid-October and fry disperse to areas downstream for rearing. Juvenile
17 migration past RBDD may begin in late July, generally peaks in September, and
18 can continue until mid-March in drier years (Vogel and Marine 1991). The
19 majority (75 percent) of winter-run Chinook Salmon outmigrate past RBDD as
20 fry (Martin et al. 2001), where they rear before outmigrating to the Delta
21 primarily in December through April (Appendix 9B). Between 44 and 81 percent
22 (mean 65 percent) of juvenile winter-run Chinook Salmon used areas downstream
23 of RBDD for nursery habitat, and the relative usage of rearing habitat upstream
24 and downstream of RBDD appeared to be influenced by river flow during fry
25 emergence (Martin et al. 2001). Winter-run Chinook Salmon usually migrate past
26 Knight's Landing once flows at Wilkins Slough rise to about 14,000 cfs; most
27 juvenile winter-run Chinook Salmon outmigrate past Chipps Island by the end of
28 March (del Rosario et al. 2013).

29 *Spring-run Chinook Salmon*

30 Historically, spring-run Chinook Salmon in the Sacramento River Basin were
31 found in the upper and middle reaches (1,000 to 6,000 feet) of the American,
32 Yuba, Feather, Sacramento, McCloud and Pit rivers, as well as smaller tributaries
33 of the upper Sacramento River downstream of present-day Shasta Dam
34 (NMFS 2009a). Estimates indicate that 82 percent of the approximately
35 2,000 miles of salmon spawning and rearing habitat available in the mid-1800s is
36 unavailable or inaccessible today (Yoshiyama et al. 1996). Naturally spawning
37 populations of spring-run Chinook Salmon currently are restricted to accessible
38 reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum
39 Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River,
40 Mill Creek, and Yuba River (DFG 1998b). Most of these reaches are outside the
41 project area; however, all spring-run Chinook Salmon migratory life stages must
42 pass through the project area.

43 Spring-run Chinook Salmon abundance in the Sacramento River mainstem has
44 apparently declined sharply through time, with escapement estimates ranging
45 from approximately 5,000 to 23,000 fish in the 1980s, 100 to 4,100 fish in the

1 1990s, and 0 to 621 fish between 2000 and 2014 (CDFW 2015). However, the
2 criteria for run classification at RBDD have changed so no conclusions can be
3 reached about changes in the number of spring-run Chinook Salmon in the
4 Sacramento River. Chinook Salmon expressing spring-run timing do spawn in
5 the mainstem Sacramento River between RBDD and Keswick Dam (NMFS
6 2009a). The Sacramento River now serves primarily as a migratory corridor for
7 the adult and juvenile life stages of spring-run (and other runs) of Chinook
8 Salmon.

9 In fresh water, juvenile spring-run Chinook Salmon rear in natal tributaries, the
10 Sacramento River mainstem, and nonnatal tributaries to the Sacramento River
11 (DFG 1998b). Outmigration timing is highly variable, as they may migrate
12 downstream as YOY or as juveniles or yearlings. The outmigration period for
13 spring-run Chinook Salmon extends from November to early May, with up to
14 69 percent of the YOY fish outmigrating through the lower Sacramento River and
15 Delta during this period (DFG 1998b). Peak movement of juvenile spring-run
16 Chinook Salmon in the Sacramento River at Knights Landing occurs in December
17 and again in March (Snider and Titus 1998, 2000b, c, d; Vincik et al. 2006;
18 Roberts 2007). Migratory cues, such as increased flows, increasing turbidity from
19 runoff, changes in day length, or intraspecific competition from other fish in their
20 natal streams, may spur outmigration of juveniles from the upper Sacramento
21 River basin when they have reached the appropriate stage of maturation (NMFS
22 2009a). Spring-run juveniles that remain in the Sacramento River over summer
23 are confined to approximately 100 miles of the upper mainstem, where cool water
24 temperatures are maintained by dam releases.

25 *Fall-/Late Fall-run Chinook Salmon*

26 The fall-run Chinook Salmon is an ocean-maturing type of salmon adapted for
27 spawning in lowland reaches of big rivers, including the mainstem Sacramento
28 River; the late fall-run Chinook Salmon is mostly a stream-maturing type
29 (Moyle 2002). Similar to spring-run, adult late fall-run Chinook Salmon typically
30 hold in the river for 1 to 3 months before spawning, while fall-run Chinook
31 Salmon generally spawn shortly after entering fresh water. Fall-run Chinook
32 Salmon migrate upstream past RBDD on the Sacramento River between July and
33 December, typically spawning in upstream reaches from October through March.
34 Late fall-run Chinook Salmon migrate upstream past RBDD from August to
35 March and spawn from January to April (NMFS 2009a, TCCA 2008). The
36 majority of young fall-run Chinook Salmon migrate to the ocean during the first
37 few months following emergence, although some may remain in fresh water and
38 migrate as yearlings. Late fall-run juveniles typically enter the ocean after 7 to
39 13 months of rearing in fresh water, at 150- to 170 mm in fork length,
40 considerably larger and older than fall-run Chinook Salmon (Moyle 2002).

41 The primary spawning area used by fall- and late fall-run Chinook Salmon in the
42 Sacramento River is the area from Keswick Dam downstream to RBDD.
43 Spawning densities for each of the runs are generally highest in this reach.

1 Annual fall-run and late fall-run Chinook Salmon escapement to the Sacramento
2 River and its tributaries has generally been declining in the last decade, following
3 peaks in the late 1990s to early 2000s (Azat 2012).

4 *Steelhead*

5 Although steelhead can be divided into two life history types, summer-run
6 steelhead and winter-run steelhead, based on their state of sexual maturity at the
7 time of river entry, only winter-run steelhead are currently found in Central
8 Valley rivers and streams. Existing wild steelhead stocks in the Central Valley
9 are mostly confined to the upper Sacramento River and its tributaries, including
10 Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in
11 other tributaries, and a few naturally spawning steelhead are produced in the
12 American and Feather rivers (McEwan and Jackson 1996).

13 Adult steelhead migrate upstream past the Fremont Weir between August and
14 March, primarily from August through October; they migrate upstream past
15 RBDD during all months of the year, but primarily during September and October
16 (NMFS 2009a). The primary spawning area used by steelhead in the Sacramento
17 River is the area from Keswick Dam downstream to RBDD. Unlike salmon,
18 steelhead may live to spawn more than once and generally rear in freshwater
19 streams for 2 to 4 years before outmigrating to the ocean. Both spawning areas
20 and migratory corridors are used by juvenile steelhead for rearing prior to
21 outmigration. The Sacramento River functions primarily as a migration channel,
22 although some rearing habitat remains in areas with setback levees (primarily
23 upstream of Colusa) and flood bypasses (e.g., Yolo Bypass) (NMFS 2009a).

24 Recent steelhead monitoring data are scarce for the upper portion of the
25 Sacramento River system. In 1989, Hallock (1989) reported that steelhead had
26 declined drastically in the Sacramento River upstream of the Feather River
27 confluence. In the 1950s, the average estimated spawning population size
28 upstream of the Feather River confluence was 20,540 fish (McEwan and Jackson
29 1996). In 1991–1992, the annual run size for the total Sacramento River system
30 was likely fewer than 10,000 adult fish (McEwan and Jackson 1996). From 1967
31 to 1993, the estimated number of steelhead passing the Red Bluff Pumping Plant
32 ranged from a low of 470 to a high of 19,615 (CHSRG 2012). Steelhead
33 escapement surveys at the site of RBDD ended in 1993.

34 *Green Sturgeon*

35 The Sacramento River provides habitat for Green Sturgeon spawning, adult
36 holding, foraging, and juvenile rearing. Suitable spawning temperatures and
37 spawning substrate exist for Green Sturgeon in the Sacramento River upstream
38 and downstream of RBDD (Reclamation 2008a). Although the upstream extent
39 of historical Green Sturgeon spawning in the Sacramento River is unknown, the
40 observed distribution of sturgeon eggs, larvae, and juveniles indicates that
41 spawning occurs from Hamilton City to as far upstream as Ink's Creek confluence
42 and possibly up to the Cow Creek confluence (Brown 2007, Poytress et al. 2013).
43 Based on the distribution of sturgeon eggs, larvae, and juveniles in the
44 Sacramento River, DFG (2002) indicated that Green Sturgeon spawn in late

1 spring and early summer. Peak spawning is believed to occur between April
2 and June.

3 Spawning migrations and spawning by Green Sturgeon in the Sacramento River
4 mainstem have been well documented over the last 15 years (Beamesderfer et al.
5 2004). Anglers fishing for White Sturgeon or salmon commonly report catches of
6 Green Sturgeon from the Sacramento River as far upstream as Hamilton City
7 (Beamesderfer et al. 2004). Eggs, larvae, and post-larval Green Sturgeon are now
8 commonly reported in sampling directed at Green Sturgeon and other species
9 (Beamesderfer et al. 2004, Brown 2007). YOY Green Sturgeon have been
10 observed annually since the late 1980s in fish sampling efforts at RBDD and the
11 Glenn-Colusa Irrigation District (GCID) intake (Beamesderfer et al. 2004).
12 Acoustically tagged Green Sturgeon were detected upstream of RBDD from 2004
13 to 2006 (Heublein et al. 2009). Adult Green Sturgeon that migrate upstream in
14 April, May, and June are completely blocked by the ACID diversion dam
15 (NMFS 2009b), rendering approximately 3 miles of spawning habitat upstream of
16 the diversion dam inaccessible.

17 Green Sturgeon from the Sacramento River are genetically distinct from their
18 northern counterparts, indicating a spawning fidelity to their natal rivers (Israel
19 et al. 2004), even though individuals can range widely (Lindley et al. 2008).
20 Larval Green Sturgeon have been regularly captured during their dispersal stage
21 at about 2 weeks of age (24 to 34 mm fork length) in rotary screw traps at RBDD
22 (DFG 2002a) and at about 3 weeks old when captured at the GCID intake (Van
23 Eenennaam et al. 2001).

24 Young Green Sturgeon appear to rear for the first 1 to 2 months in the Sacramento
25 River between Keswick Dam and Hamilton City (DFG 2002a). Rearing habitat
26 condition and function may be affected by variation in annual and seasonal river
27 flow and temperature characteristics.

28 Empirical estimates of Green Sturgeon abundance are not available for the
29 Sacramento River population or any west coast population (Reclamation 2008a),
30 and the current population status is unknown (Beamesderfer et al. 2007,
31 Adams et al. 2007). A genetic analysis of Green Sturgeon larvae captured in the
32 Sacramento River resulted in an estimate of the number of adult spawning pairs
33 upstream of RBDD ranging from 32 to 124 between 2002 and 2006 (Israel 2006).
34 NMFS (2009b) noted that, similar to winter-run Chinook Salmon, the restriction
35 of spawning habitat for Green Sturgeon to only one reach of the Sacramento
36 River increases the vulnerability of this spawning population to catastrophic
37 events. This was one of the primary reasons that the Southern DPS of Green
38 Sturgeon was federally listed as a threatened species in 2006.

39 *White Sturgeon*

40 In California, White Sturgeon are most abundant within the Delta region, but the
41 population spawns mainly in the Sacramento River; a small part of the population
42 is also thought to spawn in the Feather River (Moyle 2002). In addition to
43 spawning, White Sturgeon embryo development and larval rearing occur in the
44 Sacramento River (Moyle 2002, Israel et al. 2008). White Sturgeon are found in

1 the Sacramento River primarily downstream of RBDD (TCCA 2008), with most
2 spawning between Knights Landing and Colusa (Schaffter 1997).

3 The population status of White Sturgeon in the Sacramento River is unclear.
4 Overall, limited information on trends in adult and juvenile abundance in the
5 Delta population suggests that numbers are declining (Reis-Santos et al. 2008).
6 Spawning stage adults generally move into the lower reaches of the Sacramento
7 River during winter prior to spawning, then migrate upstream in response to
8 higher flows to spawn from February to early June (Schaffter 1997, McCabe and
9 Tracy 1994). Most spawning in the Sacramento River occurs in April and May
10 (Kohlhorst 1976). YOY White Sturgeon make an active downstream migration
11 that disperses them widely to rearing habitat throughout the lower Sacramento
12 River and Delta (McCabe and Tracy 1994, Israel et al. 2008).

13 *Sacramento Splittail*

14 Historically, Sacramento Splittail were widespread in the Sacramento River from
15 Redding to the Delta (Rutter 1908 as cited in Moyle et al. 2004). This distribution
16 has become somewhat reduced in recent years (Sommer et al. 1997, 2007b).

17 During drier years there is evidence that spawning occurs farther upstream
18 (Feyrer et al. 2005). Adult splittail migrate upstream in the lower Sacramento
19 River to above near the mouth of the Feather River and into the Sutter and Yolo
20 bypasses (Sommer et al. 1997, Feyrer et al. 2005, Sommer et al. 2007b). Each
21 year, mainly during the spring spawning season, a small number of individuals
22 have been documented at the Red Bluff Pumping Plant and the entrance to the
23 GCID intake (Moyle et al. 2004).

24 Nonreproductive adult splittail are most abundant in moderately shallow, brackish
25 areas, but can also be found in freshwater areas with tidal or riverine flow
26 (Moyle et al. 2004). Adults typically migrate upstream from brackish areas in
27 January and February and spawn in fresh water on inundated floodplains in March
28 and April (Moyle et al. 2004, Sommer et al. 2007b). In the Sacramento drainage,
29 the most important spawning areas appear to be the Yolo and Sutter bypasses;
30 however, some spawning occurs almost every year along the river edges and
31 backwaters created by small increases in flow. Splittail spawn in the Sacramento
32 River from Colusa to Knights Landing in most years (Feyrer et al. 2005).

33 Most juvenile splittail move from upstream areas downstream into the Delta from
34 April through August (Meng and Moyle 1995, Sommer et al. 2007b). The
35 production of YOY Sacramento Splittail is largely influenced by extent and
36 period of inundation of floodplain spawning habitats, with abundance spiking
37 following wet years and declining after dry years (Sommer et al. 1997, Moyle
38 et al. 2004, Feyrer et al. 2006). Other factors that may affect the Sacramento
39 Splittail adult population include flood control operations and infrastructure,
40 entrainment by irrigation diversion, recreational fishing, changed estuarine
41 hydraulics, pollutants, and nonnative species (Moyle et al. 2004,
42 Sommer et al. 2007b).

1 *Pacific Lamprey*

2 Pacific Lampreys are anadromous, rearing in fresh water before outmigrating to
3 the ocean, where they grow to full size prior to returning to their natal streams to
4 spawn. Data from mid-water trawls in Suisun Bay and the lower Sacramento
5 River indicate that adults likely migrate into the Sacramento River and tributaries
6 from late fall (November) through early-summer (June) (Hanni et al. 2006).
7 Adult Pacific Lampreys, either immature or spawning stage, have been detected at
8 the GCID diversion from December through July and nearly all year at RBDD
9 (Hanni et al. 2006). Hannon and Deason (2008) documented Pacific Lampreys
10 spawning in the American River between early January and late May, with peak
11 spawning typically in early April. Spawning in the Sacramento River is expected
12 to occur during a similar timeframe. Pacific Lamprey ammocoetes rear in parts of
13 the Sacramento River for all or part of their 5- to 7-year freshwater residence.
14 Data from rotary screw trapping at sites on the mainstem Sacramento River
15 indicate that outmigration of Pacific Lamprey peaks from early winter through
16 early summer, but some outmigration is observed year-round at both RBDD and
17 the GCID diversion dam (Hanni et al. 2006).

18 *Striped Bass*

19 Striped Bass are anadromous; adult Striped Bass are distributed mainly in the
20 lower bays and ocean during summer, and in the Delta during fall and winter.
21 Spawning takes place in spring from April to mid-June (Leet et al. 2001) at which
22 time Striped Bass swim upstream to spawning grounds. Striped Bass are not
23 believed to spawn or rear in the Sacramento River upstream of RBDD
24 (TCCA 2008). Most Striped Bass spawning occurs in the lower Sacramento
25 River between Colusa and the confluence of the Sacramento and Feather rivers
26 (Moyle 2002). About one-half to two-thirds of the eggs are spawned in the
27 Sacramento River and the remainder in the Delta (Leet et al. 2001). After
28 spawning, most adult Striped Bass move downstream into brackish and salt water
29 for summer and fall.

30 Eggs are free-floating and negatively buoyant, hatching as they drift downstream
31 with larvae occurring in shallow and open waters of the lower reaches of the
32 Sacramento and San Joaquin rivers, the Delta, Suisun Bay, Montezuma Slough,
33 and Carquinez Strait. The Sacramento River functions primarily as a migration
34 corridor for both adults and drifting eggs/larvae.

35 **9.3.4.4.2 Aquatic Habitat**

36 The mainstem Sacramento River provides habitat for native and introduced
37 (nonnative) fish and other aquatic species. The diversity of aquatic habitats
38 ranges from fast-water riffles and glides in the upper reaches to tidally influenced
39 slow-water pools and glides in the lower reaches (Vogel 2011).

40 A few miles downstream of Keswick Dam, near Redding, the river enters the
41 valley and the floodplain broadens. Historically, this area likely had wide
42 expanses of riparian forests, but much of the river's riparian zone is subject to
43 urban encroachment, particularly in the Anderson/Redding area. In the middle
44 Sacramento River between Red Bluff and Chico Landing, the mainstem channel

1 is flanked by broad floodplains (TNC 2007a). In the lower reaches downstream
2 of Verona, much of the Sacramento River is constrained by levees. Dredging,
3 dams, levee construction, urban encroachment, and other human activities in the
4 Sacramento River have modified aquatic habitat, altered sediment dynamics,
5 simplified stream bank and riparian habitat, reduced floodplain connectivity, and
6 modified hydrology (NMFS 2009a). However, some complex floodplain habitats
7 remain in the system such as reaches with setback levees and the Yolo and
8 Sutter bypasses.

9 *Holding Habitat*

10 An abundance of deep, cold-water pools in the mainstem Sacramento River
11 provide habitat for holding adult anadromous salmonids during all months of the
12 year (Vogel 2011). Green Sturgeon also use deep pools for holding but can
13 tolerate warmer water temperatures than salmon and, therefore, can hold farther
14 downstream. Large numbers of adult Green Sturgeon have been observed holding
15 during summer in deep pools in the Sacramento River near Hamilton City
16 (Vogel 2011).

17 *Spawning Habitat*

18 Spawning habitat on the Sacramento River is affected by lack of sediment and
19 flow patterns as determined by the operations of the CVP and local water
20 diverters.

21 *Sediment Conditions*

22 Shasta and Keswick dams substantially influence sediment transport in the upper
23 Sacramento River because they block sediment that would normally have been
24 transported downstream (TNC 2007a, DWR 1985). The result has been a net loss
25 of coarse sediment, including gravel particle sizes suitable for salmon spawning,
26 in the Sacramento River downstream of Keswick Dam (Reclamation 2013b).
27 To address the issue of spawning gravel loss downstream of Keswick Dam,
28 Reclamation has placed approximately 5,000 tons of washed spawning gravel into
29 the Sacramento River downstream of Keswick about every other year since 1997
30 (Reclamation 2010a).

31 *Spawning Habitat Availability*

32 Winter-run Chinook Salmon spawning in the upper reaches of the Sacramento
33 River is affected by the operations of the seasonal ACID diversion dam, which
34 involves placement of flashboards in the river between April and May. Flows in
35 the river vary with the operation of the diversion dam and releases of water from
36 Shasta Lake into the river. When the dam is installed in the river, the WUA
37 upstream of the Cow Creek confluence is higher than when the dam is removed.
38 Farther downstream, there is less variability in WUA.

39 The WUA for winter-run Chinook Salmon spawning peaks at around 10,000 cfs
40 in the upstream reach upstream of the ACID intake when the dam flashboards are
41 in. With the boards out, the peak is around 5,500 cfs. In the next reach
42 downstream (ACID intake to Cow Creek), spawning WUA also peaked at around
43 10,000 cfs. In the lower reach (Cow Creek to Battle Creek), WUA spawning

1 habitat peaks at around 5,250 cfs, but there is low variability in spawning WUA
2 from 3,250 to 8,000 cfs

3 Overall, spawning habitat WUA values differ for fall-run and late fall-run
4 Chinook Salmon, but the flow versus habitat relationship is about the same for the
5 two runs. Upstream of the ACID intake, spawning habitat WUA for fall- and late
6 fall-run Chinook Salmon peaks at the lowest flow analyzed (3,250 cfs) with the
7 dam flashboards out and at about 6,000 cfs with the flashboards in. Between the
8 ACID intake and Cow Creek, spawning habitat WUA peaks at around 5,000 cfs
9 for both runs. Between Cow Creek and Battle Creek, spawning habitat WUA for
10 both runs peaks at about 3,500 cfs. The highest density of redds for fall- and late
11 fall-run Chinook Salmon occur in the middle ACID intake to Cow Creek reach.

12 The spawning habitat WUA values for steelhead peaks at the lowest river flow
13 analyzed (3,250 cfs) in the reach upstream of the ACID intake. This habitat
14 relationship held regardless of whether the flashboards were in or out. In the
15 reach between the ACID intake and Cow Creek, spawning habitat WUA peaks at
16 river flows around 6,000 cfs. In the lower reach, from Cow Creek to Battle
17 Creek, spawning habitat WUA also peaks at river flows of about 6,500 cfs, but do
18 not vary substantially in a flow range between about 4,000 and 8,000 cfs.

19 USFWS (2005b) conducted limiting life-stage analyses for winter-, fall-, and
20 late-fall-run Chinook Salmon in the Sacramento River upstream of the Battle
21 Creek confluence and found that in most cases, juvenile habitat is limiting. In
22 some cases (fall- and late fall-run in between the ACID intake and Cow Creek),
23 spawning habitat may be limiting at higher flows.

24 USFWS (2005a) developed spawning flow-habitat relationships for fall-run
25 Chinook Salmon spawning habitat in the Sacramento River between Battle Creek
26 and Deer Creek. Between Battle Creek and RBDD, spawning habitat WUA
27 values for fall-run Chinook Salmon peaked at approximately 3,750 cfs, but
28 showed little variation over flows from 3,250 cfs (the lowest flow evaluated) and
29 6,000 cfs, but declined substantially at higher flows. Between the Red Bluff
30 Pumping Plant and Deer Creek, spawning habitat WUA values for fall-run
31 Chinook salmon peaked at 5,500 cfs, with little variation at flows from 4,250 to
32 8,000 cfs (USFWS 2005a).

33 *Rearing Habitat*

34 In the Sacramento River between Red Bluff and Chico Landing, the mainstem
35 channel is flanked by broad floodplains. Ongoing sediment deposition in these
36 areas provides evidence of continued inundation of floodplains in this reach
37 (DWR 1994). Between Chico Landing and Colusa, the Sacramento River is
38 bounded by levees that provide flood protection for cities and agricultural areas.
39 However, the levees in this portion of the Sacramento River are, for the most part,
40 set back from the mainstem channel such that flooding can be significant within
41 the river corridor (TNC 2007b).

42 Fry rearing habitat WUA for winter-run Chinook Salmon fry rearing habitat peaks
43 at around 5,500 cfs in the reach upstream of the ACID intake when the dam
44 flashboards are in. With the boards out, the peak is around 6,500 cfs. In the next

1 reach downstream (ACID intake to Cow Creek), fry rearing habitat WUA for
2 winter-run Chinook Salmon peaks at around 31,000 cfs (the highest flow
3 evaluated). In the lower reach (Cow Creek to Battle Creek), fry rearing habitat
4 WUA for winter-run Chinook Salmon also peaked at around 31,000 cfs, but there
5 was little variation at flows.

6 The fry rearing habitat WUA values differ for fall-run and late fall-run Chinook
7 Salmon, but the flow versus habitat relationship was similar for the two runs.
8 Upstream of the ACID intake, fry rearing habitat WUA for fall- and late fall-run
9 Chinook Salmon peaks at the lowest flow analyzed (3,250 cfs) with the dam
10 flashboards in. With the flashboards out, fry rearing habitat WUA peaks at
11 around 23,000 cfs for both species. Between the ACID intake and Cow Creek,
12 fry rearing habitat WUA for fall- and late fall-run Chinook Salmon peaked at
13 around 3,750 cfs for both runs, with little variation from 3,250 cfs to 6,000 cfs
14 and only slightly lower WUA values at flows greater than 21,000 cfs. Between
15 Cow Creek and Battle Creek, fry rearing habitat WUA for both runs peaks at
16 3,250 cfs (the lowest flow evaluated), declining as flows increase.

17 Juvenile rearing habitat WUA for winter-run Chinook Salmon juvenile rearing
18 habitat peaks at around 8,000 cfs in the upstream reach above the ACID intake
19 when the dam flashboards are in. With the boards out, the peak is around
20 9,000 cfs. However, there is little variation in juvenile winter-run Chinook
21 Salmon rearing habitat WUA from around 5,500 to 11,000 cfs in this reach. In
22 the next reach downstream between the ACID intake to Cow Creek, juvenile
23 rearing habitat WUA for winter-run Chinook Salmon peaks at around 31,000 cfs
24 (the highest flow evaluated). In the lower reach (Cow Creek to Battle Creek),
25 juvenile rearing habitat WUA for winter-run Chinook Salmon peaks at around
26 3,500 cfs but shows only moderate (<50 percent) reductions in WUA over the
27 entire range of flows evaluated.

28 The juvenile rearing habitat WUA values differ for fall-run and late fall-run
29 Chinook Salmon, but the flow versus habitat relationship is similar for the two
30 runs. Upstream of the ACID intake, juvenile rearing habitat WUA for fall- and
31 late fall-run Chinook Salmon peaked in the 5,000- to 6,000-cfs range with the
32 dam flashboards in or out; there were only moderate (<50 percent) reductions in
33 juvenile rearing WUA over the entire range of flows evaluated. Between the
34 ACID intake and Cow Creek, fry rearing WUA peaked at around 3,250 cfs (the
35 lowest flow evaluated) for both runs, declining to a minimum at around
36 15,000 cfs and increasing to around 70 percent of the maximum at flows above
37 21,000 cfs. Between Cow Creek and Battle Creek, fry rearing WUA for both runs
38 peaked at 3,250 cfs (the lowest flow evaluated), declining as flow increased.

39 Vogel (2011) suggested that the mainstem Sacramento River may not provide
40 adequate rearing areas for fry-stage anadromous salmonids, as evidenced by rapid
41 displacement of fry from upstream to downstream areas and into nonnatal
42 tributaries during increased flow events. Underwater observations of salmon fry
43 in the mainstem Sacramento River suggest that optimal habitats for rearing may
44 be limited at higher flows (Vogel 2011). USFWS (2005) conducted limiting
45 life-stage analyses for winter-, fall-, and late-fall-run Chinook Salmon in the

1 Sacramento River above Battle Creek and found that in most cases, juvenile
2 habitat is limiting. An important limitation of this analysis is that it did not take
3 into account fry and juvenile rearing habitat below Battle Creek or in the Delta.
4 The minimum required Sacramento River flow is 3,250 cfs. Flows during
5 summer generally exceed this amount in order to meet temperature requirements
6 for winter-run Chinook Salmon. The water temperature requirements established
7 for winter-run Chinook Salmon result in water temperatures also suitable for
8 year-round rearing of steelhead in the upper Sacramento River.

9 **9.3.4.4.3 Fish Passage and Entrainment**

10 Historically, anadromous salmonids had access to a minimum of approximately
11 493 miles of habitat in the Sacramento River (Yoshiyama et al. 1996). After
12 completion of Shasta Dam in 1945, access to approximately 207 miles was
13 blocked. Keswick Dam, just downstream of Shasta Dam, is now the upstream
14 extent of available habitat for anadromous fish in the Sacramento River.

15 Until recently, three large-scale, upper Sacramento River diversions, including the
16 ACID and GCID intakes and RBDD, were of particular concern as potential
17 passage or entrainment problems for Chinook Salmon, steelhead, and other
18 migratory fish species (NRC 2012, NMFS 2009a, McEwan and Jackson 1996).
19 Recently, RBDD was eliminated, the GCID fish screens were installed, and fish
20 passage at the ACID intake was improved (NRC 2012). At the ACID intake, new
21 fish ladders and fish screens were installed around the diversion and were
22 operated starting in the summer 2001 diversion period. However, adult Green
23 Sturgeon that migrate upstream in April, May, and June are completely blocked
24 by the ACID intake (NMFS 2009a), rendering approximately 3 miles of spawning
25 habitat upstream of the diversion dam inaccessible. Adult Green Sturgeon that
26 pass upstream of the intake before April are delayed for 6 months until the
27 flashboards are pulled before returning downstream to the ocean. Newly emerged
28 Green Sturgeon larvae that hatch upstream of the ACID intake would need to hold
29 for 6 months upstream of the dam or pass over it and be subjected to higher
30 velocities and turbulent flow below the intake (NMFS 2009a).

31 Numerous other diversions are located on the Sacramento River. Herren and
32 Kawasaki (2001) documented up to 431 diversions from the Sacramento River
33 between Shasta Dam and the City of Sacramento. Hanson (2001) studied juvenile
34 Chinook Salmon entrainment at unscreened diversions at the Princeton Pumping
35 Plant and documented the entrainment of approximately 0.05 percent of juvenile
36 Chinook Salmon passing the diversion. Similar to the results of Hanson (2001),
37 Vogel (2013) found that entrainment of juvenile salmon in 12 unscreened
38 diversions was low relative to other fish species. The study did not discern
39 measurable effects of factors such as size of the diversion, longitudinal location in
40 the river, water temperatures, localized habitat conditions, intake position in the
41 river channel, and depth of the intakes on salmonid entrainment. It appeared that
42 juvenile salmon were entrained in a much lower proportion than the proportion of
43 flow diverted (Vogel 2013), similar to results noted by Hanson (2001). Mussen
44 et al. (2014) examined the risk to Green Sturgeon from unscreened water

1 diversions and found that juvenile Green Sturgeon entrainment susceptibility (in a
2 laboratory setting) was high relative to that estimated for Chinook Salmon,
3 suggesting that unscreened diversions could be a contributing mortality source for
4 threatened Southern DPS Green Sturgeon.

5 Reclamation is currently coordinating with USFWS to support improvements at
6 other fish screens. In 2013, CVPIA funds were used to construct the Natomas
7 Mutual Sankey Fish Screen on the Sacramento River that replaced two existing
8 diversions on the Natomas Cross Canal. This project also resulted in the removal
9 of an anadromous fish migration barrier (seasonal diversion dam) on the Natomas
10 Cross Canal. The fish screening program also completed construction of four fish
11 screens on the Sacramento River and one fish screen in the Delta.

12 Potential barriers to migration for adult Green Sturgeon into the upper reaches of
13 the Sacramento River include structures such as the ACID intake, Sacramento
14 River Deep Water Ship Channel locks, Fremont Weir, Sutter Bypass, and DCC
15 gates on the Sacramento River (70 FR 17386). A set of locks at the end of the
16 Sacramento River Deep Water Ship Channel at the connection with the
17 Sacramento River “blocks the migration of all fish from the deep-water ship
18 channel back to the Sacramento River” (DWR 2005).

19 **9.3.4.4.4 Hatcheries**

20 The Livingston Stone NFH, located at the foot of Shasta Dam, is a conservation
21 hatchery that has been producing and releasing juvenile winter-run Chinook
22 Salmon since 1998. There is growing concern about the potential genetic effects
23 that may result from the use of a conventional hatchery program to supplement
24 winter-run Chinook Salmon populations. To maintain a low risk of compromised
25 genetic fitness, Lindley et al. (2007) recommend that no more than 5 percent of
26 the naturally spawning population should be composed of hatchery fish. Since
27 2001, more than 5 percent of the winter-run Chinook Salmon run has been
28 composed of hatchery-origin fish, and in 2005 the contribution of hatchery fish
29 was more than 18 percent (Lindley et al. 2007).

30 The Livingston Stone NFH minimizes hatchery effects in the population by
31 preferentially collecting wild adult winter-run Chinook Salmon for brood stock
32 (USFWS 2011b). Up to 15 percent of the estimated run size for winter-run
33 Chinook Salmon run may be collected for brood stock use (up to a maximum of
34 120 natural-origin winter-run Chinook Salmon per brood year). Although
35 there is no adult production goal, Livingston Stone NFH releases up to
36 250,000 winter-run Chinook Salmon a year in late January or early February.
37 Winter-run Chinook Salmon are released at the pre-smolt stage and are intended
38 to rear in the freshwater environment prior to smoltification. The pre-smolts are
39 released into the Sacramento River at Caldwell Park in Redding, about 10 miles
40 downstream of the hatchery. All juvenile winter-run Chinook Salmon produced
41 at Livingston Stone NFH are adipose fin-clipped and coded wire-tagged
42 (CHSRG 2012).

1 The Delta Smelt propagation program at the Livingston Stone NFH is operated as
2 a captive broodstock program. Delta Smelt propagation at Livingston Stone NFH
3 functions as a backup refugial population. No Delta Smelt from the Livingston
4 Stone NFH are currently released (USFWS 2011b).

5 **9.3.4.4.5 Predation**

6 On the mainstem Sacramento River, high rates of predation have been known to
7 occur at the diversion facilities and areas where rock revetment has replaced
8 natural river bank vegetation (NMFS 2009a). Chinook Salmon fry, juveniles, and
9 smolts are more susceptible to predation at these locations because Sacramento
10 Pikeminnow and Striped Bass congregate in areas that provide predator refuge
11 (Williams 2006, Tucker et al. 2003).

12 **9.3.4.5 Battle Creek**

13 Battle Creek is a tributary that enters the Sacramento River about 20 miles
14 southeast of Redding. The cold, spring-fed waters of Battle Creek historically
15 supported large runs of Chinook Salmon and steelhead. Diversion dams
16 constructed in the early 1900s for hydroelectric power production reduced
17 instream flow and blocked anadromous salmonids from accessing habitat in large
18 portions of the north and south forks of Battle Creek.

19 Coleman NFH, located on Battle Creek, was established in 1942 by Reclamation
20 to partially mitigate habitat and fish losses from historical spawning areas caused
21 by construction of two CVP features, Shasta and Keswick dams. The hatchery is
22 funded by Reclamation and operated by USFWS. The steelhead program at the
23 hatchery was initiated in 1947 to mitigate losses resulting from the CVP
24 (USFWS 2012). The weir at the hatchery is a barrier to anadromous fish passage,
25 as are various Pacific Gas & Electric Company (PG&E) dams (e.g., Wildcat)
26 located on Battle Creek (Yoshiyama et al. 1996). Yoshiyama et al. (1996)
27 reported that the Coleman South Fork Diversion Dam is the first impassible
28 barrier on Battle Creek.

29 Beginning in 1995, planning was initiated to restore naturally spawning
30 anadromous fish populations in Battle Creek, and construction began in 2010 on
31 the Battle Creek Salmon and Steelhead Restoration Project (Reclamation 2014a).
32 When complete, the Battle Creek restoration project will restore ecological
33 processes along 42 miles of Battle Creek and 6 miles of tributaries while
34 minimizing reductions to hydroelectric power generation, although five dams are
35 decommissioned (Wildcat, Coleman, South, Lower Ripley, and Soap Creek
36 feeder diversion dams). New fish screens and fish ladders that meet NMFS and
37 CDFW criteria will be constructed at three diversion dams (North Battle Creek
38 Feeder, Eagle Canyon, and Inskip Diversion Dams). Connectors are proposed
39 that prevent the discharge of North Fork Battle Creek water to South Fork Battle
40 Creek and the mixing of flow sources. Higher minimum flow requirements will
41 increase instream flows, subsequently cooling water temperatures, increasing
42 stream area, and providing reliable passage conditions for adult salmonids in
43 downstream reaches. The project will result in 42 miles of newly accessible
44 anadromous fish habitat and improved water quality for the Coleman NFH.

1 **9.3.4.6 Lake Oroville and Thermalito Complex**

2 Lake Oroville on the Feather River is formed by Oroville Dam, approximately
3 70 miles upstream from its confluence with the Sacramento River. Lake Oroville
4 is fed by the north, middle, and south forks of the Feather River. A portion of the
5 water released from Lake Oroville flows into the Thermalito Complex, as
6 described in Chapter 5, Surface Water Resources and Water Supplies.

7 **9.3.4.6.1 Fish in Lake Oroville**

8 Lake Oroville thermally stratifies in spring, destratifies in fall, and remains
9 destratified throughout winter. FERC (2007b) reports indicate that surface water
10 temperatures of the epilimnion begin to warm in the early spring, reach maximum
11 temperatures (approximately mid-80°F) during late July, and gradually decline to
12 winter minimums. The transition zone (i.e., metalimnion) between the upper
13 warmer and lower colder waters typically ranges from about 30 to 50 feet below
14 the lake surface during midsummer. The deeper water of the hypolimnion can
15 reach a temperature of about 44°F near the reservoir bottom during periods of
16 stratification (FERC 2007b). Cold-water fish species include Coho Salmon,
17 Rainbow Trout, Brown Trout, and Lake Trout. The Lake Oroville cold-water
18 fishery is not self-sustaining, possibly because of insufficient spawning and
19 rearing habitat in the reservoir and accessible tributaries; cold-water spawning is
20 not known to occur in Lake Oroville. The Coho Salmon fishery is sustained by a
21 “put-and-grow” hatchery stocking program (FERC 2007b). The Lake Oroville
22 warm-water fishery is a regionally important self-sustaining recreational fishery
23 and is the site of several annual bass fishing tournaments. Spotted Bass are the
24 most abundant bass species in Lake Oroville, followed by Largemouth Bass,
25 Redeye Bass, and Smallmouth Bass, respectively. Other important warm-water
26 species include catfish, crappie, and sunfish. Common carp are also abundant in
27 Lake Oroville.

28 **9.3.4.6.2 Fish in Thermalito Forebay and Afterbay**

29 Ambient meteorological conditions and the temperature of the water released
30 from Lake Oroville generally affect water temperatures in the Thermalito
31 Diversion Pool and Thermalito Forebay (FERC 2007b). Thermalito Forebay is an
32 open, cold, shallow reservoir that remains cold throughout the year because it is
33 supplied with water from Thermalito Diversion Pool, although pump-back
34 operations from Thermalito Afterbay can increase water temperatures in the
35 forebay. Thermalito Forebay provides habitat primarily for cold-water fish
36 species, although the same warm-water fish species found in Lake Oroville are
37 believed to exist in the forebay in low numbers (FERC 2007b). Additionally,
38 CDFW manages a “put-and-take” trout fishery in Thermalito Forebay.

39 Thermalito Afterbay provides habitat for cold-water and warm-water fish species
40 including Largemouth Bass, Smallmouth Bass, Rainbow Trout, Brown Trout,
41 Bluegill, Redear Sunfish, Black Crappie, Channel Catfish, carp, and large schools
42 of Wakasagi (FERC 2007b). A popular Largemouth Bass fishery currently exists,
43 large trout are sometimes caught near the inlet, and an experimental steelhead
44 fishery occurs in the Afterbay. Only limited salmonid stocking occurs at the

1 afterbay, so these fish most likely passed through the Thermalito Pumping-
2 Generating Plant from the forebay.

3 **9.3.4.7 Feather River from Lake Oroville and the Thermalito Complex to**
4 **the Sacramento River**

5 The Feather River is a major tributary to the Sacramento River, providing
6 approximately 25 percent of the flow in the Sacramento River (FERC 2007b).
7 The lower Feather River extends downstream from the Fish Barrier Dam to the
8 confluence with the Sacramento River near Verona. The Fish Barrier Dam is
9 located downstream of the Thermalito Diversion Dam and immediately upstream
10 of the Feather River Fish Hatchery (FERC 2007b).

11 **9.3.4.7.1 Fish in the Feather River**

12 The Feather River below Oroville supports a variety of anadromous and resident
13 fish species. The distribution of anadromous fish in the Feather River is limited
14 to approximately 67 miles of river downstream from the Fish Barrier Dam. At
15 least 44 species of fish have been reported to historically or currently occur in the
16 lower Feather River system, including numerous resident native and introduced
17 species and several anadromous species (FERC 2007b).

18 The analysis is focused on the following species:

- 19 • Chinook Salmon (winter-, spring-, and fall/late fall-run)
- 20 • Steelhead
- 21 • Green Sturgeon
- 22 • White Sturgeon
- 23 • Sacramento Splittail
- 24 • Pacific Lamprey
- 25 • Striped Bass
- 26 • American Shad

27 *Spring-run Chinook Salmon*

28 Approximately two-thirds of the natural spring-run and fall-run Chinook Salmon
29 spawning occur in the low-flow channel of the lower Feather River, downstream
30 of the Fish Barrier Dam, and one-third of the spawning occurs in the high-flow
31 channel downstream of the Thermalito Afterbay Outlet (FERC 2007b). NMFS
32 (2009a) indicated that significant redd superimposition occurs in the lower
33 Feather River because of oversaturation of the natural carrying capacity of the
34 available spawning habitat (e.g., Sommer et al. 2001b) with an overproduction of
35 hatchery spring-run Chinook Salmon and a lack of physical separation between
36 spring-run and fall-run Chinook Salmon adults.

37 Adult spring-run Chinook Salmon typically enter fresh water in spring, hold over
38 summer, and spawn in fall. Juveniles typically spend a year or more in fresh
39 water before outmigrating. Adult spring-run Chinook Salmon begin their
40 upstream migration from the ocean in late January and early February
41 (DFG 1998b) and migrate from the Sacramento River into spawning tributaries
42 primarily between mid-April and mid-June (Lindley et al. 2004). Adult Chinook

1 Salmon exhibiting the typical life history of the spring-run have been found
2 holding at the Thermalito Afterbay Outlet and the Fish Barrier Dam as early as
3 April (FERC 2007b). Spring-run Chinook Salmon spawning occurs during
4 September and October, depending on water temperatures (NMFS 2012a).
5 Spring-run Chinook Salmon fry emerge from the gravel from November to March
6 (Moyle 2002). Most juvenile spring-run Chinook Salmon outmigrate from the
7 lower Feather River within a few days of emergence, and 95 percent of the
8 juvenile Chinook have typically outmigrated from the Oroville facilities project
9 area by the end of May (FERC 2007b).

10 An independent population of spring-run Chinook Salmon historically occurred in
11 the lower Feather River downstream of Oroville Dam, and a naturally spawning
12 population of spring-run Chinook Salmon may persist in this reach (Lindley et al.
13 2004). The number of naturally spawning spring-run Chinook Salmon in the
14 Feather River has been estimated only periodically since the 1960s, with estimates
15 ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of
16 this population is questionable because of the significant temporal and spatial
17 overlap between spawning populations of spring-run Chinook Salmon and
18 fall-run Chinook Salmon (Good et al. 2005).

19 Substantial numbers of spring-run Chinook Salmon, as identified by run timing,
20 return to the Feather River Fish Hatchery. From 1986 to 2011, the median
21 number of spring-run Chinook Salmon returning to the Feather River Fish
22 Hatchery was 3,655, compared to a median of 7,869 spring-run Chinook Salmon
23 returning to the entire Sacramento River Basin (NMFS 2012a). Abundance
24 estimates of lower Feather River spring-run Chinook Salmon may be distorted by
25 naturally occurring genetic introgression with fall-run Chinook Salmon, Feather
26 River Fish Hatchery practices, and Federal and state escapement estimation
27 methodology. Coded wire tags obtained from Feather River Fish Hatchery
28 returns indicate substantial introgression has occurred between spring-run
29 Chinook Salmon and fall-run Chinook Salmon populations within the lower
30 Feather River (NMFS 2009a).

31 *Fall-run Chinook Salmon*

32 Fall-run Chinook Salmon generally begin upstream migration into the lower
33 Feather River during summer months (FERC 2007b). Although timing of fall-run
34 Chinook Salmon spawning may be influenced by water temperature conditions
35 (FERC 2007b), spawning activity in the lower Feather River occurs from late
36 August through December and generally peaks during mid- to late November
37 (Myers et al. 1998). Concurrent spawning with spring-run Chinook Salmon,
38 which generally occurs from September to October, has led to hybridization
39 between the spring- and fall-run Chinook Salmon in the lower Feather River
40 (NMFS 2012a).

41 In the lower Feather River, fall-run Chinook Salmon embryo incubation and
42 alevin (yolk-sac fry) emergence generally occurs from mid-October through
43 March, depending on water temperature conditions (FERC 2007b). Fall-run
44 Chinook Salmon fry emergence generally occurs in the lower Feather River
45 downstream of the Fish Barrier Dam from late December through March, and

1 most juvenile fall-run Chinook Salmon outmigrate from the lower Feather River
2 within a few days of emergence (FERC 2007b).

3 *Steelhead*

4 Steelhead immigrate into the Feather River from July to March (McEwan 2001).
5 Currently, most of the natural steelhead spawning in the lower Feather River
6 occurs in the low-flow channel downstream of the Fish Barrier Dam; however,
7 limited spawning also occurs downstream of the Thermalito Afterbay Outlet
8 (FERC 2007b). Results of a 13-week redd survey conducted between January 6
9 and April 3, 2003, indicated that redd construction generally occurs in the lower
10 Feather River between late December and March, peaking in late January
11 (FERC 2007b). The FERC (2007b) study suggests that nearly half (48 percent) of
12 all redds were constructed in the uppermost mile of the low-flow channel
13 downstream of the Fish Barrier Dam. Redd density in this 1-mile section of the
14 low-flow channel was approximately 36 redds per mile, more than 10 times more
15 than any other section of the lower Feather River (FERC 2007b).

16 A moderate percentage of the steelhead fry appear to outmigrate from the lower
17 Feather River soon after emerging from the gravel. Juvenile steelhead that do not
18 outmigrate may rear in the river for up to 1 year. Juvenile steelhead in the Feather
19 River outmigrate from about February through September, with peak
20 outmigration occurring from March through mid-April. In-river juvenile rearing
21 is generally associated with secondary channels in the low-flow channel
22 (e.g., Hatchery Ditch) (FERC 2007b).

23 *Pacific Lamprey*

24 The Pacific Lamprey inhabits accessible reaches of the lower Feather River
25 (DWR 2003a). Information on Pacific Lamprey status in the lower Feather River
26 is limited, but the loss of access to historical habitat and apparent population
27 declines throughout California and the Sacramento and San Joaquin River basins
28 indicate populations are greatly decreased compared with historical levels
29 (Moyle et al. 2009). Little information is available on factors limiting Pacific
30 Lamprey populations in the lower Feather River, but they are likely affected by
31 many of the same factors as salmon and steelhead because of parallels in their
32 life cycles.

33 Ocean-stage adults likely migrate into the lower Feather River in spring and early
34 summer, where they hold for approximately 1 year before spawning (Hanni et al.
35 2006). Hannon and Deason (2008) have documented Pacific Lamprey spawning
36 in the nearby American River from between early January and late May, with
37 peak spawning typically occurring in early April. Pacific Lamprey ammocoetes
38 rear in the lower Feather River for all or part of their 5- to 7-year freshwater
39 residence. Data from rotary screw trapping suggest that outmigration of Pacific
40 Lamprey generally occurs from early winter through early summer (Hanni et al.
41 2006), although some outmigration likely occurs year-round as observed in the
42 mainstem Sacramento River (Hanni et al. 2006) and in other river systems
43 (Moyle 2002).

1 *Sacramento Splittail*

2 Sacramento Splittail enter the lower Feather River, primarily in wet years, with
3 most individuals collected in the high-flow channel downstream of Thermalito
4 Afterbay Outlet (DWR 2004a). On the lower Feather River, February through
5 May was assumed to encompass the period of splittail spawning, egg incubation,
6 and initial rearing (Sommer et al. 2008, DWR 2004a). Splittail use shallow
7 flooded vegetation for spawning and are infrequently observed in the Feather
8 River from the confluence with the Sacramento River up to Honcut Creek. The
9 majority of spawning activity in the Feather River is thought to occur downstream
10 of the Yuba River confluence (FERC 2007b). The primary factor that likely
11 limits the lower Feather River splittail population is availability of spawning and
12 rearing habitats as related to inundation of floodplains (Moyle et al. 2004,
13 DWR 2004a).

14 *Green Sturgeon*

15 Historically, Green Sturgeon likely spawned in the Sacramento, Feather, and San
16 Joaquin rivers (Adams et al. 2007). A substantial amount of habitat in the Feather
17 River was lost with the construction of Oroville Dam. Although the presence of
18 Green Sturgeon in the Sacramento River has been supported by direct angler
19 observations and rotary screw trapping of eggs, larvae, and YOY Green Sturgeon,
20 only intermittent observations of Green Sturgeon have been reported in the lower
21 Feather River (Beamesderfer et al. 2007). The occasional capture of larval Green
22 Sturgeon in outmigrant traps suggests that Green Sturgeon spawn in the lower
23 Feather River (Moyle 2002). However, prior to 2011 only two records of adult
24 Green Sturgeon in the lower Feather River were confirmed (NMFS 2005b). In
25 2011, videography monitoring conducted by the Anadromous Fish Restoration
26 Program confirmed Green Sturgeon spawning activity in the lower Feather River
27 and found evidence of spawning behavior in the Yuba River (AFRP 2011).
28 Seesholtz et al. (2014) provided the first documentation of Green Sturgeon
29 spawning in the Feather River.

30 *White Sturgeon*

31 White Sturgeon are known to use the lower Feather River primarily for spawning,
32 embryo development, and early rearing. Limited quantitative information is
33 available on the status of White Sturgeon in the lower Feather River, but the
34 spawning population was most likely much larger prior to construction of
35 Oroville Dam in 1961 (Israel et al. 2008). Seesholtz (2003) reported no evidence
36 of sturgeon was found in the lower Feather River after an exhaustive search for
37 their presence in 2003. However, 16 White Sturgeon were recorded from creel
38 surveys and sightings during 2006, and more were captured by anglers in 2007
39 (Israel et al. 2008). Numerous factors likely limit the success of the White
40 Sturgeon population in the lower Feather River, but loss of historical habitat,
41 alteration of temperatures and flows caused by Oroville Dam and other
42 impoundments in the watershed, and recreational fishing and poaching are
43 expected to be among the most important factors.

1 *Striped Bass*

2 Striped Bass occur in the lower Feather River and have been reported to occur in
3 the Thermalito Forebay (FERC 2007b). Striped Bass are a popular sport fish in
4 the lower Feather River during periods when they migrate upstream to spawn.

5 *American Shad*

6 American Shad enter the Feather River annually in spring to spawn and are
7 popular for sport fishing. American Shad are present in the lower Feather River
8 from May through mid-December during the adult immigration, spawning, and
9 outmigration periods of their life cycle (DWR 2003a).

10 **9.3.4.7.2 Aquatic Habitat**

11 Historically, spawning habitat suitable for anadromous salmonid species likely
12 existed above the current location of Oroville Dam on the Feather River
13 (Yoshiyama et al. 2001). Extensive mining, irrigation, and development of
14 hydroelectric dams significantly reduced the amount of suitable habitat for these
15 species (Yoshiyama et al. 2001). Schick et al. (2005) estimated approximately
16 71 miles of suitable habitat was historically available for spring-run Chinook
17 Salmon in the lower Feather River.

18 Most Chinook Salmon and steelhead spawning is concentrated in the uppermost
19 3 miles of accessible habitat in the lower Feather River downstream of the Feather
20 River Fish Hatchery (FERC 2007b). As a result, salmonid spawning is
21 concentrated to unnaturally high levels in the low-flow channel of the lower
22 Feather River directly downstream of Oroville Dam and the Fish Barrier Dam. A
23 physical habitat simulation analysis conducted by the California Department of
24 Water Resources (DWR) in 2002 indicated that Chinook spawning habitat
25 suitability in the low-flow channel reached a maximum between 800 and 825 cfs,
26 and in the high-flow channel, it reached a maximum at 1,200 cfs. The steelhead
27 spawning habitat index in the low-flow channel had no distinct optimum over the
28 range of flow between 150 and 1,000 cfs. In the high-flow channel, spawning
29 habitat suitability was maximized at a flow just under 1,000 cfs (DWR 2004b).

30 The FERC (2007b) study reported that an estimated 97 percent of the sediment
31 from the upstream watershed is trapped in Lake Oroville, such that only very fine
32 sediment is discharged from Lake Oroville to the lower Feather River. As a
33 result, gravel and large woody material from upstream reaches are limited along
34 the lower Feather River. The FERC (2007b) study reported that the median
35 gravel diameter (D50) of surface samples suggests that gravels in the low-flow
36 channel generally are too large for successful redd construction by steelhead or
37 salmon and that armoring is particularly evident in this reach; however, suitability
38 of gravel sizes for spawning Chinook Salmon generally increased with distance
39 downstream of Oroville Dam. The study suggested that size distributions of
40 subsurface gravel samples were similar in the low- and high-flow channels.
41 Analyses of fine sediment (less than 6 mm in diameter) suggested that fine
42 sediment within gravels in the lower Feather River were suitable for incubating
43 Chinook Salmon and steelhead embryos (FERC 2007b).

1 **9.3.4.7.3 Fish Passage**

2 The Oroville facilities, including Oroville Dam, Thermalito Diversion Dam, and
3 the Fish Barrier Dam, currently block the upstream migration of anadromous fish
4 to historically available spawning areas in the upstream tributaries of the Feather
5 River. In a study of Green Sturgeon passage impediments, FERC identified three
6 potential physical barriers to upstream migration by Green Sturgeon in the lower
7 Feather River during representative low-flow conditions (approximately 2,074 cfs
8 during November 2002) and high-flow conditions (approximately 9,998 cfs
9 during July 2003) (FERC 2007b). The three potential physical barriers are
10 Shanghai Bench, the Sunset Pumps, and Steep Riffle (located 2 miles upstream of
11 the Thermalito Afterbay Outlet). However, the study also noted that
12 determinations of potential passage barriers in the lower Feather River are
13 speculative.

14 **9.3.4.7.4 Hatcheries**

15 The Feather River Fish Hatchery is part of the SWP Oroville Complex and is a
16 mitigation hatchery for loss of habitat upstream of DWR's Oroville Dam that is
17 no longer accessible to anadromous fish species (NMFS 2009a). Three hatchery
18 programs are conducted here, producing fall-run Chinook Salmon, spring-run
19 Chinook Salmon, and steelhead. The Feather River Fish Hatchery supports the
20 only spring-run Chinook Salmon hatchery program currently in the Central Valley
21 (CHSRG 2012). Spring-run Chinook Salmon produced at the Feather River Fish
22 Hatchery are included in the listed spring-run Chinook Salmon ESU
23 (70 FR 37160). FERC is in consultation with NMFS on the effects of
24 relicensing Oroville Dam (including the effects of Feather River Fish Hatchery).

25 Fall-run Chinook Salmon in the Feather River are trapped and spawned at the
26 hatchery with a goal of producing 6 million fall-run Chinook Salmon smolts for
27 release into Carquinez Straits between April and June. Up to 2 million additional
28 fish may be reared as part of a separate ocean enhancement program. Feather
29 River fall-run Chinook Salmon are currently marked at a 25 percent rate (constant
30 fractional marking) with an adipose fin-clip and a coded wire-tag (CHSRG 2012).

31 Adult hatchery-produced spring-run Chinook are intended to spawn naturally or
32 to be genetically integrated with the natural population through artificial
33 propagation. There are no specific goals for the number of adult spring-run
34 Chinook Salmon; however, the juvenile production goal is to release 2 million
35 smolts during April or May. These fish are all released into the Feather River
36 south of Yuba City at the Boyd's Pump Boat Launch (44 miles downstream of the
37 hatchery). Juvenile hatchery-produced spring-run Chinook Salmon are currently
38 100 percent marked with an adipose fin-clip and a coded wire-tag
39 (CHSRG 2012).

40 The steelhead program at the Feather River Hatchery traps and artificially spawns
41 both marked hatchery-origin and unmarked natural-origin steelhead. Only a few
42 unmarked fish are trapped annually. Currently, only fish returning to the Feather
43 River Basin are used for broodstock. There are no specific goals for the number
44 of adult steelhead produced by this program; however, the juvenile production

1 goal is to release 450,000 yearling steelhead annually during late January or
2 February. All Feather River Hatchery steelhead are marked with an adipose
3 fin-clip prior to release. These fish are all released into the Feather River south of
4 Yuba City at the Boyd's Pump Boat Launch or at the confluence of the Feather
5 and Sacramento rivers (Verona Marina) (CHSRG 2012).

6 Prior to 2004, separation of spring-run and fall-run Chinook Salmon returning to
7 the Feather River Fish Hatchery was solely based on run timing, which resulted in
8 considerable mixing of fall-run and spring-run Chinook Salmon stocks (DWR
9 2009, NMFS 2012a). In 2005, the Feather River Fish Hatchery implemented a
10 methodology change for distinguishing spring-run Chinook Salmon from fall-run
11 Chinook Salmon (CHSRG 2012). To maintain genetic integrity, fish entering the
12 Feather River Fish Hatchery prior to July 1 receive an external tag, and only these
13 externally tagged fish are used as spring-run Chinook Salmon broodstock
14 (DWR 2009). Since 2005, the hatchery has attempted to mark 100 percent of
15 spring-run Chinook Salmon produced at the hatchery with an adipose fin-clip,
16 coded wire-tag (CHSRG 2012) and race and brood year specific otolith thermal
17 marks (DWR 2009).

18 The Feather River Fish Hatchery employs best management practices and
19 protocols to avoid the spread of diseases from the hatchery. The hatchery has
20 been successful in adaptively managing disease concerns as they arise by the
21 installing an ultraviolet treatment system, modifying the stocking of Lake
22 Oroville, conducting periodic testing, and using prescribed therapeutic treatments
23 (DWR 2004c).

24 **9.3.4.7.5 Disease**

25 Several endemic salmonid pathogens and diseases occur in the Feather River
26 Basin, including *Ceratomyxa shasta* (salmonid ceratomyxosis), *Flavobacterium*
27 *columnare* (columnaris), Infectious Hematopoietic Necrosis (IHN) virus,
28 *Renibacterium salmoninarum* (bacterial kidney disease), and *Flavobacterium*
29 *psychrophilum* (cold-water disease) (DWR 2004c). Each of these diseases has
30 been shown to infect stocked and native salmonids in the Feather River; however,
31 these diseases are not known to infect non-salmonids (FERC 2007b). Whirling
32 disease has never been detected in the lower Feather River downstream of
33 Oroville Dam, but has been found in upstream tributaries such as the north and
34 south forks of the Feather River (DWR 2004c). Of the fish diseases in the Feather
35 River Basin, IHN and salmonid ceratomyxosis are main contributors to fish
36 mortality at the Feather River Fish Hatchery and are of highest concern for
37 fisheries management in the region (DWR 2004c). The Feather River Fish
38 Hatchery experienced severe IHN outbreaks in 2000 and 2001. A study by the
39 University of California at Davis and USFWS indicated that although there were
40 no clinical signs of disease, adult salmonids returning to either the Yuba or the
41 Feather rivers demonstrated IHN infection rates of 28 percent and 18 percent,
42 respectively (Brown et al. 2004).

1 Salmonid ceratomyxosis is endemic to the Feather River Basin; local salmonid
2 stocks have co-evolved with this pathogen and exhibit some natural resistance.
3 Salmonid ceratomyxosis causes mortality in all ages of anadromous and resident
4 trout and salmon, although Rainbow Trout and steelhead are more susceptible to
5 the disease than are Chinook and Coho Salmon (DWR 2004c). Mortality
6 generally occurs when water temperatures exceed 50°F; however, fish can
7 become infected at temperatures as low as 39°F (Bartholomew 2012).

8 **9.3.4.7.6 Predation**

9 The FERC (2007b) study suggests that the Fish Barrier Dam, which directs most
10 anadromous salmonid spawning to occur in the low-flow channel, concentrates
11 juvenile salmonids within this reach. Counts of known predators on juvenile
12 anadromous salmonids in the low-flow channel are reported to be low; however,
13 significant numbers of predators reportedly do exist in the high-flow channel
14 downstream of Thermalito Afterbay Outlet (Seesholtz et al. 2004). Limited
15 information is available to estimate the current rate of predation on juvenile
16 salmonids in the lower Feather River.

17 **9.3.4.8 Yuba River**

18 Portions of the Yuba River watershed along the North Yuba River between New
19 Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River
20 between Englebright Lake and the Feather River could be affected by operation of
21 the Lower Yuba River Water Accord (DWR et al. 2007), as described in
22 Chapter 5, Surface Water Resources and Water Supplies.

23 Fish species found in the New Bullards Bar Reservoir include Rainbow Trout,
24 Brown Trout, Kokanee Salmon, bass, Bluegill, crappie, and bullhead (DWR et al.
25 2007). A similar mix of species is found in Englebright Reservoir. Fall-run and
26 spring-run Chinook Salmon and steelhead occur in the Yuba River downstream of
27 Englebright Dam (YCWA 2009). Sacramento Splittail have been documented
28 only in the lower Feather River and not in the Yuba River. Low numbers of
29 Green Sturgeon and White Sturgeon occasionally range into the Yuba River
30 (Beamesderfer et al. 2004). Other species found in the lower Yuba River include
31 American Shad, Smallmouth Bass, and Striped Bass (DWR et al. 2007).

32 **9.3.4.9 Bear River**

33 The Bear River flows into the Feather River downstream of the confluence of the
34 Feather and Yuba rivers. The Bear River includes Nevada Irrigation District's
35 Rollins and Combie reservoirs along the upper and middle reaches of the Bear
36 River and South Sutter Water District's Camp Far West Reservoir along the lower
37 reach of the Bear River (FERC 2013, NID 2005).

38 Fall-run and spring-run Chinook Salmon and steelhead occur in the Bear River
39 (YCWA 2009). Sacramento Splittail have been documented only in the lower
40 Feather River and not in the Bear River. Low numbers of Green Sturgeon and
41 White Sturgeon occasionally range into the Bear River (Beamesderfer et al.
42 2004). Rollins Reservoir is currently managed as a put-and-take fishery for
43 rainbow and Brown Trout. Kokanee reproduce naturally in the lake. Gill net

1 surveys from 1970 to 1983 documented numerous other species including bass,
2 catfish, sunfish, Golden Shiner, Tui Chub, Pond Smelt, crappie, and Bluegill
3 (DFG 1974-1983 in NID 2008). Native fishes found in Combie Reservoir may
4 include Sacramento Pikeminnow, Sacramento Sucker, Hardhead, Tui Chub,
5 Hitch, and Inland Silverside. Nonnative fishes likely include Bluegill, Green
6 Sunfish, Largemouth Bass, Spotted Bass, Smallmouth Bass, common carp,
7 Golden Shiner, Threadfin Shad, Black Crappie, Brown Bullhead, White Catfish,
8 Channel Catfish, Western Mosquitofish, and stocked Rainbow Trout (NID 2009).

9 **9.3.4.10 Folsom Lake and Lake Natoma**

10 The American River watershed encompasses approximately 2,100 square miles
11 (Reclamation et al. 2006). The three forks of the American River (north, middle,
12 and south forks) converge upstream of Folsom Dam, with the combined flow
13 moving through Lake Natoma and the lower American River for about 23 miles
14 before entering the Sacramento River.

15 Water surface elevations vary annually as a result of seasonal inflow and water
16 release and are generally the least variable during spring and most variable during
17 summer (USACE et al. 2012). Thermal stratification of the reservoir generally
18 begins during April and usually persists throughout summer until November,
19 when cooler temperatures, winter rains, and high inflows create mixing and result
20 in “turnover” (Reclamation 2005, USACE et al. 2012). During summer, a
21 thermocline develops that separates the epilimnion (i.e., upper layer of warm
22 water) and the hypolimnion (i.e., lower layer of cooler water). This thermal
23 stratification and segregation of habitats allow for both cold-water and
24 warm-water species to coexist in Folsom Lake (USACE et al. 2012).

25 Warm-water fish species include native Hardhead, California Roach, Sacramento
26 Pikeminnow, and Sacramento Sucker, as well as nonnative Largemouth Bass,
27 Smallmouth Bass, Spotted Bass, sunfish, Black Crappie, and White Crappie
28 (Reclamation 2007). Cold-water fish species include native Rainbow Trout and
29 planted Chinook and Kokanee Salmon, as well as nonnative Brown Trout
30 (Reclamation 2007).

31 Nimbus Dam creates Lake Natoma, which serves as a regulating afterbay to the
32 Folsom power plant, maintaining more uniform flows in the lower American
33 River. Lake Natoma is a shallow reservoir with an average depth of about 16 feet
34 (Reclamation 2005). Surface water elevations in Lake Natoma may fluctuate
35 between 4 and 7 feet daily (USACE et al. 2012). Lake Natoma has relatively low
36 productivity as a fishery due to the effects of wide water temperature variability
37 associated with the lake fluctuating elevation. Reclamation (2007) reports that
38 fish species found in Lake Natoma are generally the same as those in Folsom
39 Lake. Although CDFW annually stocks Lake Natoma with hatchery Rainbow
40 Trout, conditions in Lake Natoma are more favorable for warm-water fish species
41 (Reclamation 2007).

1 **9.3.4.11 Lower American River between Lake Natoma and the**
 2 **Sacramento River**

3 The lower American River extends approximately 23 miles from Nimbus Dam
 4 downstream to the confluence with the Sacramento River. Access to the upper
 5 reaches of the river by anadromous fish is blocked at Nimbus Dam.

6 **9.3.4.11.1 Fish in the Lower American River**

7 The lower American River system supports numerous resident native and
 8 introduced species as well as several anadromous species.

9 The analysis is focused on the following species:

- 10 • Fall-run Chinook Salmon
- 11 • Steelhead
- 12 • White Sturgeon
- 13 • Sacramento Splittail
- 14 • Pacific Lamprey
- 15 • Striped Bass
- 16 • American Shad

17 *Fall-run Chinook Salmon*

18 Historically, the American River supported fall-run and perhaps late fall-run
 19 Chinook Salmon (Williams 2001). Both naturally and hatchery produced
 20 Chinook Salmon spawn in the lower American River. Recent analysis by DFG
 21 and USFWS (2010) indicated that approximately 84 percent of the natural fall-run
 22 Chinook Salmon spawners in the American River are hatchery-origin fish.
 23 Kormos et al. (2012) reported that 79 percent of the fall-run Chinook Salmon
 24 entering the Nimbus Fish Hatchery in 2010 and 32 percent of the fish spawning in
 25 the American River were of hatchery origin.

26 Adult fall-run Chinook Salmon enter the lower American River from about
 27 mid-September through January, with peak migration from approximately
 28 mid-October through December (Williams 2001). Spawning occurs from about
 29 mid-October through early February, with peak spawning from mid-October
 30 through December. Chinook Salmon spawning occurs within an 18-mile stretch
 31 from Paradise Beach to Nimbus Dam; however, most spawning occurs in the
 32 uppermost 3 miles (DFG 2012a). Chinook Salmon egg and alevin incubation
 33 occurs in the lower American River from about mid-October through April.
 34 There is high variability from year to year; however, most incubation occurs from
 35 about mid-October through February. Chinook Salmon fry emergence occurs
 36 from January through mid-April, and juvenile rearing extends from January to
 37 about mid-July (Williams 2001). Most Chinook Salmon outmigrate from the
 38 lower American River as fry between December and July, peaking in February to
 39 March (Snider and Titus 2002, PSMFC 2014).

1 *Steelhead*

2 Natural spawning by steelhead in the American River occurs (Hannon and
3 Deason 2008), but the population is supported primarily by the Nimbus Fish
4 Hatchery. The total estimated steelhead return to the river (spawning naturally
5 and in the hatchery) has ranged from 946 to 3,426 fish, averaging 2,184 fish per
6 year from 2002 to 2010 (CHSRG 2012). Steelhead spawning surveys have shown
7 approximately 300 steelhead spawning in the river each year (Hannon and Deason
8 2008). Lindley et al. (2007) classifies the listed (i.e., naturally spawning)
9 population of American River steelhead at a high risk of extinction because it is
10 reportedly mostly composed of steelhead originating from Nimbus Fish Hatchery.
11 NMFS views the American River population as important to the survival and
12 recovery of the species (NMFS 2009a).

13 Nielsen et al. (2005) found steelhead in the American River to be genetically
14 different from other Central Valley stocks. Eel River steelhead were used to
15 found the Nimbus Hatchery stock, and steelhead from the American River
16 (collected from both the Nimbus Fish Hatchery and the American River) are
17 genetically more similar to Eel River steelhead than other Central Valley
18 Steelhead stocks. Based on studies by Hallock et al. (1961), Staley (1976), and
19 Neilsen (2005), Lee and Chilton (2007) reported that American River winter-run
20 steelhead are genetically and phenotypically different, and demonstrate a later
21 upstream migration period than Central Valley Steelhead. Zimmerman et al.
22 (2008) also noted that there remains a strong resident component (i.e., fish that do
23 not migrate to the ocean) of the *O. mykiss* population that interacts with and
24 produces anadromous individuals. Steelhead and Rainbow Trout are the same
25 species and when juveniles of the species are found in fresh water, it is unclear if
26 they will exhibit an anadromous (steelhead) or resident (Rainbow Trout) life
27 history strategy. Thus, they are often collectively referred to as *O. mykiss* at this
28 stage to indicate this uncertainty.

29 Adult steelhead enter the American River from November through April with a
30 peak occurring from December through March (SWRI 2001). Steelhead have
31 been trapped at Nimbus Fish Hatchery as early as the first week of October.
32 Results of a spawning survey conducted from 2001 through 2007 indicate that
33 steelhead spawning occurs in the lower American River from late December
34 through early April, with the peak occurring in late February to early March
35 (Hannon and Deason 2008). Spawning density is highest in the upper 7 miles of
36 the river, but spawning occurs as far downstream as Paradise Beach. About
37 90 percent of spawning occurs upstream of the Watt Avenue Bridge (Hannon and
38 Deason 2008).

39 Embryo incubation begins with the onset of spawning in late December and
40 generally extends through May, although incubation can occur into June in some
41 years (SWRI 2001). Steelhead embryo and alevin mortality associated with high
42 flows in the American River has not been documented, but flows high enough to
43 mobilize spawning gravels do occur during the spawning and embryo incubation
44 periods (i.e., late December through early April) (NMFS 2009a).

1 Juvenile *O. mykiss* have been documented year-round throughout the lower
2 American River, with rearing generally upstream of spawning areas. Juveniles
3 reportedly can rear in the lower American River for a year or more before
4 outmigrating as smolts from January through June (Snider and Titus 2000a,
5 SWRI 2001). However, Snider and Titus (2002) reported only 1 yearling
6 steelhead capture, and PSMFC (2014) reported capturing primarily YOY fry and
7 parr. Peak outmigration occurs from March through May (McEwan and Jackson
8 1996, SWRI 2001, PSMFC 2014).

9 Rearing habitat for juvenile steelhead in the lower American River occurs
10 throughout the upper reaches downstream to Paradise Beach. In summer,
11 juveniles occur in most major riffle areas, with the highest concentrations near the
12 higher density spawning areas (Reclamation 2008a). The number of juveniles in
13 the American River decreases throughout summer (Reclamation 2008a). Warm
14 water temperatures stress juvenile steelhead rearing in the American River,
15 particularly during summer and early fall (LARTF 2002, Water Forum 2005c,
16 NMFS 2014b). However, laboratory studies suggest that American River
17 steelhead may be more tolerant of high temperatures than steelhead from regions
18 farther north (Myrick and Cech 2004).

19 *Pacific Lamprey*

20 The Pacific Lamprey inhabits accessible reaches of the American River.
21 Information on the status of Pacific Lamprey in the American River is limited, but
22 the loss of historical habitat and apparent population declines throughout
23 California indicate populations are greatly decreased compared to historical levels
24 (Moyle et al. 2009).

25 Hannon and Deason (2008) documented Pacific Lamprey spawning in the
26 American River between early January and late May, with peak spawning
27 typically in early April. Pacific Lamprey ammocoetes rear in the American River
28 for all or part of their 5- to 7-year freshwater residence. Data from rotary screw
29 trapping in the nearby Feather River suggest that outmigration of Pacific Lamprey
30 generally occurs from early winter through early summer (Hanni et al. 2006),
31 although some outmigration likely occurs year-round, as observed at sites on the
32 mainstem Sacramento River (Hanni et al. 2006) and in other river systems
33 (Moyle 2002).

34 Because of the parallels in their life cycles, particularly spawning, lampreys may
35 be affected by many of the same factors as salmon and steelhead. Little
36 information is available on factors influencing Pacific Lamprey populations in the
37 American River, but the dams likely play an important role. Moyle et al. (2009)
38 suggested that in addition to blocking upstream migration, dams may disrupt
39 upstream sediment inputs required to maintain habitat for ammocoetes and subject
40 ammocoetes to rapid decreases in stream flow. Moyle et al. (2009) also indicated
41 that ramping rates sufficient to protect salmonids may not be adequate to prevent
42 the stranding of ammocoetes and metamorphosing individuals, which are
43 vulnerable to desiccation and avian predation. Additionally, commercial harvest
44 of lampreys on the American River (presumably for bait) may reduce spawning
45 success in some years (Hannon and Deason 2008).

1 *Sacramento Splittail*

2 Splittail likely spawn in the lower reaches of the American River (Sommer et al.
3 1998, 2008; Moyle et al. 2004). During wet years, upstream migration is more
4 directed and fish tend to swim farther upstream (Moyle 2002), thus more
5 individuals are expected to use the American River in wet years. Although
6 juvenile splittail are known to rear in upstream areas for a year or more (Baxter
7 1999), most move to the Delta after only a few weeks of rearing on floodplain
8 habitat (Reclamation 2008a). Most juveniles move downstream into the Delta
9 from April to August (Meng and Moyle 1995). The primary factor potentially
10 limiting the American River population of Sacramento Splittail is availability of
11 inundated floodplains for spawning and rearing habitats (Moyle et al. 2004).

12 *White Sturgeon*

13 Limited quantitative information is available on the distribution and status of
14 White Sturgeon in the American River; however, small numbers of adults
15 apparently use the American River, as evidenced by sturgeon report cards
16 submitted to CDFW by anglers in recent years (e.g., DFG 2012b).

17 *Striped Bass*

18 Striped Bass are found in the American River throughout the year, with the
19 greatest abundance in summer (SWRI 2001). Although the occurrence of
20 spawning in the American River is uncertain, the river is believed to serve as a
21 nursery area for YOY and subadult Striped Bass (SWRI 2001). Striped Bass are
22 distributed from the confluence with the Sacramento River to Nimbus Dam
23 (Moyle 2002), and they provide a locally important sportfishing resource.

24 *American Shad*

25 Adult American Shad ascend the lower American River to spawn during the late
26 spring. During this period, they provide an important sport fishery. The shortage
27 of adequate attraction flows in major tributaries such as the American River may
28 be contributing to declines in the population (Moyle 2002).

29 **9.3.4.11.2 Aquatic Habitat**

30 Since 1955, Nimbus Dam has blocked upstream passage by anadromous fish and
31 restricted available habitat in the lower American River to the approximately
32 23 river miles between the dam and the confluence with the Sacramento River.
33 Additionally, Folsom Dam has blocked the downstream transport of sediment that
34 contributes to the formation and maintenance of habitat for aquatic species.

35 In 2008, Reclamation, in coordination with USFWS and the Sacramento Water
36 Forum, began implementation of salmonid habitat improvement in the lower
37 American River. An estimated 5,000 cubic yards of gravel and cobble were
38 placed just upstream of Nimbus Fish Hatchery in 2008, followed by an estimated
39 7,000 cubic yards adjacent to the Nimbus Fish Hatchery in fall 2009. In
40 September 2010, approximately 11,688 cubic yards (approximately 16,200 tons)
41 of gravel and cobble were placed at Sailor Bar to enhance spawning habitat for
42 Chinook Salmon and steelhead in the lower American River (Merz et al. 2012).
43 Additionally, the 2010 augmentation site contained a constructed cobble island

1 and “scallop” in the substrate designed to add habitat heterogeneity to the main
2 channel and rearing habitat for juvenile Chinook Salmon and steelhead.
3 Additionally, approximately 5,500 tons of cleaned cobble were placed
4 downstream of the 2010 augmentation site. The specific purpose of this
5 placement was to divert flow into an adjacent, perched side channel, thereby
6 preventing the dewatering of salmonid redds in a historically important spawning
7 and rearing area during low-flow conditions.

8 During higher flows, channel geomorphology in the lower American River is
9 characterized by bar complexes and side channel areas, which may become
10 limited at lower flows (NMFS 2009a). Spawning bed materials in the lower
11 American River may begin to mobilize at flows of 30,000 cfs, with more
12 substantial mobilization at flows of 50,000 cfs or greater (Reclamation 2008a).
13 At 115,000 cfs (the highest flow modeled), particles up to 70 mm median
14 diameter would be moved in the high-density spawning areas around Sailor Bar
15 and Sunrise Avenue. Flood frequency analysis for the American River at Fair
16 Oaks gage shows that, on average, flood control releases exceed 30,000 cfs about
17 once every 4 years and exceed 50,000 cfs about once every 5 years
18 (Reclamation 2008a).

19 In 2008, Reclamation began implementing floodplain and spawning habitat
20 restoration projects in the American River to assist in meeting the requirements of
21 the 1992 CVPIA, Section 3406 (b)(13). The side channel at Upper Sunrise was
22 identified as a suitable site for steelhead spawning habitat restoration. In 2008,
23 the CVPIA (b)(13) program cut and widened the side channel so that it inundated
24 at a greater range of flows. The project reduced steelhead stranding, but also
25 inadvertently reduced Chinook Salmon and steelhead spawning and rearing
26 habitat (AFRP 2012). Consequently, the main channel was filled at the head-cut
27 to create greater head pressure, thereby allowing flow once again through the side
28 channel. Monitoring at the Upper Sunrise project revealed immediate response
29 from Chinook Salmon and steelhead moving up into the side channel to spawn
30 after completion of the project. Spawning and rearing habitat enhancement
31 projects occurred each year from 2008 through 2014 in the reach from Nimbus
32 Dam down to River Bend Park. These annual projects are planned to continue.

33 **9.3.4.11.3 Fish Passage**

34 Including the mainstem, north, middle, and south forks, more than 125 miles of
35 riverine habitat historically were available for anadromous salmonids in the
36 American River watershed (Yoshiyama et al. 1996). Access to the upper reaches
37 of the river has been blocked by a series of impassable dams, including Old
38 Folsom Dam, first constructed in the American River between 1895 and 1939.

39 Reclamation operates a fish diversion weir approximately 0.25 mile downstream
40 of Nimbus Dam, which functions to divert adult steelhead and Chinook Salmon
41 into Nimbus Fish Hatchery. The weir is annually installed during September
42 prior to the arrival of fall-run Chinook Salmon and steelhead and is removed at
43 the conclusion of fall-run Chinook Salmon immigration in early January
44 (Reclamation and DFG 2011). Some steelhead may be trapped prior to weir

1 removal, but they are returned to the river. A new fish passageway is being
2 implemented in the Nimbus Dam stilling basin, commonly referred to as Nimbus
3 Shoals. The passageway will replace the existing fish diversion weir with a new
4 flume and fish ladder that will connect to the existing fish ladder near Nimbus
5 Fish Hatchery.

6 **9.3.4.11.4 Hatcheries**

7 CDFW operates the Nimbus Salmon and Steelhead Hatchery and American River
8 Trout Hatchery, located immediately downstream from Nimbus Dam. Facilities
9 associated with Nimbus Fish Hatchery include a fish weir, fish ladder, gathering
10 and handling tanks, hatchery-specific buildings, and rearing ponds. Nimbus Fish
11 Hatchery was constructed primarily to mitigate the loss of spawning habitat for
12 Chinook Salmon and Central Valley Steelhead that were blocked by the
13 construction of Nimbus Dam (Reclamation and DFG 2011); it does not address
14 lost habitat upstream from Folsom Dam (CHSRG 2012). The hatchery operations
15 include the trapping, artificial spawning, rearing, and release of steelhead and fall-
16 /late fall-run Chinook Salmon. Propagation programs for American River winter-
17 run steelhead and Central Valley fall/ late fall-run Chinook Salmon are operated
18 by CDFW under contract with Reclamation (Lee and Chilton 2007). The Nimbus
19 Fish Hatchery Winter-run Steelhead Program is an isolated-harvest program
20 (i.e., it does not include natural-origin steelhead in the broodstock), designed and
21 implemented to artificially spawn the adipose fin-clipped adult steelhead that
22 seasonally enter the trapping facilities (CHSRG 2012). These fin-clipped fish are
23 not part of the Central Valley Steelhead DPS. The Nimbus Fish Hatchery
24 Winter-run Steelhead Program propagates fish for recreational fishing
25 opportunities and harvest (CHSRG 2012).

26 Steelhead have been trapped at Nimbus Fish Hatchery as early as the first week of
27 October; however, since 2000, the ladder has been opened in early November.
28 Trapping of steelhead has continued to occur as late as the second week of March.
29 Presently, winter-run steelhead are trapped at Nimbus Fish Hatchery, and
30 artificially spawned adults are marked with an adipose fin clip (CHSRG 2012).
31 Unmarked steelhead adults are not retained at Nimbus Fish Hatchery for use in
32 the annual broodstock and are released back to the river (CHSRG 2012). In
33 addition, marked or unmarked *O. mykiss* that are less than 16 inches long may be
34 resident hatchery-origin trout and are returned to the river (CHSRG 2012).

35 On average, the program has raised and released approximately 422,000 yearling
36 steelhead since brood year 1999 (CHSRG 2012). Since 1998, all
37 steelhead/Rainbow Trout produced in Nimbus Fish Hatchery have been marked
38 with an adipose fin-clip to aid in subsequently identifying hatchery-origin fish.

39 Juvenile steelhead yearlings are not held past March 30 because of increasing
40 hatchery water temperatures and to encourage outmigration during spring. If
41 releases occur during periods of low flows in the Sacramento River and possibly
42 the American River, some released fish migrate back to Nimbus Fish Hatchery
43 and may take up residency rather than migrating downstream (Lee and Chilton
44 2007). Additionally, juvenile fish are released in February and early March to

1 coincide with State Water Resources Control Board (SWRCB) D-1641 closures
2 of the DCC gates from February 1 through May 20 to reduce straying into the
3 Delta. Reclamation determines the exact timing and duration of the gate closures
4 after discussion with USFWS, CDFW, and NMFS.

5 Reclamation is implementing a genetic screening study of Nimbus Fish Hatchery
6 steelhead. Reclamation, in contract with NMFS, is conducting a parental-based
7 tagging study of American River steelhead and continuing a study to determine a
8 more genetically appropriate stock.

9 CDFW releases all hatchery-produced steelhead juveniles into the American
10 River at boat ramps on the American River or at the confluence of the Sacramento
11 and American rivers and releases all unclipped steelhead adults returning to
12 Nimbus Fish Hatchery into the lower American River via the river return tube that
13 is just downstream of the fish ladder. In accordance with California law, the
14 current protocol of Nimbus Fish Hatchery is to destroy all surplus eggs to prevent
15 inter-basin transfer of eggs or juveniles to other hatcheries or waters.

16 The goal of the Nimbus Fish Hatchery Integrated Fall/Late Fall-run Chinook
17 Salmon Program is to release 4 million smolts. Each fall, Nimbus Hatchery staff
18 collect approximately 10,000 adult fall-run Chinook Salmon, with an annual goal
19 of harvesting 8,000,000 eggs and releasing the 4,000,000 smolts. All adult
20 fall-run Chinook Salmon collected at the hatchery are euthanized, and no trapped
21 salmon are returned to the American River (Reclamation 2008a).

22 **9.3.4.11.5 Disease**

23 The occurrence of a bacterial-caused inflammation of the anal vent (commonly
24 referred to as “rosy anus”) of steelhead in the lower American River has been
25 reported by CDFW to be associated with relatively warm water temperatures
26 (Water Forum 2005b). Anal vent inflammation of steelhead in the lower
27 American River was observed in 2004 during periods when water temperatures
28 were measured between 65°F and 68°F (Water Forum 2005a, 2005b). The Water
29 Forum (2005b) suggested that, in addition to possible diminished immune system
30 responses and incidences of diseases associated with elevated water temperatures,
31 disease transmission may be exacerbated by crowding under conditions when
32 water flows are reduced.

33 **9.3.4.11.6 Predation**

34 Reduced cold-water storage in Folsom Lake and using Folsom Lake to meet Delta
35 water quality objectives and demands influence habitat conditions in the lower
36 American River for warm-water predator species that feed on juvenile salmonids
37 and potentially alter predation pressure (Water Forum 2005b). Additionally,
38 isolation of redds in side channels resulting from fluctuations in Folsom Lake
39 releases may increase predation of emergent fry (Water Forum 2005b).

1 **9.3.4.12 Delta**

2 Ecologically, the Delta consists of three major landscapes and geographic regions:
3 (1) the north Delta freshwater flood basins composed primarily of freshwater
4 inflow from the Sacramento River system; (2) the south Delta distributary
5 channels composed of predominantly San Joaquin River system inflow; and
6 (3) the central Delta tidal islands landscape wherein the Sacramento, San Joaquin,
7 and east side tributary flows converge and tidal influences from San Francisco
8 Bay are greater.

9 **9.3.4.12.1 Fish in the Delta**

10 The Delta provides unique and, in some places, highly productive habitats for a
11 variety of fish species, including euryhaline and oligohaline resident species and
12 anadromous species. For anadromous species, the Delta is used by adult fish
13 during upstream migration and by rearing juvenile fish that are feeding and
14 growing as they migrate downstream to the ocean. Conditions in the Delta
15 influence the abundance and productivity of all fish populations that use the
16 system. Fish communities currently in the Delta include a mix of native species,
17 some with low abundance, and a variety of introduced fish, some with high
18 abundance (Matern et al. 2002, Feyrer and Healey 2003, Nobriga et al. 2005,
19 Brown and May 2006, Moyle and Bennett 2008, Grimaldo et al. 2012).

20 The analysis is focused on the following species:

- 21 • Chinook Salmon (winter-, spring-, and fall-/late fall-run)
- 22 • Steelhead
- 23 • Green Sturgeon
- 24 • White Sturgeon
- 25 • Sacramento Splittail
- 26 • Pacific Lamprey
- 27 • Striped Bass
- 28 • American Shad
- 29 • Delta Smelt
- 30 • Longfin Smelt
- 31 • Sacramento Splittail

32 The Interagency Ecological Program (IEP) has been monitoring fish populations
33 in the San Francisco Estuary for decades. Survey methods have included beach
34 seining, midwater trawls, Kodiak trawls, otter trawls, and other methods (Honey
35 et al. 2004) to sample the pelagic fish assemblage throughout the estuary. Three
36 of the most prominent resident pelagic fishes captured in the surveys (Delta
37 Smelt, Longfin Smelt, and Striped Bass) have shown substantial long-term
38 population declines (Kimmerer et al. 2000, Bennett 2005, Rosenfield and
39 Baxter 2007). Reductions in pelagic fish abundance since 2002 have been
40 recognized as a serious water and fish management issue and have become known
41 as the Pelagic Organism Decline (POD) (Sommer et al. 2007a).

1 In response to the POD, the IEP formed a study team in 2005 to evaluate the
 2 potential causes of the decline. Since completion of the first set of studies in late
 3 2005, alternative models have been developed based on the available data and at
 4 professional judgment of the POD-Modeling Team regarding the extent to which
 5 individual drivers are likely to affect each species-life stage. The nine drivers
 6 identified (Baxter et al. 2010) were: (1) mismatch of larvae and food; (2) reduced
 7 habitat space; (3) adverse water movement/transport; (4) entrainment; (5) toxic
 8 effects on fish; (6) toxic effects on fish food items; (7) harmful *Microcystis*
 9 *aeruginosa* blooms; (8) *Potamocorbula amurensis* effects on food availability;
 10 and (9) disease and parasites.

11 An overall negative trend in habitat quality has occurred for Delta Smelt and
 12 Striped Bass (and potentially other fish species) as measured by water quality
 13 attributes and midwater trawl catch data since 1967, with Delta Smelt and Striped
 14 Bass experiencing the most apparent declines in abundance, distribution, and a
 15 related index of environmental quality (Feyrer et al. 2007, 2010). More
 16 specifically, the position of X2 and water clarity may be important factors
 17 influencing the quality of habitat for these species (McNally et al. 2010). Other
 18 factors, such as the introduction of nonnative clam species, also contribute to
 19 reducing habitat quality. Pelagic habitat suitability in the San Francisco Estuary
 20 has been characterized by changes in X2 (Feyrer et al. 2007, 2010). The
 21 abundance of several taxa increases in years when flows into the estuary are high
 22 and X2 is pushed seaward (Jassby et al. 1995; Kimmerer 2002a, b), implying that
 23 the quantity or suitability of estuarine habitat increases when outflows are high.
 24 Recent analyses by Kimmerer et al. (2009) indicated that neither changes in area
 25 or volume of low salinity water (habitat) account for this relationship, except for
 26 striped bass and American shad. This suggests that X2 is indexing other
 27 environmental variables or processes rather than simple extent of habitat (Baxter
 28 et al. 2010).

29 *Winter-run Chinook Salmon*

30 Winter-run Chinook Salmon use the Delta for upstream migration as adults and
 31 for downstream migration and rearing as juveniles (del Rosario et al. 2013).
 32 Adults migrate through the Delta during winter and into late spring (May/June)
 33 enroute to their spawning grounds in the mainstem Sacramento River downstream
 34 of Keswick Dam (USFWS 2001b, 2003b). Adults are believed to primarily use
 35 the mainstem Sacramento River for passage through the Delta (NMFS 2009a).
 36 After entry into the Delta, juvenile winter-run Chinook Salmon remain and rear in
 37 the Delta until they are 5 to 10 months of age (based on scale analysis) (Fisher
 38 1994, Myers et al. 1998). Although the duration of residence in the Delta is not
 39 precisely known, del Rosario et al. (2013) suggested that it can be up to several
 40 months. Winter-run Chinook Salmon juveniles have been documented in the
 41 north Delta (e.g., Sacramento River, Steamboat Slough, Sutter Slough, Miner
 42 Slough, Yolo Bypass, and Cache Slough complex); the central Delta
 43 (e.g., Georgiana Slough, DCC, Snodgrass Slough, and Mokelumne River complex
 44 below Dead Horse Island); south Delta channels, including Old and Middle rivers,
 45 and the joining waterways between Old and Middle rivers (e.g., Victoria Canal,

1 Woodward Canal, and Connection Slough); and the western central Delta,
2 including the mainstem channels of the Sacramento and San Joaquin rivers and
3 Threemile Slough (NMFS 2009a).
4 Sampling at Chipps Island in the western Delta suggests that winter-run Chinook
5 Salmon exit the Delta as early as December and as late as May, with a peak in
6 March (Brandes and McLain 2001, del Rosario et al. 2013). The peak timing of
7 the outmigration of juvenile winter-run Chinook Salmon through the Delta is
8 corroborated by recoveries of winter-run-sized juvenile Chinook Salmon from the
9 SWP Skinner Delta Fish Protection Facility and the CVP Tracy Fish Collection
10 Facility in the south Delta (NMFS 2009a).

11 *Spring-run Chinook Salmon*

12 The Delta is an important migratory route for all remaining populations of spring-
13 run Chinook Salmon. Like all salmonids migrating up through the Delta, adult
14 spring-run Chinook Salmon must navigate the many channels and avoid direct
15 sources of mortality (e.g., fishing and predation), but also must minimize
16 exposure to sources of nonlethal stress (e.g., high temperatures) that can
17 contribute to prespawn mortality in adult salmonids (Budy et al. 2002, Naughton
18 et al. 2005, Cooke et al. 2006, NMFS 2009a). Habitat degradation in the Delta
19 caused by factors such as channelization and changes in water quality can present
20 challenges for outmigrating juveniles. Additionally, outmigrating juveniles are
21 subjected to predation and entrapment in the project export facilities and smaller
22 diversions (NMFS 2009a). Further detail is provided later in this section.

23 Spring-run Chinook Salmon returning to spawn in the Sacramento River system
24 enter the San Francisco Estuary from the ocean in January to late February and
25 move through the Delta prior to entering the Sacramento River. Several
26 populations of spring-run Chinook Salmon occur in the Sacramento River Basin,
27 but historical populations that occurred in the San Joaquin River and tributaries
28 have been extirpated. The Sacramento River channel is the main spring-run
29 Chinook Salmon migration route through the Delta. However, adult spring-run
30 Chinook Salmon may stray into the San Joaquin River side of the Delta in
31 response to water from the Sacramento River Basin flowing into the
32 interconnecting waterways that join the San Joaquin River channel through the
33 DCC, Georgiana Slough, and Threemile Slough. Closure of the DCC radial gates
34 is intended to minimize straying, but some southward net flow still occurs
35 naturally in Georgiana and Threemile sloughs.

36 Juvenile spring-run Chinook Salmon show two distinct outmigration patterns in
37 the Central Valley: outmigrating to the Delta and ocean during their first year of
38 life as YOY, or holding over in their natal streams and outmigrating the following
39 fall/winter as yearlings. Peak movement of juvenile spring-run Chinook Salmon
40 in the Sacramento River at Knights Landing generally occurs in December, and
41 again in March. However, juveniles also have been observed migrating between
42 November and the end of May (Snider and Titus 1998, 2000b, c, d; Vincik et al.
43 2006; Roberts 2007).

1 YOY spring-run Chinook Salmon presence in the Delta peaks during April and
2 May, as suggested by the recoveries of Chinook Salmon in the CVP and SWP
3 salvage operations and the Chipps Island trawls of a size consistent with the
4 predicted size of spring-run fish at that time of year. However, it is difficult to
5 distinguish the YOY spring-run Chinook Salmon outmigration from that of the
6 fall-run due to the similarity in their spawning and emergence times and size.
7 Together, these two runs generate an extended pulse of Chinook Salmon smolts
8 outmigrating through the Delta throughout spring, frequently lasting into June.
9 Spring-run Chinook Salmon juveniles also overlap spatially with juvenile winter-
10 run Chinook Salmon in the Delta (NMFS 2009a). Typically, juvenile spring-run
11 Chinook Salmon are not found in the channels of the eastern side of the Delta or
12 the mainstem of the San Joaquin River upstream of Columbia and Turner Cuts.

13 *Fall-/Late fall-run Chinook Salmon*

14 Central Valley fall- and late fall-run Chinook Salmon pass through the Delta as
15 adults migrating upstream and juveniles outmigrating downstream. Adult fall-
16 and late fall-run Chinook Salmon migrating through the Delta must navigate the
17 many channels and avoid direct sources of mortality and minimize exposure to
18 sources of nonlethal stress. Additionally, outmigrating juveniles are subject to
19 predation and entrainment in the project export facilities and smaller diversions.

20 Adult fall-run Chinook Salmon migrate through the Delta and into Central Valley
21 rivers from June through December. Adult late fall-run Chinook Salmon migrate
22 through the Delta and into the Sacramento River from October through April.
23 Adult Central Valley fall- and late fall-run Chinook Salmon migrating into the
24 Sacramento River and its tributaries primarily use the western and northern
25 portions of the Delta, whereas adults entering the San Joaquin River system to
26 spawn use the western, central, and southern Delta as a migration pathway.

27 Most fall-run Chinook Salmon fry rear in fresh water from December through
28 June, with outmigration as smolts primarily from January through June. In
29 general, fall-run Chinook Salmon fry abundance in the Delta increases following
30 high winter flows. Smolts that arrive in the estuary after rearing upstream migrate
31 quickly through the Delta and Suisun and San Pablo bays. A small number of
32 juvenile fall-run Chinook Salmon spend over a year in fresh water and outmigrate
33 as yearling smolts the following November through April. Late fall-run fry rear
34 in fresh water from April through the following April and outmigrate as smolts
35 from October through February (Snider and Titus 2000b). Juvenile Chinook
36 Salmon were found to spend about 40 days migrating through the Delta to the
37 mouth of San Francisco Bay (MacFarlane and Norton 2002).

38 Results of mark-recapture studies conducted using juvenile Chinook Salmon
39 released into both the Sacramento and San Joaquin rivers have shown high
40 mortality during passage downstream through the rivers and Delta (Brandes and
41 McLain 2001, Newman and Rice 2002, Buchanan et al. 2013). Juvenile salmon
42 migrating from the San Joaquin River generally experience greater mortality than
43 fish outmigrating from the Sacramento River. In years when spring flows are
44 reduced and water temperatures are increased, mortality is typically higher in both
45 rivers. Closing the DCC gates and installation of the Head of Old River Barrier to

1 reduce the movement of juvenile salmon into the south Delta from the
2 Sacramento and San Joaquin rivers, respectively, may contribute to improved
3 survival of outmigrating juvenile Chinook Salmon from these watersheds (see
4 Section 9.3.4.12.6).

5 Although not directly comparable to these previous coded-wire tag studies in the
6 San Joaquin River, Buchanan et al. (2013, 2015) found that survival of
7 acoustically tagged hatchery-origin (Feather River) juvenile Chinook Salmon was
8 either not statistically different between routes (2009) or was higher through the
9 south Delta via the Old River route than via the San Joaquin River (2010).
10 Additionally, most fish in the Old River that survived to the end of the Delta had
11 been salvaged from the federal water export facility on the Old River and trucked
12 around the remainder of the Delta (Buchanan et al. 2013, SJRGA 2013).
13 Buchanan et al. 2013 indicated that the differences in their results compared to
14 past CWT studies may reflect that an alternative non-physical barrier was being
15 used during their investigation to examine its ability to keep fish out of the Old
16 River instead of the HORB which is a physical barrier that reduces not only the
17 number of fish, but also the majority of flows, from entering the Old River.
18 Nonphysical barriers may deprive smolts routed to the San Joaquin River of the
19 increased flows needed for improved survival and created habitat for increased
20 predation at the site (Buchanan et al. 2013).

21 Juvenile fall- and late fall-run Chinook Salmon migrating through the Delta
22 toward the Pacific Ocean use the Delta, Suisun Marsh, and the Yolo Bypass for
23 rearing to varying degrees, depending on their life stage (fry versus juvenile),
24 size, river flows, and time of year. Movement of juvenile Chinook Salmon in the
25 estuarine environment is driven by the interaction between tidally influenced
26 saltwater intrusion through San Francisco Bay and freshwater outflow from the
27 Sacramento and San Joaquin rivers (Healey 1991).

28 In the Delta, tidal and floodplain habitat areas provide important rearing habitat
29 for foraging juvenile salmonids, including fall-run Chinook Salmon. Studies have
30 shown that juvenile salmon may spend 2 to 3 months rearing in these habitat
31 areas, and losses resulting from land reclamation and levee construction are
32 considered to be major stressors (Williams 2010). The channeled, leveed, and
33 riprapped river reaches and sloughs common in the Delta typically have low
34 habitat diversity and complexity, have low abundance of food organisms, and
35 offer little protection from predation by fish and birds.

36 *Steelhead*

37 Upstream migration of steelhead begins with estuarine entry from the ocean as
38 early as July and continues through February or March in most years (McEwan
39 and Jackson 1996, NMFS 2009a). Populations of steelhead occur primarily
40 within the watersheds of the Sacramento River Basin, although not exclusively.
41 Steelhead can spawn more than once, with postspawn adults (typically females)
42 potentially moving back downstream through the Delta after completion of
43 spawning in their natal streams.

1 Adult steelhead can be present in portions of the Delta with suitable conditions
2 during any month of the year. Upstream migrating adult steelhead enter the
3 Sacramento and San Joaquin River basins through their respective mainstem river
4 channels. Steelhead entering the Mokelumne River system (including Dry Creek
5 and the Cosumnes River) and the Calaveras River system to spawn are likely to
6 move up the mainstem San Joaquin River channel before branching off into the
7 channels of their natal rivers, although some may detour through the South Delta
8 waterways and enter the San Joaquin River through the Head of Old River.

9 Steelhead entering the San Joaquin River Basin appear to have a later spawning
10 run, with adults entering the system starting in late October through December,
11 indicating that migration up through the Delta may begin a few weeks earlier.
12 During fall, warm water temperatures in the south Delta waterways and water
13 quality impairment because of low dissolved oxygen at Stockton have been
14 suggested as potential barriers to upstream migration (NMFS 2009a). Reduced
15 water temperatures, as well as rainfall runoff and flood control release flows,
16 provide the stimulus to adult steelhead holding in the Delta to move upriver
17 toward their spawning reaches in the San Joaquin River tributaries. Adult
18 steelhead may continue entering the San Joaquin River Basin through winter.

19 Juvenile steelhead can be found in all waterways of the Delta, but particularly in
20 the main channels leading from their natal river systems (NMFS 2009a). Juvenile
21 steelhead are recovered in trawls from October through July at Chipps Island and
22 at Mossdale. Chipps Island catch data indicate there is a difference in the
23 outmigration timing between wild and hatchery-reared steelhead smolts from the
24 Sacramento and eastside tributaries. Hatchery fish are typically recovered at
25 Chipps Island from January through March, with a peak in February and March
26 corresponding to the schedule of hatchery releases of steelhead smolts from the
27 Central Valley hatcheries (Nobriga and Cadrett 2001, Reclamation 2008a). The
28 timing of wild (unmarked) steelhead outmigration is more spread out, and based
29 on salvage records at the CVP and SWP fish collection facilities, outmigration
30 occurs over approximately 6 months with the highest levels of recovery in
31 February through June (Aasen 2011, 2012). Steelhead are salvaged annually at
32 the project export facilities (e.g., 4,631 fish were salvaged in 2010, and 1,648 in
33 2011) (Aasen 2011, 2012).

34 Outmigrating steelhead smolts enter the Delta primarily from the Sacramento or
35 San Joaquin River. Mokelumne River steelhead smolts can either follow the
36 north or south branches of the Mokelumne River through the central Delta before
37 entering the San Joaquin River, although some fish may enter farther upstream if
38 they diverge from the south branch of the Mokelumne River into Little Potato
39 Slough. Calaveras River steelhead smolts enter the San Joaquin River
40 downstream of the Port of Stockton. Although steelhead have been routinely
41 documented by CDFW in trawls at Mossdale since 1988 (SJRG 2011), it is
42 unknown whether successful outmigration occurs outside the seasonal installation
43 of the barrier at the Head of Old River (between April 15 and May 15 in most
44 years). Prior to the installation of the Head of Old River barrier, steelhead smolts
45 exiting the San Joaquin River Basin could follow one of two routes to the ocean,

1 either staying in the mainstem San Joaquin River through the central Delta, or
2 entering the Head of Old River and migrating through the south Delta and its
3 associated network of channels and waterways.

4 *Green Sturgeon*

5 Green Sturgeon reach maturity around 14 to 16 years of age and can live to be
6 70 years old, returning to their natal rivers every 3 to 5 years for spawning
7 (Van Eenennaam et al. 2005). Adult Green Sturgeon move through the Delta
8 from February through April, arriving at holding and spawning locations the
9 upper Sacramento River between April and June (Heublein 2006, Kelly et al.
10 2007). Following their initial spawning run upriver, adults may hold for a few
11 weeks to months in the upper river before moving back downstream in fall
12 (Vogel 2008, Heublein et al. 2009), or they may migrate immediately back
13 downstream through the Delta. Radio-tagged adult Green Sturgeon have been
14 tracked moving downstream past Knights Landing during summer and fall,
15 typically in association with pulses of flow in the river (Heublein et al. 2009),
16 similar to behavior exhibited by adult Green Sturgeon on the Rogue River and
17 Klamath River systems (Erickson et al. 2002, Benson et al. 2007).

18 Similar to other estuaries along the west coast of North America, adult and sub-
19 adult Green Sturgeon frequently congregate in the San Francisco Estuary during
20 summer and fall (Lindley et al. 2008). Specifically, adults and subadults may
21 reside for extended periods in the central Delta as well as in Suisun and San Pablo
22 bays, presumably for feeding, because bays and estuaries are preferred feeding
23 habitat rich in benthic invertebrates (e.g., amphipods, bivalves, and insect larvae).
24 In part because of their bottom-oriented feeding habits, sturgeon are at risk of
25 harmful accumulations of toxic pollutants in their tissues, especially pesticides
26 such as pyrethroids and heavy metals such as selenium and mercury (Israel and
27 Klimley 2008, Stewart et al. 2004).

28 Juvenile Green Sturgeon and White Sturgeon are periodically (although rarely)
29 collected from the lower San Joaquin River at south Delta water diversion
30 facilities and other sites (NMFS 2009a; Aasen 2011, 2012). Green Sturgeon are
31 salvaged from the south Delta Project diversion facilities and are generally
32 juveniles greater than 10 months but less than 3 years old (Reclamation 2008a).
33 NMFS (2005b) suggested that the high percentage of San Joaquin River flows
34 contributing to the Tracy Fish Collection Facility could mean that some entrained
35 Green Sturgeon originated in the San Joaquin River Basin. Jackson (2013)
36 reported spawning by White Sturgeon in the San Joaquin River, and anglers have
37 reported catching a few Green Sturgeon in recent years in the San Joaquin River
38 (DFG 2012b).

39 After hatching, larvae and juveniles migrate downstream toward the Delta.
40 Juveniles are believed to use the Delta for rearing for the first 1 to 3 years of their
41 lives before moving out to the ocean and are likely to be found in the main
42 channels of the Delta and the larger interconnecting sloughs and waterways,
43 especially within the central Delta and Suisun Bay/Marsh. Project operations at
44 the DCC have the potential to reroute Green Sturgeon as they outmigrate through
45 the lower Sacramento River to the Delta (Israel and Klimley 2008, Vogel 2011).

1 When the DCC is open, there is no passage delay for adults, but juveniles could
2 be diverted from the Sacramento River into the interior Delta. This has been
3 shown to reduce the survival of juvenile Chinook Salmon (Brandes and McLain
4 2001, Newman and Brandes 2010, Perry et al. 2012), but it is unknown whether it
5 has similar effects on Green Sturgeon.

6 *White Sturgeon*

7 White Sturgeon are similar to Green Sturgeon in terms of their biology and life
8 history. Like Green Sturgeon and other sturgeon species, White Sturgeon are
9 late-maturing and infrequent spawners, which makes them vulnerable to
10 overexploitation and other sources of adult mortality. White Sturgeon are
11 believed to be most abundant within the San Francisco Bay-Delta region
12 (Moyle 2002). Both nonspawning adults and juveniles can be found throughout
13 the Delta year-round (Radtke 1966, Kohlhorst et al. 1991, Moyle 2002,
14 DWR et al. 2013). When not undergoing spawning or ocean migrations, adults
15 and subadults are usually most abundant in brackish portions of the Bay-Delta
16 (Kohlhorst et al. 1991). The population status of White Sturgeon in the Delta is
17 unclear, but it is not presently listed. Overall, information on trends in adults and
18 juveniles suggests that numbers are declining (Moyle 2002, NMFS 2009a).

19 The Delta population of White Sturgeon spawns mainly in the Sacramento and
20 Feather rivers, with occasional spawning in the San Joaquin River (Moyle 2002,
21 Jackson 2013). Spawning-stage adults generally move into the lower reaches of
22 rivers during winter prior to spawning and migrate upstream in response to higher
23 flows to spawn from February to early June (McCabe and Tracy 1994,
24 Schaffter 1997).

25 After absorbing yolk sacs and initiating feeding, YOY White Sturgeon make an
26 active downstream migration that disperses them widely to rearing habitat
27 throughout the lower rivers and the Delta (McCabe and Tracy 1994). White
28 Sturgeon larvae have been observed to be flushed farther downstream in the Delta
29 and Suisun Bay in high outflow years, but are restricted to more interior locations
30 in low outflow years (Stevens and Miller 1970).

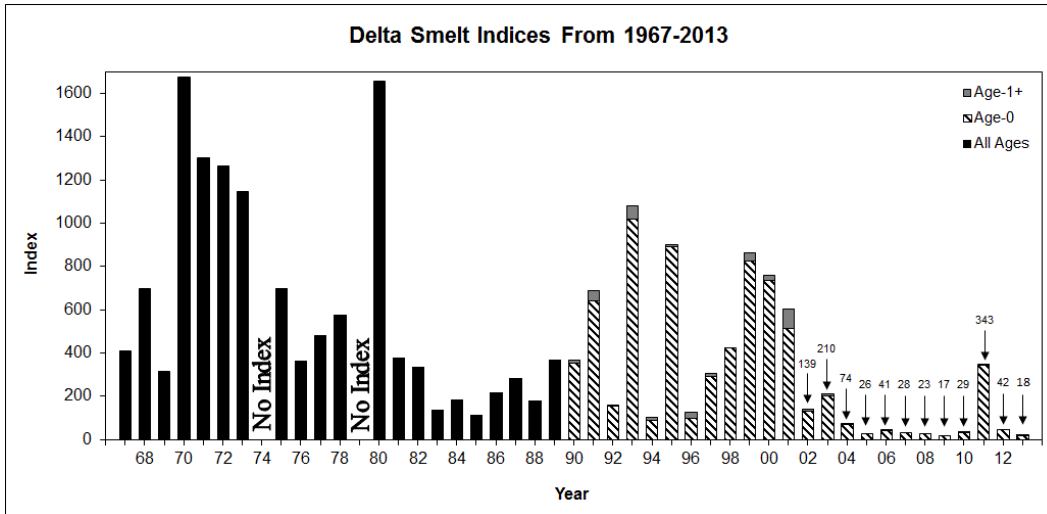
31 Salinity tolerance increases with increasing age and size (McEnroe and Cech
32 1985), allowing White Sturgeon to access a broader range of habitat in the San
33 Francisco Estuary (Israel et al. 2008). During dry years, White Sturgeon have
34 been observed following brackish waters farther upstream, while the opposite
35 occurs in wet years (Kohlhorst et al. 1991). Adult White Sturgeon tend to
36 concentrate in deeper areas and tidal channels with soft bottoms, especially during
37 low tides, and typically move into intertidal or shallow subtidal areas to feed
38 during high tides (Moyle 2002). These shallow water habitats provide
39 opportunities for feeding on benthic organisms, such as opossum shrimp,
40 amphipods, and even invasive overbite clams, and small fishes (Israel et al. 2008,
41 Kogut 2008). White Sturgeon also have been found in tidal habitats of
42 medium-sized tributary streams to the San Francisco Estuary, such as Coyote
43 Creek and Guadalupe River in the south bay and Napa and Petaluma rivers and
44 Sonoma Creek in the north bay (Leidy 2007).

1 Numerous factors likely affect the White Sturgeon population in the Delta, similar
2 to those for Green Sturgeon. Survival during early life history stages may be
3 adversely affected by insufficient flows, lack of rearing habitat, predation, warm
4 water temperatures, decreased dissolved oxygen, chemical toxicants in the water,
5 and entrainment at diversions (Cech et al. 1984, Israel et al. 2008). Historical
6 habitats, including shallow intertidal feeding habitats, have been lost in the Delta
7 because of channelization. Over-exploitation by recreational fishing and
8 poaching also likely has been an important factor adversely affecting numbers of
9 adult sturgeon (Moyle 2002), although new regulations were implemented in
10 2007 by CDFW to reduce harvest. Like Green Sturgeon, there are substantial
11 passage problems for White Sturgeon such as the Fremont Weir
12 (Sommer et al. 2014).

13 *Delta Smelt*

14 Delta Smelt are endemic to the Delta (Moyle et al. 1992, Bennett 2005). Delta
15 Smelt were once regarded as one of the most common pelagic fish in the Delta,
16 but declines in their population led to their listing under the ESA as threatened in
17 1993 (USFWS 2008a). Delta Smelt are one of four pelagic fish species (including
18 Longfin Smelt, Threadfin Shad, and juvenile Striped Bass) documented to be in
19 decline based on fall midwater trawl abundance indices (Sommer et al. 2007a).
20 The causes of the declines have been extensively studied and are thought to
21 include a combination of factors, such as decreased habitat quantity and quality,
22 increased mortality rates, and reduced food availability (Feyrer et al. 2007,
23 Sommer et al. 2007a, Moyle and Bennett 2008, Baxter et al. 2010, MacNally et al.
24 2010, Rose et al. 2013a, b, Sommer and Mejia 2013). Two statistical analyses
25 that used similar data but different statistical methods, (MacNally et al. 2010;
26 Thomson et al. 2010) examined the dynamics of the four fish species. Both
27 analyses identified several covariates that were related to abundance of the fish,
28 but they could not resolve the cause of the recent declines. The analysis of model
29 results and data for 1995–2005 conducted by Rose et al. (2013a) indicated that it
30 has been difficult to ascribe the Delta Smelt’s decline to a single cause, either
31 over the long term or as part of the recent 2002 decline.

32 The status of the Delta Smelt is uncertain, as indicators of Delta Smelt abundance
33 have continued to decline and the number of fish collected in sampling programs,
34 such as the trawl surveys conducted by the IEP, have dropped even lower in
35 recent years. The Fall Midwater Trawl (FMWT) Survey is recognized by some as
36 the best available long-term index of Delta Smelt relative abundance
37 (USFWS 2008). Figure 9.1 presents the FMWT abundance indices for Delta
38 Smelt from 1967 to 2013 (CDFW 2014b). Fewer than 10 Delta Smelt were
39 collected in these surveys in 2014; the 2014 Delta Smelt index was 9, making it
40 the lowest in FMWT history (CDFW 2014a, 2015). Results for Delta Smelt from
41 the 2015 spring Kodiak trawl, 20-mm survey, and summer townet survey reported
42 in the June 2015 Smelt Working Group meeting summary were similarly low
43 (Smelt Working Group 2015).



1

2 **Figure 9.1 Fall Midwater Trawl Abundance Indices for Delta Smelt from 1967**
 3 **to 2013**

4 Source: California Department of Fish and Wildlife, Trends in Abundance of Selected
 5 Species, January 15, 2014. <http://www.dfg.ca.gov/delta/data/fmwt/Indices/>

6 Studies conducted to synthesize available information about Delta Smelt indicate
 7 that Delta Smelt have been documented throughout their geographic range during
 8 much of the year (Merz et al. 2011, Sommer and Mejia 2013, Brown et al. 2014).
 9 Studies indicate that in fall, prior to spawning, Delta Smelt are found in the Delta,
 10 Suisun and San Pablo bays, the Sacramento River and San Joaquin River
 11 confluence, Cache Slough, and the lower Sacramento River (Murphy and
 12 Hamilton 2013). By spring, they move to freshwater areas of the Delta region,
 13 including the Sacramento River and San Joaquin River confluence, the Upper
 14 Sacramento River, and Cache Slough (Brown et al. 2014, Murphy and
 15 Hamilton 2013).

16 Sommer et al. 2011 described that during winter, adult Delta Smelt initiate
 17 upstream spawning migrations in association with “first flush” freshets. Others
 18 report this seasonal change as a multi-directional and more circumscribed
 19 dispersal movement to freshwater areas throughout the Delta region (Murphy and
 20 Hamilton 2013). After arriving in freshwater staging habitats, adult Delta Smelt
 21 hold until spawning commences during favorable water temperatures in the late
 22 winter-spring (Bennett 2005, Grimaldo et al. 2009, Sommer et al. 2011). Delta
 23 Smelt spawn over a wide area throughout much of the Delta, including some areas
 24 downstream and upstream as conditions allow. Although the specific substrates
 25 or habitats used for spawning by Delta Smelt are not known, spawning habitat
 26 preferences of closely related species (Bennett 2005) suggest that spawning may
 27 occur in shallow areas over sandy substrates. The nonpelagic habitats used by
 28 larval Delta Smelt before they move into the pelagic areas also are not known
 29 (Swanson et al. 1998, Sommer et al. 2011).

1 During and after larval rearing in fresh water, many young Delta Smelt move with
2 river and tidal currents to remain in favorable rearing habitats, often moving
3 increasingly into the low salinity zone to avoid seasonally warm and highly
4 transparent waters that typify many areas in the central Delta (Nobriga et al.
5 2008). Bennett and Burau (2014) showed that during winter, delta smelt
6 aggregate near frontal zones at the shoal-channel interface moving laterally into
7 the shoals on ebb tides and back into the channel on flood tides. They suggest
8 that this migration strategy can minimize the energy spent swimming against
9 strong river and tidal currents, as well as predation risks by remaining in
10 turbid water.

11 During summer and fall, many juvenile Delta Smelt continue to grow and rear in
12 the low salinity zone until maturing the following winter (Bennett 2005). Some
13 Delta Smelt also rear in upstream areas such as the Cache Slough complex and
14 Sacramento Deepwater Ship Channel, depending on habitat conditions (Sommer
15 and Mejia 2013).

16 During summer and fall, the distribution of juvenile Delta Smelt rearing is
17 influenced by the position of the low salinity zone (as indexed by the position of
18 X2), although their distribution can also be influenced by temperature and
19 turbidity (Bennett 2005; Feyrer et al. 2007, 2010; Kimmerer et al. 2009; Sommer
20 and Mejia 2013). The geographical position of the low salinity zone varies
21 primarily as a function of freshwater outflow; thus, X2 typically lies farther east
22 in summer and fall during low outflow conditions and drier water years and
23 farther west during high outflow conditions (Jassby et al. 1995).

24 Higher outflow causes X2 and the low salinity zone to more frequently overlap
25 with the Suisun Bay/Marsh region, which is broader and shallower and typically
26 has greater turbidity than the mainstem Sacramento and San Joaquin rivers. The
27 overlap of the low salinity zone (or X2) with the Suisun Bay/Marsh results in a
28 dramatic increase in the habitat index (Feyrer et al. 2010); however others (see
29 Manly et al. 2015) have questioned the use by Feyrer et al. (2010) of outflow and
30 X2 location as an indicator of Delta Smelt habitat because other factors may be
31 influencing survival.

32 In addition to salinity, turbidity is an important factor associated with habitat use;
33 Delta Smelt show a strong preference for higher turbidity water (Feyrer et al.
34 2007, 2010; Sommer and Mejia 2013) and turbidity may be a key habitat feature
35 and cue initiating the delta smelt spawning migration (Bennett and Burau 2014).
36 Turbidity has decreased in recent decades within the Delta (Kimmerer 2004,
37 Schoellhamer 2011), which has likely contributed to declines in environmental
38 quality of Delta Smelt habitat (Feyrer et al. 2007, 2010). Higher turbidities are
39 believed to allow Delta Smelt to hide from open-water predators, such as Striped
40 Bass (Gregory and Levings 1998, Nobriga et al. 2005), and contribute to feeding
41 success (Lindberg et al. 2000, IEP 2015).

42 Water temperature is another important environmental factor that affects Delta
43 Smelt habitat and population dynamics (Sommer and Mejia 2013). A longer
44 period of optimal water temperatures in cooler years increases the number of

1 spawning events and cohorts produced (Bennett 2005). During rearing, summer
2 water temperatures also have been shown to be an important predictor of Delta
3 Smelt occurrence, based on multi-decadal analyses of summer tow net survey data
4 (Nobriga et al. 2008).

5 The quality and availability of food also have important effects on the abundance
6 and distribution of Delta Smelt (Sommer and Mejia 2013, Kimmerer 2008). Delta
7 Smelt feed primarily on zooplankton, and Nobriga (2002) showed that Delta
8 Smelt larvae with food in their guts typically co-occurred with higher calanoid
9 copepod densities. Food quality and availability have varied substantially, largely
10 because of the history of nonnative species introduction into the San Francisco
11 Estuary (Baxter et al. 2008, Winder and Jassby 2011). The decline of
12 zooplankton in the western Delta has been hypothesized to be related to several
13 factors, including increased ammonium concentrations from wastewater effluent
14 and agricultural runoff (Wilkerson et al. 2006; Dugdale et al. 2007; Miller et al.
15 2012; Glibert 2010; Glibert et al. 2011, 2014).

16 In 2011 and 2012, an unanticipated change in water management operations led to
17 relatively large phytoplankton blooms in the western Delta, including in the
18 Sacramento River near Rio Vista. Historically, rice fields along the Colusa Basin
19 Drain are flooded in fall to decompose the rice stubble, and the water is released
20 through the Knights Landing Outfall gates into the Sacramento River. In 2011
21 and 2012, construction at the outfall gates required the water to be diverted into
22 the Yolo Bypass, resulting in higher than normal flows. These events temporarily
23 resulted in a fall pulse flow in the Yolo Bypass that increased the volume of flow
24 by more than 300 to 900 percent (Frantzich 2014). Concurrently, a substantial
25 increase in nutrients, phytoplankton, and zooplankton was observed in the Yolo
26 Bypass and Cache Slough. In 2013, the fall pulse flow of rice drainage water did
27 not occur in the Yolo Bypass, and nutrient concentrations did not increase. These
28 nutrient inputs, when they occur, and corresponding increases in phytoplankton
29 and zooplankton production, could contribute to improved foraging opportunities
30 for Delta Smelt.

31 Results in prior years indicate that entrainment and salvage-related mortality of
32 Delta Smelt associated with water pumping and CVP/SWP exports from the Delta
33 occur primarily from December to July (Kimmerer 2008, Grimaldo et al. 2009,
34 Baxter et al. 2010). Entrainment occurs when migrating and spawning adult Delta
35 Smelt and their larvae overlap in time and space with reverse (southward, or
36 upstream) flows in the Old and Middle river channels (Kimmerer 2008, Grimaldo
37 et al. 2009, Baxter et al. 2010).

38 In January 2015, the IEP Management Analysis and Synthesis Team (MAST)
39 published a report to provide an assessment and conceptual model of factors
40 affecting Delta Smelt throughout its life cycle. One focus of the report was an
41 evaluation of a notable increase in abundance of all Delta Smelt life stages in
42 2011, which indicated that the Delta Smelt population could potentially rebound
43 when conditions are favorable for spawning, growth, and survival.

1 The IEP MAST updated conceptual model described the habitat conditions and
2 ecosystem drivers affecting each Delta Smelt life stage, across seasons and how
3 the seasonal effects contributed to the annual success of the species. The
4 conclusions of the report highlighted some key points about Delta Smelt and their
5 habitat, using 2011 as the example year. In summary, the report concluded that
6 Delta Smelt likely benefitted from the following favorable habitat conditions
7 in 2011:

- 8 1) Adults and larvae benefitted from high winter 2010 and spring 2011 outflows,
9 which reduced entrainment risk and possibly improved other habitat
10 conditions, prolonged cool spring water temperatures, and possibly good food
11 availability in late spring.
- 12 2) Juvenile Delta Smelt benefitted from cool water temperatures in late spring
13 and early summer as well as from relatively good food availability and low
14 levels of harmful *Microcystis*.
- 15 3) Subadults benefitted from good food availability and from favorable habitat
16 conditions in the large low salinity zone, located more toward Suisun Bay in
17 2010.

18 *Longfin Smelt*

19 Longfin Smelt populations occur along the Pacific Coast of North America, and
20 the San Francisco Estuary represents the southernmost population. Longfin Smelt
21 generally occur in the Delta; Suisun, San Pablo, and San Francisco bays; and the
22 Gulf of the Farallones, just outside San Francisco Bay. Longfin Smelt are not a
23 focus of any specific RPA actions. However, RPA actions that benefit Delta
24 Smelt, salmonids, and sturgeon, including increasing Delta outflow, have the
25 potential to benefit other fish, including Longfin Smelt, given their similar habitat
26 requirements and trophic feeding levels.

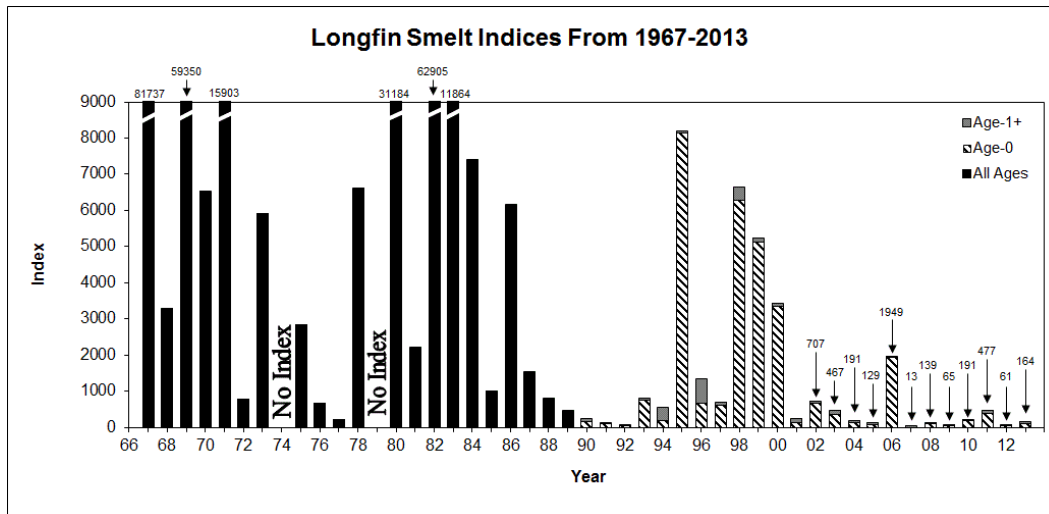
27 Longfin Smelt are anadromous and spawn in fresh water in the Delta, generally at
28 2 years of age (Moyle 2002). They migrate upstream to spawn during late fall
29 through winter, with most spawning from November through April (DFG 2009a).
30 Spawning in the Sacramento River is believed to occur from just downstream of
31 the confluence of the Sacramento and San Joaquin rivers upstream to about Rio
32 Vista. Spawning on the San Joaquin River extends from the confluence upstream
33 to about Medford Island (Moyle 2002). Spawning likely also occurs in Suisun
34 Marsh and the Napa River (DFG 2009a).

35 Longfin Smelt larvae are most abundant in the water column usually from January
36 through April (Reclamation 2008a). The geographic distribution of Longfin
37 Smelt larvae is closely associated with the position of X2; the center of
38 distribution varies with outflow conditions, but not with respect to X2 (Dege and
39 Brown 2004). This pattern is consistent with juveniles migrating downstream to
40 low salinity, brackish habitats for growth and rearing. Larger Longfin Smelt feed
41 primarily on opossum shrimps and other invertebrates (Feyrer et al. 2003).
42 Copepods and other crustaceans also can be important food items, especially for
43 smaller fish (Reclamation 2008a).

1 Longfin Smelt in the San Francisco Estuary are broadly distributed in both time
2 and space, and interannual distribution patterns are relatively consistent
3 (Rosenfield and Baxter 2007). Seasonal patterns in abundance indicate that the
4 population is at least partially anadromous (Rosenfield and Baxter 2007), and the
5 detection of Longfin Smelt within the estuary throughout the year suggests that,
6 similar to Striped Bass, anadromy is one of several life history strategies or
7 contingents in this population.

8 The relative population size of Longfin Smelt in the San Francisco Estuary is
9 measured by indices of abundance generated from different sampling programs.
10 The abundance of age 0 and older fish is best indexed by the Fall Midwater Trawl
11 and Bay Study, while the abundance of larvae and young juveniles is best indexed
12 by the 20-mm survey. The relationship between these indices and actual
13 population sizes is unknown. Although the Fall Midwater Trawl data suggest a
14 sharp decline in Longfin Smelt abundance during the last decade, some of that
15 decline might be attributable to a downstream movement in the longfin
16 distribution into regions better covered by the Bay Study fish survey. The Bay
17 Study uses two types of trawls, an otter trawl and a midwater Trawl. The Longfin
18 Smelt abundance index created from the Fall Midwater Trawl is consistent with
19 the trend in the Bay Study midwater trawl but not the Bay Study otter Trawl. In
20 addition, there have been an increasing proportion of false zeros in the survey data
21 where the Bay Study midwater trawl failed to detect any Longfin Smelt when
22 they were detected in the otter trawl.

23 The abundance of Longfin Smelt in the estuary has fluctuated over time but has
24 exhibited statistically significant step-declines around 1989 to 1991 and in 2004
25 (Thomson et al. 2010). A synthesis of prior studies conducted by USFWS in its
26 12-Month Finding on a Petition to List the San Francisco Bay-Delta Population of
27 the Longfin Smelt as Endangered or Threatened (USFWS 2012) reported that
28 increased Delta outflow in winter and spring is the largest factor possibly
29 affecting Longfin Smelt abundance. The trend in Longfin Smelt abundance from
30 1967 through 2013 is presented on Figure 9.2.



1

2 **Figure 9.2 Fall Midwater Trawl Abundance Indices for Longfin Smelt from 1967 to**
 3 **2013**

4 Source: California Department of Fish and Wildlife, Trends in Abundance of Selected
 5 Species, January 15, 2014. <http://www.dfg.ca.gov/delta/data/fmwt/Indices/>

6 Habitat for Longfin Smelt is open water, largely away from shorelines and
 7 vegetated inshore areas except perhaps during spawning. This includes all of the
 8 large embayments in the estuary and the deeper areas of many of the larger
 9 channels in the western Delta; habitat suitability in these areas for Longfin Smelt
 10 can be strongly influenced by variation in freshwater flow (Jassby et al. 1995,
 11 Bennett and Moyle 1996, Kimmerer 2004, Kimmerer et al. 2009).

12 Water exports and inadvertent entrainment at the SWP and CVP export facilities
 13 are anthropogenic sources of mortality for Longfin Smelt. The export facilities
 14 are known to entrain most species of fish in the Delta (Brown et al. 1996).
 15 Longfin Smelt entrainment mainly occurs from December to May, with peak
 16 adult entrainment from December to February (Grimaldo et al. 2009). In water
 17 year 2011, Aasen (2012) reported four adult Longfin Smelt were salvaged at the
 18 project export facilities, compared with much higher numbers in the early 2000s
 19 and late 1980s. The entrainment of Longfin Smelt in recent years has been
 20 reduced likely because of changes in export operations and a decline in
 21 abundance.

22 *Sacramento Splittail*

23 Sacramento Splittail are found primarily in marshes, turbid sloughs, and slow-
 24 moving river reaches throughout the Delta subregion (Sommer et al. 1997, 2008).
 25 Sacramento Splittail are most abundant in moderately shallow, brackish tidal
 26 sloughs and adjacent open-water areas, but they also can be found in freshwater
 27 areas with tidal or riverine flow (Moyle et al. 2004).

28 Adult Sacramento Splittail typically migrate upstream from brackish areas in
 29 January and February and spawn in fresh water, particularly on inundated
 30 floodplains when they are available, in March and April (Sommer et al. 1997,
 31 Moyle et al. 2004, Sommer et al. 2008). A substantial amount of splittail

1 spawning occurs in the Yolo and Sutter bypasses and the Cosumnes River area of
2 the Delta (Moyle et al. 2004). Spawning also can occur in the San Joaquin River
3 during high-flow events (Sommer et al. 1997, 2008). However, not all adults
4 migrate significant distances to spawn as evidenced by spawning in the Napa and
5 Petaluma rivers (Feyrer et al. 2005).

6 Although juvenile Sacramento Splittail are known to rear in upstream areas for a
7 year or more (Baxter 1999), most move to the Delta after only a few weeks or
8 months of rearing in floodplain habitats along the rivers (Feyrer et al. 2006).
9 Juveniles move downstream into the Delta from April to August (Meng and
10 Moyle 1995, Feyrer et al. 2005). Sacramento Splittail recruitment is largely
11 limited by extent and period of inundation of floodplain spawning habitats, with
12 abundance observed to spike following wet years and dip after dry years
13 (Moyle et al. 2004). However, the 5- to 7-year life span buffers the adult
14 population abundance (Sommer et al. 1997, Moyle et al. 2004). Other factors that
15 may adversely affect the splittail population in the Delta include entrainment,
16 predation, changed estuarine hydraulics, nonnative species (Moyle et al. 2004),
17 pollutants (Greenfield et al. 2008), and limited food.

18 *American Shad*

19 American Shad is a recreationally important anadromous species introduced into
20 the Sacramento-San Joaquin River Basin in the 1870s (Moyle 2002). American
21 Shad spend most of their adult life at sea and may make extensive migrations
22 along the coast. American Shad become sexually mature while in the ocean and
23 migrate through the Delta to spawning areas in the Sacramento, Feather,
24 American, and Yuba rivers. Some spawning also takes place in the lower San
25 Joaquin, Mokelumne, and Stanislaus rivers (USFWS 1995). The spawning
26 migration may begin as early as February, but most adults migrate into the Delta
27 in March and early April (Skinner 1962). Migrating adults generally take 2 to
28 3 months to pass through the Sacramento-San Joaquin estuary (Painter et al.
29 1979).

30 Fertilized eggs are slightly negative buoyant, are not adhesive, and drift in the
31 current. Newly hatched larvae are found downstream of spawning areas and can
32 be rapidly transported downstream by river currents because of their small size.
33 Juvenile shad rear in the Sacramento River below Knights Landing, the Feather
34 River below Yuba City, and the Delta; rearing also takes place in the Mokelumne
35 River near the DCC to the San Joaquin River. No rearing occurs in the American
36 and Yuba rivers (Painter et al. 1979). Some juvenile shad may rear in the Delta
37 for up to a year before outmigrating to the ocean (USFWS 1995). Outmigration
38 from the Delta begins in late June and continues through November
39 (Painter et al. 1979).

40 Juvenile American Shad are frequently encountered in the Delta during the
41 FMWT Survey and in fish salvage monitoring at the south Delta SWP and CVP
42 fish facilities (DWR et al. 2013). American Shad use of the Delta has been
43 observed to vary with salinity (e.g., X2 position) and outflows (Kimmerer 2002).

1 American Shad are entrained at the Tracy Fish Collection Facility (Bowen et al.
2 1998) and in the Clifton Court Forebay, mostly during May through December
3 when young American Shad migrate downstream. The American Shad
4 population in the Sacramento-San Joaquin River Basin has declined since the late
5 1970s, most likely because of increased diversion of water from rivers and the
6 Delta, combined with changing ocean conditions, and possibly pesticides
7 (Moyle 2002). Salvage of American Shad at project export facilities in water year
8 2011 represented nearly 659,000 fish (Aasen 2012), with similar but slightly
9 lower salvage in 2010 (545,125 fish) (Aasen 2011).

10 *Striped Bass*

11 Striped Bass is a recreationally important anadromous species introduced into the
12 Sacramento-San Joaquin River Basin between 1879 and 1882 (Moyle 2002).
13 Despite their nonnative status and piscivorous feeding habits, Striped Bass are
14 considered important because they are a major game fish in the Delta. Striped
15 Bass use the Delta as a migratory route and for rearing and seasonal foraging.
16 Striped Bass spend the majority of their lives in salt water, returning to fresh
17 water to spawn. When not migrating for spawning, adult Striped Bass in the San
18 Francisco Bay-Delta are found in San Pablo Bay, San Francisco Bay, and the
19 Pacific Ocean (Moyle 2002). Adult Striped Bass spend about 6 to 9 months of the
20 year in San Francisco and San Pablo bays (Hassler 1988). Striped Bass also use
21 deeper areas of many of the larger channels in the Delta, in addition to large
22 embayments such as Suisun Bay.

23 Spawning occurs in spring, primarily in the Sacramento River between
24 Sacramento and Colusa and in the San Joaquin River between Antioch and
25 Venice Island (Farley 1966). Eggs are free-floating and negatively buoyant and
26 hatch as they drift downstream, with larvae occurring in shallow and open waters
27 of the lower reaches of the Sacramento-San Joaquin rivers, the Delta, Suisun Bay,
28 Montezuma Slough, and Carquinez Strait. According to Hassler (1988), the
29 distribution of larvae in the estuary depends on river flow. In low-flow years, all
30 Striped Bass eggs and larvae are found in the Delta, while in high-flow years, the
31 majority of eggs and larvae are transported downstream into Suisun Bay.

32 YOY Striped Bass distribute themselves in accordance with the estuarine salinity
33 gradient (Kimmerer 2002, Feyrer et al. 2007), indicating that salinity is a major
34 factor affecting their habitat use and geographic distributions. Kimmerer (2002)
35 found that distributions of fish species, including Striped Bass, substantially
36 overlapped with the low salinity zone. Older Striped Bass are increasingly
37 flexible about their distribution relative to salinity (Moyle 2002).

38 The entrainment of Striped Bass has been observed at the project export facilities,
39 including Clifton Court Forebay (Stevens et al. 1985, Bowen et al. 1998,
40 Aasen 2012). In water year 2011, salvage of Striped Bass at export facilities
41 (approximately 550,000 fish) continued a generally low trend observed since the
42 mid-1990s. Prior to 1995, annual Striped Bass salvage was generally above
43 1 million fish (Aasen 2012). DWR et al. (2013) reported that Striped Bass longer
44 than 24 mm were effectively screened at Tracy Fish Collection Facility and

1 bypassed the pumps. However, planktonic eggs, larvae, and juveniles smaller
2 than 24 mm in length received no protection from entrainment.

3 Striped Bass, primarily YOY, are one of the pelagic fish of the upper estuary that
4 have shown substantial variability in their populations, with evidence of long-
5 term declines (Kimmerer et al. 2000, Sommer et al. 2007a). As discussed earlier
6 for Delta Smelt, a substantial portion of the abundance patterns has been
7 associated with variation of outflow in the estuary (Jassby et al. 1995, Kimmerer
8 et al. 2001, Loboschefskey et al. 2012), although this is disputed by some
9 stakeholders (Bourez 2011). However, surveys showed that population levels for
10 YOY Striped Bass began to decline sharply around 1987 and 2002
11 (Thomson et al. 2010), despite relatively moderate hydrology, which typically
12 supports at least modest fish production (Sommer et al. 2007a). Moyle (2002)
13 cites causes of decline in Striped Bass to include climatic factors, entrainment at
14 project export facilities in the south Delta, other diversions, pollutants, reduced
15 estuarine productivity, invasions by alien species, and human exploitation.
16 Kimmerer et al. (2000, 2001) attribute the decline in juvenile YOY Striped Bass
17 to declining carrying capacity, likely related to food limitation. Loboschefskey
18 et al. (2012) showed that there had been no long-term decline for age 1 and older
19 Striped Bass as of 2004.

20 *Pacific Lamprey*

21 The Pacific Lamprey is a widely distributed species that uses the Delta for
22 upstream migration as adults, for downstream migration as juveniles, and for
23 rearing as ammocoetes (larval form) (Hanni et al. 2006, Moyle et al. 2009).
24 Pacific Lampreys are present in the north, central, and south Delta, and
25 ammocoetes are present year-round in all of the regions (DWR et al. 2013).
26 Limited information on status of Pacific Lamprey in the Delta exists, but the
27 number of lampreys inhabiting the Delta is likely greatly suppressed compared
28 with historical levels, as suggested by the loss of access to historical habitat and
29 apparent population declines throughout California and the Sacramento-San
30 Joaquin River Basin (Moyle et al. 2009).

31 Limited data indicate most adult Pacific Lamprey migrate through the Delta
32 enroute to upstream holding and spawning grounds in the early spring through
33 early summer (Hanni et al. 2006). As documented in other large river systems, it
34 is likely that some adult migration through the Delta occurs from late fall and
35 winter through summer and possibly over an even broader period (Robinson and
36 Bayer 2005, Hanni et al. 2006, Moyle et al. 2009, Clemens et al. 2012, Lampman
37 2011). Data from the FMWT Survey in the lower Sacramento and San Joaquin
38 rivers and Suisun Bay suggest that peak outmigration of Pacific Lamprey through
39 the Delta coincides with high-flow events from fall through spring (Hanni et al.
40 2006). Some outmigration likely occurs year-round, as observed at sites farther
41 upstream (Hanni et al. 2006), and in other river systems (Moyle 2002). Some
42 Pacific Lamprey ammocoetes likely spend part of their extended (5 to 7 years)
43 freshwater residence rearing in the Delta, particularly in the upstream, freshwater
44 portions (DWR et al. 2013).

1 **9.3.4.12.2 Aquatic Habitat**

2 Flow management in the Delta has created stress on aquatic resources by
3 (1) changing aspects of the historical flow regime (timing, magnitude, duration)
4 that supported life history traits of native species; (2) limiting access to or quality
5 of habitat; (3) contributing to conditions better suited to invasive, nonnative
6 species (reduced spring flows, increased summer inflows and exports, and low
7 and less-variable interior Delta salinity [Moyle and Bennett 2008]); and
8 (4) causing reverse flows in channels leading to project export facilities that can
9 entrain fish (Mount et al. 2012). Native species of the Delta are adapted to and
10 depend on variable flow conditions at multiple scales as influenced by the
11 region's dramatic seasonal and interannual climatic variation. In particular, most
12 native fishes evolved reproductive or outmigration timing associated with
13 historical peak flows during spring (Moyle 2002).

14 Water temperatures in the Delta follow a seasonal pattern of winter cold-water
15 conditions and summer warm-water conditions, largely because of the region's
16 Mediterranean climate, with alternating cool-wet and hot-dry seasons. Currently
17 in the Delta, the most significant changes in water temperatures have been in the
18 form of increased summer water temperatures over large areas of the Delta
19 because of high summer ambient air temperatures, the increased temperature of
20 river inflows, and to a lesser extent, reduced quantities of freshwater inflow and
21 modified tidal and groundwater hydraulics (Kimmerer 2004, Mount et al. 2012,
22 NRC 2012, Wagner et al. 2011). Water temperatures in summer now approach or
23 exceed the upper thermal tolerances (e.g., 20 to 25° Centigrade [C]) for
24 cold-water fish species such as salmonids and Delta-dependent species such as
25 Delta Smelt. This is especially true in parts of the south Delta and San Joaquin
26 River, potentially restricting the distribution of these species and precluding
27 previously important rearing areas (NRC 2012).

28 Landscape-scale changes resulting from flood management infrastructure, along
29 with flow modification, have eliminated most of the historical hydrologic
30 connectivity of floodplains and aquatic ecosystems in the Delta and its tributaries,
31 thereby degrading and diminishing Delta habitat for native plant and animal
32 communities (Mount et al. 2012). The large reduction of hydrologic variability
33 and landscape complexity, coupled with degradation of water quality, has
34 supported invasive aquatic species that have further degraded conditions for
35 native species. Due to the combination of these factors, the Delta appears to have
36 undergone an ecological regime shift unfavorable to many native species (Moyle
37 and Bennett 2008, Baxter et al. 2010). The major species influenced by current
38 Delta hydrology include Delta Smelt, Longfin Smelt, Sacramento Splittail, White
39 Sturgeon, juvenile Chinook Salmon, and Striped Bass (Jassby et al. 1995,
40 Kimmerer 2002, Rosenfield and Baxter 2007, Kimmerer et al. 2009, Fish 2010,
41 Perry et al. 2012, Thomson et al. 2010, Feyrer et al. 2010, Loboschefskey et al.
42 2012, Mount et al. 2012).

43 Salinity is a critical factor influencing plant and animal communities in the Delta.
44 Although estuarine fish species are generally tolerant of a range of salinity, this
45 varies by species and lifestage. Some species can be highly sensitive to

1 excessively low or high salinity during physiologically vulnerable periods, such
2 as reproductive and early life history stages. Although the Delta is tidally
3 influenced, most of the Delta is fresh water year-round, due to inflows from
4 rivers. The south Delta can have low salinity because of agricultural return water.
5 The tidally influenced low salinity zone can move upstream into the central Delta.

6 An important measure of the spatial geography of salinity in the western Delta is
7 X2. The X2 has also been correlated with the amount of suitable habitat for Delta
8 Smelt in fall (Feyrer et al. 2007, 2010; USFWS 2008a). It is also helps define the
9 extent of habitat available for oligohaline pelagic organisms and their prey. An
10 analysis of historical monitoring data by Feyrer et al. (2007) revealed that the
11 abiotic habitat of Delta Smelt can be defined as a specific envelope of salinity and
12 turbidity that changes over the course of the species' life cycle. Project operations
13 and other potential factors (e.g., lower outflows) have tended to shift the X2
14 position in fall farther upstream out of the wide expanse of Suisun Bay into the
15 much narrower channels near the confluence of the Sacramento and San Joaquin
16 rivers (near Collinsville), reducing the spatial extent of low salinity habitat
17 important for relevant species such as Delta Smelt (USFWS 2008a, 2011a;
18 Kimmerer et al. 2009; Baxter et al. 2010). However, there is emerging
19 information suggesting that a comparison of the Delta outflow during pre-project
20 and post-project time periods do not support the conclusion that project operations
21 have significantly moved X2 more easterly in September and October compared
22 to pre-project conditions and project operations have only potentially impacted
23 X2 location in November (Hutton et al. in press).

24 **9.3.4.12.3 Nutrients and Food Web Support**

25 Nutrients are essential components of terrestrial and aquatic environments
26 because they provide a resource base for primary producers. Typically in
27 freshwater aquatic environments, phosphorous is the primary limiting
28 macronutrient, whereas in marine aquatic environments, nitrogen tends to be
29 limiting. A balanced range of abundant nutrients provides optimal conditions for
30 maximum primary production, a robust food web, and productive fish
31 populations. However, changes in nutrient loadings and forms, excessive
32 amounts of nutrients, and altered nutrient ratios can lead to eutrophication and a
33 suite of problems in aquatic ecosystems, such as low dissolved oxygen
34 concentrations, un-ionized ammonia, excessive growth of toxic forms of
35 cyanobacteria, and changes in components of the food web. Nutrient
36 concentrations in the Delta have been well studied (Jassby et al. 2002;
37 Kimmerer 2004; Van Nieuwenhuysse 2007; Glibert 2010; Glibert et al. 2011,
38 2014).

39 Estuaries are commonly characterized as highly productive nursery areas for
40 numerous aquatic organisms. Nixon (1988) noted that there is a broad continuum
41 of primary productivity levels in different estuaries, which in turn affects fish
42 production and abundance. Compared to other estuaries, pelagic primary
43 productivity in the upper San Francisco Estuary is relatively poor, and a relatively
44 low fish yield is expected (Wilkerson et al. 2006). In the Delta and Suisun Marsh,
45 this appears to result from turbidity, clam grazing (Jassby et al. 2002), and

1 nitrogen and phosphorus dynamics (Wilkerson et al. 2006, Van Nieuwenhuysen
2 2007, Glibert 2010, Glibert et al. 2014).

3 There has been a significant long-term decline in phytoplankton biomass
4 (chlorophyll a) and primary productivity to low levels in the Suisun Bay region
5 and the Delta (Jassby et al. 2002). Shifts in nutrient concentrations such as high
6 levels of ammonium and nitrogen to phosphorus ratio may contribute to the
7 phytoplankton reduction and to changes in algal species composition in the San
8 Francisco Estuary (Wilkerson et al. 2006; Dugdale et al. 2007; Lehman et al.
9 2005, 2008b, 2010; Glibert 2010; Glibert et al. 2014). Low and declining primary
10 productivity in the estuary may be contributing to the long-term pattern of
11 relatively low and declining biomass of pelagic fishes (Jassby et al. 2002).

12 The introductions of two clams from Asia have led to major alterations in the food
13 web in the Delta. *Potamocorbula* is most abundant in the brackish and saline
14 water of Suisun Bay and the western Delta, and *Corbicula* is most abundant in the
15 fresh water of the central Delta. These filter feeders significantly reduce the
16 phytoplankton and zooplankton concentrations in the water column, reducing
17 food availability for native fishes, such as Delta Smelt and young Chinook
18 Salmon (Feyrer et al. 2007, Kimmerer 2002).

19 Additionally, introduction of the clams led to the decline of higher-food-quality
20 native copepods and the establishment of poorer quality nonnative copepods.
21 More recently, the cyclopoid copepod, *Limnoithona*, has rapidly become the most
22 abundant copepod in the Delta after its introduction in 1993 (Hennessy and
23 Enderlein 2013). This species is hypothesized to be a low-quality food source and
24 intraguild predator of native and nonnative calanoid copepods (CRA 2005). The
25 clam *Potamocorbula* also has been implicated in the reduction of the native
26 opossum shrimp, a preferred food of Delta native fishes such as Sacramento
27 Splittail and Longfin Smelt (Feyrer et al. 2003). Reductions in food availability
28 and food quality have led to lower fish foraging efficiency and reduced growth
29 rates (Moyle 2002).

30 Studies on food quality have been relatively limited in the San Francisco Estuary,
31 with even less information on long-term trends. Nonetheless, several studies have
32 documented or suggested the food limitations for aquatic species in the estuary,
33 including zooplankton (Mueller-Solger et al. 2002, Kimmerer et al. 2005), Delta
34 Smelt (Bennett 2005, Bennett et al. 2008), Chinook Salmon (Sommer et al.
35 2001a), Sacramento Splittail (Greenfield et al. 2008), Striped Bass
36 (Loboschewsky et al. 2012), and Largemouth Bass (Nobriga 2009).

37 **9.3.4.12.4 Turbidity**

38 Turbidity is an important water quality component in the Delta that affects
39 physical habitat through sedimentation and food web dynamics through
40 attenuation of light in the water column. Light attenuation, in turn, affects the
41 extent of the photic zone where primary production can occur and the ability of
42 predators to locate prey and for prey to escape predation.

1 Turbidity has been declining in the Delta, as indicated by sediment data collected
2 by the U.S. Geological Survey since the 1950s (Wright and Schoellhamer 2004),
3 with important implications for food web dynamics and predation. Higher water
4 clarity is at least partially caused by increased water filtration and plankton
5 grazing by highly abundant overbite clams (*Potamocorbula amurensis*) and other
6 benthic organisms (Kimmerer 2004, Greene et al. 2011). High nutrient loads,
7 coupled with reduced sediment loads and higher water clarity, could contribute to
8 plankton and algal blooms and overall increased eutrophic conditions in some
9 areas (Kimmerer 2004).

10 The first high-flow events of winter create turbid conditions in the Delta, which
11 can be drawn into the south Delta during reverse flow conditions in the Old and
12 Middle rivers. Delta Smelt may follow turbid waters into the southern Delta,
13 increasing their proximity to project export facilities and, therefore, their
14 entrainment risk (USFWS 2008a).

15 **9.3.4.12.5 Contaminants**

16 Contaminants can change ecosystem functions and productivity through
17 numerous pathways. Trends in contaminant loadings and their ecosystem effects
18 are not well understood. Efforts are underway to evaluate direct and indirect toxic
19 effects on the POD fishes of manmade contaminants and natural toxins associated
20 with blooms of *Microcystis aeruginosa*, a cyanobacterium or blue-green alga that
21 releases a potent toxin known as microcystin. Toxic microcystins cause food web
22 impacts at multiple trophic levels, and histopathological studies of fish liver tissue
23 suggest that fish exposed to elevated concentrations of microcystins have
24 developed liver damage and tumors (Lehman et al. 2005, 2008b, 2010.)

25 There are longstanding concerns related to mercury and selenium in the
26 Sacramento and San Joaquin watersheds, the Delta, and San Francisco Bay (see
27 Chapter 6, Surface Water Quality, for additional detail on these constituents).
28 Additional study is needed to avoid increases in mercury exposure resulting from
29 tidal wetlands restoration; methylmercury is produced at a relatively high rate in
30 wetlands and newly flooded aquatic habitats (Davis et al. 2003). Methylmercury
31 increases in concentration at each level in the food chain and can cause concern
32 for people and birds that eat piscivorous fish (bass) and sturgeon, as described in
33 Chapter 6, Surface Water Quality. It has not been shown to be a direct problem
34 for fish in the Delta, but studies of other fish summarized by Alpers et al. (2008)
35 indicate that mercury in fish has been linked to hormonal and reproductive
36 effects, liver necrosis, and altered behavior in fish. With regard to selenium,
37 benthic foragers like diving ducks, sturgeon, and splittail have the greatest risk of
38 selenium toxicity; the invasion of the nonnative bivalves (e.g., *P. amurensis*) has
39 resulted in increased bioavailability of selenium to benthivores in San Francisco
40 Bay (Linville et al. 2002).

41 Baxter et al. (2008) prepared a 2007 synthesis of results as part of a POD Progress
42 Report, including a summary of prior studies of contaminants in the Delta. The
43 summary included studies that suggested that phytoplankton growth rates may be
44 inhibited by localized high concentrations of herbicides (Edmunds et al. 1999).

1 Toxicity to invertebrates has been noted in water and sediments from the Delta
2 and associated watersheds (Kuivila and Foe 1995, Weston et al. 2004). The 2004
3 Weston study of sediment toxicity recommended additional study of the effects of
4 the pyrethroid insecticides on benthic organisms. Undiluted drainwater from
5 agricultural drains in the San Joaquin River watershed can be acutely toxic
6 (quickly lethal) to fish (Chinook Salmon and Striped Bass) and have chronic
7 effects on growth, likely because of high concentrations of major ions
8 (e.g., sodium and sulfates) and trace elements (e.g., chromium, mercury, and
9 selenium) (Saiki et al. 1992).

10 **9.3.4.12.6 Fish Passage and Entrainment**

11 The Delta presents a challenge for anadromous and resident fish during upstream
12 and downstream migration, with its complex network of channels, low eastern
13 and southern tributary inflows, and reverse currents created by pumping for water
14 exports. These complex conditions can lead to straying, extended exposure to
15 predators, and entrainment during outmigration. Tidal elevations, salinity,
16 turbidity, in-flow, meteorological conditions, season, habitat conditions, and
17 project exports all have the potential to influence fish movement, currents, and
18 ultimately the level of entrainment and fish passage success and survival, which is
19 the subject of extensive research and adaptive management efforts (IRP 2010,
20 2011). Michel et al. (2010, 2015) used acoustic telemetry to examine survival of
21 late fall-run Chinook Salmon smolts outmigrating from the Sacramento River
22 through the Delta and San Francisco Estuary. Survival was lowest in the
23 freshwater portion (Delta) and the brackish portion of the estuary relative to
24 survival in the riverine portion of the migration route.

25 *North Delta Fish Passage and Entrainment*

26 In the north Delta, migrating fish have multiple potential pathways as they move
27 upstream into the Sacramento or Mokelumne river systems. Marston et al. (2012)
28 studied stray rates for in-migrating San Joaquin River Basin adult salmon that
29 stray into the Sacramento River Basin. Results indicated that it was unclear
30 whether reduced San Joaquin River pulse flows or elevated exports caused
31 increased stray rates. The DCC, when open, can divert fish as they outmigrate
32 along this route. The opening of the DCC when salmon are returning to spawn to
33 the Mokelumne and Cosumnes rivers is believed to lead to increased straying of
34 these fish into the American and Sacramento rivers because of confusion over
35 olfactory cues. In recent years, experimental DCC closures have been scheduled
36 during the fall-run Chinook Salmon migration season for selected days, coupled
37 with pulsed flow releases from reservoirs on the Mokelumne River, in an attempt
38 to reduce straying rates of returning adults. These closures have corresponded
39 with reduced recoveries of Mokelumne River hatchery fish in the American River
40 system and increased returns to the Mokelumne River hatchery (EBMUD 2012).

41 Outmigrating juvenile fish moving down the mainstem Sacramento River also can
42 enter the DCC when the gates are open and travel through the Delta via the
43 Mokelumne and San Joaquin river channels. In the case of juvenile salmonids,
44 this shifted route from the north Delta to the central Delta increases their mortality

1 rate (Kjelson and Brandes 1989, Brandes and McLain 2001, Newman and
2 Brandes 2010, Perry et al. 2010, 2012). Steel et al. (2012) found that the best
3 predictor of which route was selected was the ratio of mean water velocity
4 between the two routes. Salmon migration studies show losses of approximately
5 65 percent for groups of outmigrating fish that are diverted from the mainstem
6 Sacramento River into the waterways of the central and southern Delta (Brandes
7 and McLain 2001; Vogel 2004, 2008; Perry and Skalski 2008). Perry and Skalski
8 (2008) found that, by closing the DCC gates, total through-Delta survival of
9 marked fish to Chipps Island increased by nearly 50 percent for fish moving
10 downstream in the Sacramento River system. Closing the DCC gates appears to
11 redirect the migratory path of outmigrating fish into Sutter and Steamboat sloughs
12 and away from Georgiana Slough, resulting in higher survival rates. Species that
13 may be affected include juvenile Green Sturgeon, steelhead, and winter and
14 spring-run Chinook Salmon (NMFS 2009a).

15 However, analysis by Perry et al. (2015) suggests that the mechanisms governing
16 route selection are more complex. Their analysis revealed the strong influence of
17 tidal forcing on the probability of fish entrainment into the interior Delta. The
18 probability of entrainment into both Georgiana Slough and the Delta Cross
19 Channel was highest during reverse-flow flood tides, and the probability of fish
20 remaining in the Sacramento River was near zero during flow reversals (Perry
21 et al. 2015). The magnitude and duration of reverse flows at this river junction
22 decrease as inflow of the Sacramento River increases. Consequently, reduced
23 Sacramento River inflow increases the frequency of reverse flows at this junction,
24 thereby increasing the proportion of fish that are entrained into the interior Delta,
25 where mortality is high (Perry 2010).

26 Fish passage in the north Delta also can be affected by water quality. Water
27 quality in the mainstem Sacramento River and its distributary sloughs can be poor
28 at times during summer, creating conditions that may stress migrating fish or even
29 impede migration. These conditions include dissolved oxygen, water
30 temperatures, and, for some species, salinity (e.g., Delta Smelt). For adult
31 Chinook Salmon, dissolved oxygen concentration less than 3 to 5 milligrams per
32 liter (mg/L) can impede migration (Hallock et al. 1970) as can mean daily water
33 temperatures of 21 to 23°C, depending on whether water temperatures are rising
34 or falling (Strange 2010). Dissolved oxygen levels are generally >5 mg/L
35 throughout the Delta, but water temperatures can exceed these thresholds during
36 summer and fall.

37 The SWP Barker Slough Pumping Plant, located on a tributary to Cache Slough,
38 may cause larval fish entrainment. The intake is equipped with a positive barrier
39 fish screen to prevent fish at least 25 mm in size from being entrained. CDFW
40 has monitored entrainment of larval Delta Smelt less than 20 mm at Barker
41 Slough since 1995. When the presence of Delta Smelt larvae is indicated,
42 pumping rates from Barker Slough are reduced to a 5-day running average rate of
43 65 cfs, not to exceed a 75-cfs daily average for any day, for a minimum of 5 days
44 and until monitoring shows no Delta Smelt are present.

1 *Central and South Delta Fish Passage and Entrainment*

2 The south Delta intake facilities include the CVP and SWP export facilities; local
3 agency intakes, including Contra Costa Water District intakes; and agricultural
4 intakes. Contra Costa Water District intakes and the CVP Contra Costa Canal
5 Pumping Plant include fish screens; however, most of the remaining intakes do
6 not include fish screens. Water flow patterns in the south Delta are influenced by
7 the water diversion actions and operations of the south Delta seasonal temporary
8 barriers and tides and river inflows to the Delta (Kimmerer and Nobriga 2008).
9 Delta diversions can create reverse flows, drawing fish toward project facilities
10 (Arthur et al. 1996, Kimmerer 2008, Grimaldo et al. 2009). While swimming
11 through southern Delta channels, fish can be subjected to stress from poor water
12 quality (seasonally high temperatures, low dissolved oxygen, high water
13 transparency, and *Microcystis* blooms) and slow water velocities in lake-like
14 habitats. Any of these factors can cause elevated mortality rates by weakening or
15 disorienting the fish and increasing their vulnerability to predators (Vogel 2011).

16 Cunningham et al. (2015) found a negative influence of the export/inflow ratio on
17 the survival of fall-run Chinook populations and a negative influence of increased
18 total Delta exports on the survival of spring-run Chinook populations. An
19 increase in total exports of 1 standard deviation (SD) from the 1967 to 2010
20 average was predicted to result in a 68.1 percent reduction in the survival of Deer,
21 Mill, and Butte Creek spring-run Chinook. Similarly, an increase in the ratio of
22 Delta water exports to Delta inflow of 1 SD was expected to reduce survival of
23 the four fall-run populations by 57.8 percent (Cunningham et al. 2015). Although
24 a mechanistic explanation for the reduction in survival remains elusive, "*direct*
25 *entrainment mortality seems an unlikely mechanism given the success of*
26 *reclamation and transport procedures, even given increased predation potential*
27 *at the release site. Changes to water routing may provide a more reasonable*
28 *explanation for the estimated survival influence of Delta water exports"*
29 (Cunningham et al. 2015). Although not directly comparable, this contrasts with
30 the results of Zeug and Cavallo (2012) that found there was little evidence that
31 large-scale water exports or inflows influenced CWT recovery rates in the ocean
32 from 1993 to 2003.

33 Delaney et al. (2014) reported on a mark-recapture experiment examining the
34 survival and movement patterns of acoustically tagged juvenile steelhead
35 emigrating through the central and southern Delta. Their results indicated that
36 most tagged steelhead remained in the mainstem San Joaquin River
37 (77.6 percent); however, approximately one quarter (22.4 percent) of them
38 entered Turner Cut. Route-specific survival probability for tagged steelhead
39 using the Turner Cut route was 27.0 percent. The survival probability for tagged
40 steelhead using the Mainstem route was 56.7 percent (Delaney et al. 2014).
41 Travel times for tagged steelhead also differed between these two routes with
42 steelhead using the mainstem route reaching Chipps Island significantly sooner
43 than those that used the Turner Cut route. Travel time was not significantly
44 affected by the limited OMR flow treatments examined in their study. While not
45 significant, there was some evidence that fish movement toward each export

1 facility could be influenced by relative flow entering the export facility (Delaney
2 et al. 2014).

3 Water from the San Joaquin River mainly moves downstream through the Head of
4 Old River and through the channels of Old and Middle rivers and Grant Line and
5 Fabian-Bell canals toward the south Delta intake facilities. Conversely, when
6 water to the north of the diversion points for the two facilities moves southward
7 (upstream), the net flow is negative (toward) the pumps. When the temporary
8 barriers are installed from April through November, internal reverse circulation is
9 created within the channels isolated by the barriers from other portions of the
10 south Delta. These conditions are most pronounced during late spring through
11 fall when San Joaquin River inflows are low and water diversion rates are
12 typically high. Drier hydrologic years also reduce the frequency of net
13 downstream flows in the south Delta and mainstem San Joaquin River.

14 A portion of fish that enter the CVP Jones Pumping Plant approach channel and
15 the SWP Clifton Court Forebay are salvaged at screening and fish salvage
16 facilities, transported downstream by trucks, and released. NMFS (2009a)
17 estimates that the direct loss of fish from the screening and salvage process is in
18 the range of 65 to 83.5 percent for fish from the point they enter Clifton Court
19 Forebay or encounter the trash racks at the CVP facilities. Additionally, mark-
20 recapture experiments indicate that most fish are probably subject to predation
21 prior to reaching the fish salvage facilities (e.g., in Clifton Court Forebay)
22 (Gingras 1997, Clark et al. 2009, Castillo et al. 2012). Aquatic organisms
23 (e.g., phytoplankton and zooplankton) that serve as food for fish also are
24 entrained and removed from the Delta (Jassby et al. 2002, Kimmerer et al. 2008,
25 Brown et al. 1996). Fish entrainment and salvage are particular concerns during
26 dry years when the distributions of young Striped Bass, Delta Smelt, Longfin
27 Smelt, and other migratory fish species shift closer to the project facilities
28 (Stevens et al. 1985, Sommer et al. 1997).

29 Salvage estimates reflect the number of fish entrained by project exports, but
30 these numbers alone do not account for other sources of mortality related to the
31 export facilities. These numbers do not include prescreen losses that occur in the
32 waterways leading to the diversion facilities, which may in some cases reduce the
33 number of salvageable fish (Gingras 1997, Clark et al. 2009, Castillo et al. 2012).
34 For Delta Smelt, prescreen losses appear to be where most mortality occurs
35 (Castillo et al. 2012). In addition, actual salvage numbers do not include the
36 entrainment of fish larvae, which cannot be collected by the fish screens. The
37 number of fish salvaged also does not include losses of fish that pass through the
38 louvers intended to guide fish into the fish collection facilities or the losses during
39 collection, handling, transport, and release back into the Delta.

40 The life stage of the fish at which entrainment occurs may be important for
41 population dynamics (IRP 2011). For example, winter entrainment of Delta
42 Smelt, Longfin Smelt, and Threadfin Shad may correspond to migration and
43 spawning of adult fish, and spring and summer exports may overlap with
44 development of larvae and juveniles. The loss of prespawning adults and all their
45 potential progeny may have greater consequences than entrainment of the same

1 number of larvae or juvenile fish. Entrainment risk for fish tends to increase with
2 increased reverse flows in Old and Middle rivers (Kimmerer 2008, Grimaldo
3 et al. 2009).

4 Research conducted during 2010 and 2011 showed that upriver movements of
5 adult Delta Smelt are achieved through a form of tidal rectification or active tidal
6 transport by using lateral movement to shallow edges of channels on ebb tides to
7 maintain their position (IRP 2010, 2011). Turbidity gradients could be involved
8 in the lateral positioning of Delta Smelt within the channels, but large-scale
9 turbidity pulses through the system may not be necessary to trigger upriver
10 migrations of Delta Smelt if they are already occupying sufficiently turbid water
11 (IRP 2011). The new understanding of potential tidal and turbidity effects on
12 Delta Smelt behavior may have important implications for the Delta Smelt
13 monitoring programs that are the basis for biological triggers for RPA Actions
14 1 and 2 by understanding the catch efficiency of mid-water trawl data in relation
15 to the lateral positioning of Delta Smelt within channels.

16 There are more than 2,200 diversions in the Delta (Herren and Kawasaki 2001).
17 These irrigation diversion pipes are shore-based, typically small (30 to
18 60 centimeter pipe diameter), and operated via pumps or gravity flow, and most
19 lack fish screens. These diversions increase total fish entrainment and losses and
20 alter local fish movement patterns (Kimmerer and Nobriga 2008). Delta Smelt
21 have been found in samples of Delta irrigation diversions, as well as larger
22 wetland management diversions downstream. However, Nobriga et al. (2004)
23 found that the low and inconsistent entrainment of Delta Smelt measured in the
24 study reflected habitat use by Delta Smelt and relatively small hydrodynamic
25 influence of the diversion.

26 **9.3.4.12.7 Disease**

27 Preliminary results of several histopathological studies have found evidence of
28 significant disease in Delta fish species (Reclamation 2008a). For example,
29 massive intestinal infections with an unidentified myxosporean were found in
30 yellowfin goby collected from Suisun Marsh (Baxa et al. 2013). Studies by
31 Bennett (2005) and Bennett et al. (2008) show that exposure to toxic chemicals
32 may cause liver abnormalities and cancerous cells in Delta Smelt, and stressful
33 summer conditions, warm water, and lack of food may result in liver glycogen
34 depletion and liver damage. Studies of Sacramento Splittail suggest that liver
35 abnormalities in this species are more linked to health and nutritional status than
36 to pollutant exposure (Greenfield et al. 2008).

37 Additionally, preliminary evidence suggests that contaminants and disease may
38 impair Striped Bass. Studies by Lehman et al. (2010) suggest that the liver tissue
39 and health of Striped Bass and Mississippi Silverside were adversely affected by
40 tumors, particularly at sampling stations where concentrations of tumor-
41 promoting microcystins were elevated. Exposure of Sacramento Splittail and
42 Threadfin Shad to microcystins in experimental diets resulted in severe liver
43 damage; shad also exhibited ovarian necrosis, indicating impairment of health and
44 reproductive potential (Acuna et al. 2012).

1 In contrast, histopathological and viral evaluation of juvenile Longfin Smelt and
 2 Threadfin Shad collected in 2006 indicated no histological abnormalities and no
 3 evidence of viral infections or high parasite loads (Foott et al. 2006). Parasites
 4 were noted in Threadfin Shad gills at a high frequency, but the infections were not
 5 considered severe. Thus, both Longfin Smelt and Threadfin Shad were
 6 considered healthy in 2006 (a high-flow year). Adult Delta Smelt collected from
 7 the Delta during winter 2005 also were considered healthy, showing little
 8 histopathological evidence for starvation or disease (Reclamation 2008a).
 9 However, there was some evidence of low frequency endocrine disruption. In
 10 2005, 9 of 144 (6 percent) of adult Delta Smelt males were intersex, having
 11 immature oocytes in their testes (Reclamation 2008a).

12 **9.3.4.12.8 Nonnative Invasive Species**

13 Nonnative invasive species influence the Delta ecosystem by increasing
 14 competition and predation on native species, reducing habitat quality (as result of
 15 invasive aquatic macrophyte growth), and reducing food supplies by altering the
 16 aquatic food web. Not all nonnative species are considered invasive². Some
 17 introduced species have minimal ability to spread or increase in abundance.
 18 Others have commercial or recreational value (e.g., Striped Bass, American Shad,
 19 and Largemouth Bass).

20 Many nonnative fishes have been introduced into the Delta for sport fishing
 21 (game fish such as Striped Bass, Largemouth Bass, Smallmouth Bass, Bluegill,
 22 and other sunfish), as forage for game fish (Threadfin Shad, Golden Shiner, and
 23 Fathead Minnow), for vector control (Inland Silverside, Western Mosquitofish),
 24 for human food use (Common Carp, Brown Bullhead, and White Catfish), and
 25 from accidental releases (Yellowfin Goby, Shimofuri Goby, and Shokihaze Goby)
 26 (Moyle 2002). Introduced fish may compete with native fish for resources and, in
 27 some cases, prey on native species.

28 Because of invasive species and other environmental stressors, native fishes have
 29 declined in abundance throughout the region during the period of monitoring
 30 (Matern et al. 2002, Brown and Michniuk 2007, Sommer et al. 2007a,
 31 Mount et al. 2012). Habitat degradation, changes in hydrology and water quality,
 32 and stabilization of natural environmental variability are all factors that generally
 33 favor nonnative, invasive species (Mount et al. 2012, Moyle et al. 2012).

34 **9.3.4.12.9 Predation**

35 Predation is an important factor that influences the behavior, distribution, and
 36 abundance of prey species in aquatic communities to varying degrees. Predation
 37 can have differing effects on a population of fish depending on the size or age
 38 selectivity, mode of capture, mortality rates, and other factors. Predation is a part
 39 of every food web, and native Delta fishes were part of the historical Delta food
 40 web. Because of the magnitude of change in the Delta from historical times and

² DFG (2008) defines "invasive species" as "species that establish and reproduce rapidly outside of their native range and may threaten the diversity or abundance of native species through competition for resources, predation, parasitism, hybridization with native populations, introduction of pathogens, or physical or chemical alteration of the invaded habitat."

1 the introduction of nonnative predators, it is logical to conclude that predation
2 may have increased in importance as a mortality factor for Delta fishes, with some
3 observers suggesting that it is likely the primary source of mortality for juvenile
4 salmonids in the Delta (Vogel 2011). Predation occurs by fish, birds, and
5 mammals, including sea lions. The alternatives considered in this EIS are not
6 anticipated to modify predatory actions of birds and mammals on the focal
7 species. Therefore, the predation discussion is focused on fish predators.

8 A panel of experts recently convened to review data on predation in the Delta and
9 draw preliminary conclusions on the effects of predation on salmonids. The panel
10 acknowledged that the system supports large populations of fish predators that
11 consume juvenile salmonids (Grossman et al. 2013). However, the panel
12 concluded that because of extensive flow modification, altered habitat conditions,
13 native and nonnative fish and avian predators, temperature and dissolved oxygen
14 limitations, and the overall reduction in salmon population size, it was unclear
15 what proportion of the juvenile salmonid mortality could be attributed to
16 predation. The panel further indicated that predation, while the proximate cause
17 of mortality, may be influenced by a combination of other stressors that make fish
18 more vulnerable to predation.

19 Striped Bass, White Catfish, Largemouth Bass and other centrarchids, and
20 silversides are among the introduced, nonnative species that are notable predators
21 of smaller-bodied fish species and juveniles of larger species in the Delta. Along
22 with Largemouth Bass, Striped Bass are believed to be major predators on larger-
23 bodied fish in the Delta. In open-water habitats, Striped Bass are most likely the
24 primary predator of juvenile and adult Delta Smelt (DWR et al. 2013) and can be
25 an important open-water predator on juvenile salmonids (Johnston and Kumagai
26 2012). Native Sacramento Pikeminnow may also prey on juvenile salmonids and
27 other fishes. Limited sampling of smaller pikeminnows did not find evidence of
28 salmonids in the foregut of Sacramento Pikeminnow (Nobriga and Feyrer 2007),
29 but this does not mean that Sacramento Pikeminnow do not prey on salmonids in
30 the Delta.

31 Largemouth Bass abundance has increased in the Delta over the past few decades
32 (Brown and Michniuk 2007). Although Largemouth Bass are not pelagic, their
33 presence at the boundary between the littoral and pelagic zones makes it probable
34 that they opportunistically consume pelagic fishes. The increase in salvage of
35 Largemouth Bass occurred during the time period when Brazilian waterweed was
36 expanding its range in the Delta (Brown and Michniuk 2007). The beds of
37 Brazilian waterweed provide good habitat for Largemouth Bass and other species
38 of centrarchids. Largemouth Bass have a much more limited distribution in the
39 estuary than Striped Bass, but a higher per-capita impact on small fishes (Nobriga
40 and Feyrer 2007). Increases in Largemouth Bass may have had a particularly
41 important effect on Threadfin Shad and Striped Bass, whose earlier life stages
42 occur in littoral habitat (Grimaldo et al. 2004, Nobriga and Feyrer 2007).

43 Invasive Mississippi silversides are another potentially important predator of
44 larval and pelagic fishes in the Delta. This introduced species was not believed to
45 be an important predator on Delta Smelt, but recent studies using DNA techniques

1 detected the presence of Delta Smelt in the guts of 41 percent of Mississippi
2 silversides sampled in mid-channel trawls (Baerwald et al. 2012). This finding
3 may suggest that predation impacts could be significant, given the increasing
4 numbers of Mississippi silversides in the Delta.

5 Predation of fish in the Delta is known to occur in specific areas, for example at
6 channel junctions and areas that constrict flow or confuse migrating fish and
7 provide cover for predatory fish (Vogel 2011). Sabal (2014) found similar results
8 at Woodbridge Dam on the Mokelumne River where the dam was associated with
9 increased Striped Bass per capita salmon consumption and attracted larger
10 numbers of Striped Bass, decreasing migrating juvenile salmon survival by 10 to
11 29 percent. DFG (1992) identified subadult Striped Bass as the major predatory
12 fish in Clifton Court Forebay. In 1993, for example, Striped Bass made up
13 96 percent of the predators removed (Vogel 2011). Cavallo et al. (2012) studied
14 tagged salmon smolts to test the effects of predator removal on outmigrating
15 juvenile Chinook Salmon in the south Delta. Their results suggested that predator
16 abundance and migration rates strongly influenced survival of salmon smolts.
17 Exposure time to predators has been found to be important for influencing
18 survival of outmigrating salmon in other studies in the Delta (Perry et al. 2012).

19 **9.3.4.12.10 Aquatic Macrophytes**

20 Aquatic macrophytes are an important component of the biotic community of
21 Delta wetlands and can provide habitat for aquatic species, serve as food, produce
22 detritus, and influence water quality through nutrient cycling and dissolved
23 oxygen fluctuations. Whipple et al. (2012) described likely historical conditions
24 in the Delta, which have been modified extensively, with major impacts on the
25 aquatic macrophyte community composition and distribution. The primary
26 change has been a shift from a high percentage of emergent aquatic macrophyte
27 wetlands to open water and hardened channels.

28 The introduction of two nonnative invasive aquatic plants, water hyacinth and
29 Brazilian waterweed, has reduced habitat quantity and value for many native
30 fishes. Water hyacinth forms floating mats that greatly reduce light penetration
31 into the water column, which can significantly reduce primary productivity and
32 available food for fish in the underlying water column. Brazilian waterweed
33 grows along the margins of channels in dense stands that prohibit access by native
34 juvenile fish to shallow water habitat. Additionally, the thick cover of these two
35 invasive plants provides excellent habitat for nonnative ambush predators, such as
36 bass, which prey on native fish species. Studies indicate low abundance of native
37 fish, such as Delta Smelt, Chinook Salmon, and Sacramento Splittail, in areas of
38 the Delta where submerged aquatic vegetation infestations are thick (Grimaldo
39 et al. 2004, 2012; Nobriga et al. 2005).

40 Invasive aquatic macrophytes are still equilibrating within the Delta and resulting
41 habitat changes are ongoing, with negative impacts on habitats and food webs of
42 native fish species (Toft et al. 2003, Grimaldo et al. 2009). Concerns about
43 invasive aquatic macrophytes are centered on their ability to form large, dense

1 growth that can clog waterways, block fish passage, increase water clarity,
2 provide cover for predatory fish, and cause high biological oxygen demand.

3 **9.3.4.13 Yolo Bypass**

4 The Yolo Bypass conveys flood flows from the Sacramento Valley, including the
5 Sacramento River, Feather River, American River, Sutter Bypass, and west side
6 streams

7 The Yolo Bypass provides habitat for a wide variety of fish and aquatic species,
8 including temporary migration corridors and juvenile rearing habitat for
9 anadromous salmonids and other native and anadromous fishes. Species captured
10 as adults and subsequently collected as YOY suggest that the Yolo Bypass
11 provides spawning habitat for these species, including splittail, American Shad,
12 Striped Bass, Threadfin Shad, Largemouth Bass and carp (Harrell and Sommer
13 2003, Sommer et al. 2014). The Yolo Bypass lacks suitable gravel substrate that
14 would support salmon spawning.

15 **9.3.4.13.1 Aquatic Habitat**

16 Aquatic habitats in the Yolo Basin include stream and slough channels for fish
17 migration, and when flooded, seasonal spawning habitat and productive rearing
18 habitat (Sommer et al. 2001a; CALFED 2000a, 2000b). During years when the
19 Yolo Bypass is flooded, it serves as an important migratory route for juvenile
20 Chinook Salmon and other native migratory and anadromous fishes moving
21 downstream. During these times, it provides juvenile anadromous salmonids an
22 alternative migration corridor to the lower Sacramento River (Sommer et al.
23 2003) and, sometimes, better rearing conditions than the adjacent Sacramento
24 River channel (Sommer et al. 2001a, 2005). When the floodplain is activated,
25 juvenile salmon can rear for weeks to months in the Yolo Bypass floodplain
26 before migrating to the estuary (Sommer et al. 2001a). Research on the Yolo
27 Bypass has found that juvenile salmon grow substantially faster in the Yolo
28 Bypass floodplain than in the adjacent Sacramento River, primarily because of
29 greater availability of invertebrate prey in the floodplain (Sommer et al. 2001a,
30 2005). When not flooded, the lower Yolo Bypass provides tidal habitat for young
31 fish that enter from the lower Sacramento River via Cache Slough Complex
32 (McLain and Castillo; DWR, unpublished data).

33 Sommer et al. (1997) demonstrated that the Yolo Bypass is one of the single most
34 important habitats for Sacramento Splittail. Because the Yolo Bypass is dry
35 during summer and fall, nonnative species (e.g., predatory fishes) generally are
36 not present year-round except in perennial water sources (Sommer et al. 2003). In
37 addition to providing important fish habitat, seasonal inundation of the Yolo
38 Bypass supplies phytoplankton and detritus that may benefit aquatic organisms
39 downstream in the brackish portion of the San Francisco Estuary (Sommer et al.
40 2004, Lehman et al. 2008a).

1 **9.3.4.13.2 Fish Passage**

2 The Fremont Weir is a major impediment to fish passage and a source of
 3 migratory delay and loss of adult Chinook Salmon, steelhead, and sturgeon
 4 (NMFS 2009a, Sommer et al. 2014). The Fremont Weir creates a migration
 5 barrier for a variety of species, although fish with strong jumping capabilities
 6 such as salmonids may be able to pass the weir at higher flows. Although there is
 7 a fish ladder maintained by CDFW at the center of the weir, the ladder is small,
 8 outdated, and inefficient. Additionally, there are no facilities at the weir to pass
 9 upstream migrants at lower flows. Some adult winter-run, spring-run, and fall-run
 10 Chinook Salmon and White Sturgeon migrate into Yolo Bypass when there is no
 11 flow into the floodplain via the Fremont Weir. Therefore, these fish are often
 12 unable to reach upstream spawning habitat in the Sacramento River and its
 13 tributaries (Harrell and Sommer 2003, Sommer et al. 2014). Other structures in
 14 the Yolo Bypass, such as the Toe Drain, Lisbon Weir, and irrigation dams in the
 15 northern end of the Tule Canal, also may impede upstream passage of adult
 16 anadromous fish (NMFS 2009a).

17 Fish are also attracted into the bypass during periods when water is not flowing
 18 over the Fremont Weir. Fyke trap monitoring by DWR has shown that adult
 19 salmon and steelhead migrate up the Toe Drain in autumn and winter regardless
 20 of whether the Fremont Weir spills (Harrell and Sommer 2003, Sommer et al.
 21 2014). The Toe Drain does not extend to the Fremont Weir because the channel
 22 is blocked by roads or other higher ground at several locations. Sturgeon and
 23 salmonids attracted by high flows into the basin become concentrated behind the
 24 Fremont Weir, where they are subject to heavy legal and illegal fishing pressure.

25 Stranding of juvenile salmonids and sturgeon has been reported in the Yolo
 26 Bypass in scoured areas behind the weir and in other areas as floodwaters recede
 27 (NMFS 2009a, Sommer et al. 2005). However, Sommer et al. (2005) found most
 28 juvenile salmon outmigrated off the floodplain as it drained.

29 **9.3.4.14 Suisun Marsh**

30 Suisun Bay and Marsh are ecologically linked with the central Delta, although
 31 with different tidal and salinity conditions than found upstream. Suisun Bay and
 32 Marsh are the largest expanse of remaining tidal marsh habitat within the greater
 33 San Francisco Bay-Delta ecosystem and include Honker, Suisun, and Grizzly
 34 bays; Montezuma and Suisun sloughs; and numerous other smaller channels
 35 and sloughs.

36 **9.3.4.14.1 Aquatic Habitat**

37 Suisun Marsh is a brackish-water marsh bordering the northern edge of Suisun
 38 Bay. Most of its marsh area consists of diked wetlands managed for waterfowl,
 39 with the rest of the acreage consisting of tidally influenced sloughs (Suisun
 40 Ecological Workgroup 2001). The central latitudinal location of Suisun Marsh
 41 within the San Francisco Estuary makes it an important rearing area for
 42 euryhaline freshwater, estuarine, and marine fishes. Many fish species that
 43 migrate or use Delta habitats also are found in the waters of Suisun Bay.

1 Tides reach Suisun Bay and Marsh through the Carquinez Strait, and most
2 freshwater flows enter at the southeast border of Suisun Marsh at the confluence
3 of the Sacramento and San Joaquin rivers. The mixing of freshwater outflows
4 from the Central Valley with saline tidal water in Suisun Bay and Suisun Marsh
5 results in brackish water with strong salinity gradients, complex patterns of flow
6 interactions, and generally the highest biomass productivity in the entire estuary
7 (Siegel et al. 2010).

8 Although the fish assemblages in Suisun Bay and Marsh can differ substantially
9 from the fish assemblages in the Delta, all the species that use the Delta also use
10 Suisun Bay and Marsh.

11 Flow, turbidity, and salinity are important factors influencing the location and
12 abundance of zooplankton and small prey organisms used by Delta species
13 (Kimmerer et al. 1998). The location where net current flowing inland along the
14 bottom reverses direction and sinking particles are trapped in suspension is
15 associated with higher turbidity known as the estuarine turbidity maximum.
16 Burau et al. (2000) reports that the estuarine turbidity maximum occurs near the
17 Benicia Bridge and in Suisun Bay near Garnet Point on Ryer Island.
18 Zooplanktonic organisms maintain position in this region of historically high
19 productivity in the estuary through vertical movements (Kimmerer et al. 1998).

20 Salinity in the Suisun Bay and Marsh system is a major water quality
21 characteristic that strongly influences physical and ecological processes. Fish
22 species native to Suisun Marsh require low salinities during the spawning and
23 rearing periods (Suisun Ecological Workgroup 2001; Kimmerer 2004;
24 Feyrer et al. 2007, 2010; Nobriga et al. 2008). The Suisun Bay and Marsh usually
25 contain both the maximum estuarine salinity gradient and the low salinity zone.
26 The overall estuarine salinity gradient trends from west (higher) to east (lower) in
27 Suisun Bay and Marsh. The location of the low salinity zone gradient and X2 can
28 be influenced by outflow. Suisun Marsh also exhibits a persistent north-south
29 salinity gradient. Despite low and seasonal flows, the surrounding watersheds
30 have a significant water freshening effect because of the long residence times of
31 freshwater discharges from the upper sloughs and wastewater effluent.

32 The Suisun Bay and Marsh system contains a wide variety of habitats such as
33 marsh plains, tidal creeks, sloughs, channels, cuts, mudflats, and bays. These
34 features and the complex hydrodynamics and water quality of the system have
35 historically fostered significant biodiversity within Suisun tidal aquatic habitats,
36 but, like the Delta, these habitats also have been significantly altered and
37 degraded by human activities over the decades.

38 Categories of tidal aquatic habitat were identified as part of the Suisun Marsh
39 Plan development process and were defined using physical boundaries; habitats
40 include bays, major sloughs, minor sloughs, and the intertidal mudflats in those
41 areas (Engle et al. 2010). These tidal habitats total approximately 26,000 acres,
42 with the various embayments totaling about 22,350 acres. Tidal slough habitat is
43 composed of major and minor sloughs, with major sloughs of Suisun Marsh
44 having a combined acreage of about 2,200 acres consisting of both shallow and

1 deep channels. Minor sloughs are made up of shallow channel habitat and have a
 2 combined acreage of about 1,100 acres. Habitats in Suisun Marsh bays and
 3 sloughs support a diverse assemblage of aquatic species that typically use
 4 open-water tidal areas for breeding, foraging, rearing, or migrating.

5 **9.3.4.14.2 Fish Entrainment**

6 Several facilities have been constructed by DWR and Reclamation to provide
 7 lower-salinity water to managed wetlands in the Suisun Marsh, including the
 8 Roaring River Distribution System, Morrow Island Distribution System, and
 9 Goodyear Slough Outfall. Other facilities constructed under the Suisun Marsh
 10 Preservation Agreement that could entrain fish include the Lower Joice Island and
 11 Cygnus Drain diversions.

12 The intake to the Roaring River Distribution System is screened to prevent
 13 entrainment of fish larger than approximately 25 mm (approximately 1 inch).
 14 DWR monitored fish entrainment from September 2004 to June 2006 at the
 15 Morrow Island Distribution System to evaluate entrainment losses at the facility.
 16 Monitoring took place over several months under various operational
 17 configurations and focused on Delta Smelt and salmonids. Over 20 species were
 18 identified during the sampling, but only 2 fall-run-sized Chinook Salmon (at the
 19 South Intake in 2006) and no Delta Smelt from entrained water were caught
 20 (Reclamation 2008a). The Goodyear Slough Outfall system is open for free fish
 21 movement except near the outfall when flap gates are closed during flood tides
 22 (Reclamation 2008a). Conical fish screen have been installed on the Lower Joice
 23 Island diversion on Montezuma Slough.

24 **9.3.4.15 San Joaquin River from Confluence of the Stanislaus River to** 25 **the Delta**

26 Since the construction of Friant Dam, significant changes in physical (fluvial
 27 geomorphic) processes and substantial reductions in streamflows in the San
 28 Joaquin River have occurred, resulting in large-scale alterations to the river
 29 channel and associated aquatic, riparian, and floodplain habitats. Throughout the
 30 area, there are physical barriers, reaches with poor water quality or no surface
 31 flow, and false migration pathways that have reduced habitat connectivity for
 32 anadromous and resident native fishes (Reclamation and DWR 2011). As a
 33 result, there has been a general decline in both the abundance and distribution of
 34 native fishes, with several species extirpated from the system (Moyle 2002).

35 Moyle (2002) reported that of the 21 native fish species historically present in the
 36 San Joaquin River, at least 8 are now uncommon, rare, or extinct. The deep-
 37 bodied fish assemblage (e.g., Sacramento Splittail, Sacramento Blackfish) has
 38 been replaced by nonnative species like carp and catfish.

39 The San Joaquin River from the Stanislaus River to the Delta is dominated by
 40 nonnative species such as Largemouth Bass, Inland Silverside, carp, and several
 41 species of sunfish and catfish (Moyle 2002). Anadromous species include fall-run
 42 Chinook Salmon, steelhead, Striped Bass, American Shad, White Sturgeon, and
 43 several species of lamprey (Reclamation et al. 2003). The fall-run Chinook

1 Salmon population is supported in part by hatchery stock in the Merced River.
2 Spawning by anadromous salmonids in the San Joaquin River Basin occurs only
3 in the tributaries to the San Joaquin River, including the Merced, Tuolumne, and
4 Stanislaus rivers (Brown and Moyle 1993). Spring-run Chinook Salmon no
5 longer exist in the San Joaquin River, but are targeted for restoration in this
6 system under Reclamation's San Joaquin River Restoration Program. In early
7 2015, the program experimentally released juvenile spring-run Chinook Salmon
8 into the San Joaquin River near the Merced River. Surviving adults may return to
9 the San Joaquin River as early as spring 2017. Because of the uncertainty of
10 future restoration success and the current lack of natural presence in the San
11 Joaquin River, spring-run Chinook Salmon is not included in the analysis of San
12 Joaquin River fish.

13 **9.3.4.15.1 Fish in the San Joaquin River**

14 The analysis is focused on the following species:

- 15 • Fall-run Chinook Salmon
- 16 • Steelhead
- 17 • White Sturgeon
- 18 • Sacramento Splittail
- 19 • Pacific Lamprey
- 20 • Striped Bass
- 21 • American Shad

22 *Fall-run Chinook Salmon*

23 Fall-run Chinook Salmon are present in the San Joaquin River and its major
24 tributaries upstream to and including the Merced River. Spawning and rearing
25 occur in the major tributaries (Merced, Tuolumne, and Stanislaus rivers)
26 downstream of the mainstem dams. Weir counts in the Stanislaus River suggest
27 that adult fall-run Chinook Salmon in the San Joaquin River Basin typically
28 migrate into the upper rivers between late September and mid-November and
29 spawn shortly thereafter (Pyper et al. 2006; Anderson et al. 2007;
30 FISHBIO 2010a, 2011).

31 The San Joaquin River downstream of the Stanislaus River primarily provides
32 upstream passage for adult fall-run Chinook Salmon and downstream passage for
33 juveniles and smolts as they outmigrate from the tributary spawning and rearing
34 areas to the Delta to the Pacific Ocean. The juvenile fall-run Chinook Salmon
35 outmigration in the San Joaquin River Basin typically occurs during winter and
36 spring, extending primarily from January through May. The outmigration
37 consists primarily of fry in winter and smolts in spring (FISHBIO 2007, 2013).
38 Trawl sampling in the lower San Joaquin River from Mossdale to the Head of Old
39 River (the Mossdale Trawl) captures Chinook Salmon from February into July,
40 with peak catches generally during April and May (Speegle et al. 2013).

1 *Steelhead*

2 Steelhead were historically present in the San Joaquin River, though data on their
3 population levels are lacking (McEwan 2001). The current steelhead population
4 in the San Joaquin River is substantially reduced compared with historical levels,
5 although resident Rainbow Trout occur throughout the major San Joaquin River
6 tributaries. Additionally, small populations of steelhead persist in the lower San
7 Joaquin River and tributaries (e.g., Stanislaus, Tuolumne, and possibly the
8 Merced rivers) (Zimmerman et al. 2009, McEwan 2001). Steelhead/Rainbow
9 Trout of anadromous parentage occur at low numbers in all three major San
10 Joaquin River tributaries. These tributaries have a higher percentage of resident
11 Rainbow Trout compared to the Sacramento River and its tributaries
12 (Zimmerman et al. 2009).

13 Presence of steelhead smolts from the San Joaquin River Basin is estimated
14 annually by CDFW based on the Mossdale Trawl (SJRGGA 2011). The sampling
15 trawls capture steelhead smolts, although usually in small numbers. One
16 steelhead smolt was captured and returned to the river during the 2009 sampling
17 period (SJRGGA 2010), and three steelhead were captured and returned in both
18 2010 and 2011 (Speegle et al. 2013).

19 *Sacramento Splittail*

20 Historically, Sacramento Splittail were widespread in the San Joaquin River and
21 found upstream to Tulare and Buena Vista lakes, where they were harvested by
22 native peoples (Moyle et al. 2004). Today, Sacramento Splittail likely ascend the
23 San Joaquin River to Salt Slough during wet years (Baxter 1999). During dry
24 years, Sacramento Splittail are uncommon in the San Joaquin River downstream
25 of the Tuolumne River (Moyle et al. 2004). Most spawning takes place in the
26 flood bypasses, along the lower reaches of the Sacramento and San Joaquin rivers
27 and major tributaries, and lower Cosumnes River and similar areas in the
28 western Delta.

29 Most juveniles apparently move downstream into the Delta from April to August
30 (Meng and Moyle 1995). Factors influencing the Sacramento Splittail population
31 are unclear, but the population is largely influenced by extent and period of
32 inundation of floodplain spawning habitats, with abundance spiking following wet
33 years and declining after dry years (Moyle et al. 2004). Other factors that may
34 influence the San Joaquin River portion of the population include flood control,
35 entrainment by diversion, recreational fishing, pollutants, and nonnative species
36 (Moyle et al. 2004).

37 *Pacific Lamprey*

38 The Pacific Lamprey is a widely distributed anadromous species found in
39 accessible reaches of the San Joaquin River and many of its tributaries.

40 Data from mid-water trawls in the lower San Joaquin River near Mossdale
41 indicate that adults likely migrate into the San Joaquin River in spring and early
42 summer (Hanni et al. 2006). In other large river systems, the initial adult
43 migration from the ocean generally stops in summer, and Pacific Lampreys hold
44 until the following winter or spring before undergoing a secondary migration to

1 spawning grounds (Robinson and Bayer 2005, Clemens et al. 2012). Midwater
2 trawl surveys in the San Joaquin River suggest that peak ammocoete outmigration
3 occurs in January and February (Hanni et al. 2006).

4 Little information is available on factors influencing Pacific Lamprey in the San
5 Joaquin River, but they are likely affected by many of the same factors as salmon
6 and steelhead because of parallels in their life cycles. Lack of access to historical
7 spawning habitats because of the mainstem dams and other migration barriers,
8 modification of spawning and rearing habitats, altered hydrology, entrainment by
9 water diversions, and predation by nonnative invasive species such as Striped
10 Bass all likely influence Pacific Lamprey in the San Joaquin River and tributaries.

11 *Striped Bass*

12 Striped Bass are regularly found in San Joaquin River tributaries, including in
13 lower mainstem deep pools of the Stanislaus and Tuolumne rivers (e.g., Anderson
14 et al. 2007). Ainsley et al. (2013) reported that Striped Bass were collected at two
15 locations between the Head of the Old River and the mouth of the Stanislaus
16 River on the mainstem San Joaquin River in May.

17 *American Shad*

18 Little is known about American Shad populations inhabiting the San Joaquin
19 River. American Shad may spawn in the San Joaquin River system, but their
20 abundance is unknown. Sport fishing for American Shad occurs seasonally in the
21 San Joaquin River.

22 *Sturgeon*

23 Little is known about White Sturgeon populations inhabiting the San Joaquin
24 River. Spawning-stage adults generally move into the lower reaches of rivers
25 during winter prior to spawning, then migrate upstream to spawn in response to
26 higher flows (Schaffter 1997, McCabe and Tracy 1994). Based on tag returns
27 from White Sturgeon tagged in the Sacramento-San Joaquin Estuary and
28 recovered by anglers, Kohlhorst et al. (1991) estimated that over 10 times as
29 many White Sturgeon spawn in the Sacramento River as in the San Joaquin River.

30 CDFW fisheries catch information for the San Joaquin River obtained from
31 fishery report cards (DFG 2008b, 2009b, 2010, 2011, 2012b; CDFW 2013, 2014)
32 documented that anglers upstream of Highway 140 caught between 8 and
33 25 mature White Sturgeon annually between 2007 and 2013. Below Highway
34 140 downstream to Stockton, anglers caught between 2 and 35 mature White
35 Sturgeon annually over the same time period; most of the White Sturgeon caught
36 were released.

37 White Sturgeon spawning in the San Joaquin River was documented for the first
38 time in 2011 and confirmed in 2012. Viable White Sturgeon eggs were collected
39 in 2011 at one sampling location downstream of Laird Park (Gruber et al. 2012)
40 and in 2012 at four sampling locations generally between Laird Park and the
41 Stanislaus River confluence (Jackson and Van Eenennaam 2013). Although the
42 majority of sturgeon likely spawn in the Sacramento River, the results of these
43 surveys confirm that White Sturgeon do spawn in the San Joaquin River in both

1 wet- and dry-year conditions and may be an important source of production for
2 the White Sturgeon population in the Sacramento-San Joaquin river system.

3 Green Sturgeon are also present in the San Joaquin River, but at considerably
4 lower numbers than White Sturgeon. Between 2007 and 2012, anglers reported
5 catching six Green Sturgeon in the San Joaquin River (Jackson and Van
6 Eenennaam 2013). Although the reported presence of Green Sturgeon in the
7 San Joaquin River coincides with the spawning migration period of Green
8 Sturgeon within the Sacramento River, no evidence of spawning has been
9 detected (Jackson and Van Eenennaam 2013).

10 **9.3.4.15.2 Aquatic Habitat**

11 Aquatic habitat conditions vary spatially and temporally throughout the lower San
12 Joaquin River because of differences in habitat availability and connectivity,
13 water quantity and quality (including water temperature), and channel
14 morphology.

15 Downstream of the Stanislaus River confluence, the San Joaquin River is more
16 sinuous than upstream reaches and contains oxbows, side channels, and remnant
17 channels. It conveys the combined flows of the major tributaries, including the
18 Merced, Tuolumne, Stanislaus, and Calaveras rivers. Flood control levees closely
19 border much of the river but are set back in places, creating some off-channel
20 aquatic habitat areas when inundated (Reclamation and DWR 2011). The channel
21 gradient in this portion of the San Joaquin River is low, and the lack of gravel or
22 coarser substrate precludes spawning by salmonids.

23 **9.3.4.15.3 Fish Passage**

24 In the reach of the river downstream of the confluence of the Stanislaus River,
25 fish encounter passage challenges associated with water diversions, and adult
26 salmon migrating upstream from the Delta also may encounter prohibitively high
27 stream temperatures that delay migration until temperatures decline (McBain and
28 Trush 2002). Installation of seasonal barriers in the Delta also can impair fish
29 passage.

30 **9.3.4.15.4 Hatcheries**

31 No hatcheries in the San Joaquin River Basin are affected by CVP or SWP
32 operations. The Merced River Hatchery, located on the Merced River, is operated
33 by CDFW to supplement the fall-run Chinook Salmon population. It is not
34 included in the CVP or SWP service areas. As part of the San Joaquin River
35 Restoration Program, CDFW has begun operation of a conservation hatchery
36 downstream of Friant Dam to produce spring-run Chinook Salmon (Reclamation
37 and DWR 2010).

38 **9.3.4.15.5 Predation**

39 Recent studies of predation in the San Joaquin River are limited to the major
40 tributaries, where largemouth and Smallmouth Bass have been identified as the
41 most important predators of juvenile Chinook Salmon (McBain and Trush and

1 Stillwater Sciences 2006). Striped Bass also have been identified as salmon
2 predators, though recent evidence for the San Joaquin River is lacking.

3 **9.3.4.16 New Melones Reservoir, Tulloch Reservoir, and Goodwin Dam**

4 The north, middle, and south forks of the Stanislaus River converge upstream of
5 the CVP New Melones Reservoir. Water from New Melones Reservoir flows
6 into Tulloch Reservoir (Reclamation 2010b). Downstream of Tulloch Reservoir,
7 the Stanislaus River flows through the reservoir formed by Goodwin Dam and
8 then approximately 40 miles to the confluence with the San Joaquin River.

9 New Melones Reservoir is located approximately 60 miles upstream from the
10 confluence of the Stanislaus and San Joaquin rivers and is operated by
11 Reclamation. New Melones Reservoir is an artificial environment and does not
12 support a naturally evolved aquatic community. Most of the species in the
13 reservoir were introduced, although a few native species may still be present.
14 From a fisheries perspective, recreational fishing is the most important use of
15 New Melones Reservoir. Fish species in New Melones Reservoir include
16 Rainbow Trout, Brown Trout, Largemouth Bass, sunfishes such as Black Crappie
17 and Bluegill, and three species of catfish (Reclamation 2010b). Rainbow Trout,
18 Brown Trout, and large Channel Catfish are generally restricted to colder, deeper
19 water during summer, when New Melones Reservoir has two distinct thermal
20 layers of water, although large Brown Trout and Channel Catfish are found in
21 shallow water near steep banks at night when they ascend to feed.

22 Tulloch Reservoir is operated as an afterbay for the New Melones Reservoir and
23 is subject to fluctuating water levels that occur on a daily and seasonal basis.
24 Tulloch Reservoir stratifies weakly during summer and contains a reserve of
25 relatively cold, well-oxygenated water that is released downstream. Tulloch
26 Reservoir supports both warm and cold freshwater habitat. Goodwin Power
27 (2013) reported that DFG captured 15 species in Tulloch Reservoir from
28 1969 through 1998. Five dominant species made up almost 80 percent of the
29 catch; White Catfish (31 percent of the total), Bluegill (20 percent), Sacramento
30 Sucker (11 percent), Smallmouth Bass (10 percent), and Black Crappie
31 (7 percent). Of these, only the Sacramento Sucker is native. Other native species
32 in the catch were Sacramento Hitch, Hardhead, Sacramento Pikeminnow, and
33 Rainbow Trout (now stocked). Other nonnative fish found in Tulloch reservoir
34 include Largemouth Bass and Threadfin Shad (DFG 2002b).

35 Little information exists regarding aquatic resources in the reservoir formed by
36 Goodwin Dam. It is assumed that fish assemblies are similar to those described
37 for Tulloch Reservoir.

38 **9.3.4.17 Stanislaus River from Goodwin Dam to the San Joaquin River**

39 **9.3.4.17.1 Fish in the Stanislaus River**

40 Steelhead and fall-run Chinook Salmon currently occur in the lower Stanislaus
41 River. Historically, spring-run Chinook Salmon were believed to be the primary
42 salmon run in the Stanislaus River. Native spring-run Chinook salmon have been

1 extirpated from all tributaries in the San Joaquin River Basin, which represents a
 2 large portion of their historic range and abundance (NMFS 2014b). Other
 3 anadromous fish species that occur in the lower Stanislaus River include Striped
 4 Bass, American Shad, and an unidentified species of lamprey (SRFG 2003). The
 5 analysis is focused on the following species:

- 6 • Fall-run Chinook Salmon
- 7 • Steelhead
- 8 • Pacific Lamprey
- 9 • Striped Bass
- 10 • American Shad

11 *Fall-run Chinook Salmon*

12 Data collected by private fishery consultants, nonprofit organizations, and DFG
 13 demonstrate the majority of fall-run Chinook Salmon adults migrate upstream
 14 from late September through December with peak migration from late October
 15 through early November. Most Chinook Salmon spawning occurs between
 16 Riverbank (River Mile 33) and Goodwin Dam (River Mile 58.4) (Reclamation
 17 2012b). Based on redd surveys conducted by FISHBIO, peak spawning typically
 18 occurs in November with roughly 7 percent of spawning occurring prior to
 19 November 1, and 2 percent prior to October 15. The few redds created during late
 20 September and early October are typically in the reach just below Goodwin Dam.
 21 By late October, the amount of spawning in downstream locations increases as
 22 water temperatures decrease, and the median redd location is typically around
 23 Knights Ferry (SWRCB 2015).

24 In 2010, over 20 percent of the fall-run Chinook Salmon observed passing the
 25 Stanislaus River weir had adipose fin clips, indicating the presence of a coded-
 26 wire-tag (CWT) in their snout. Since there is no hatchery on the Stanislaus River
 27 and no hatchery releases have been conducted into this tributary since 2006, it is
 28 apparent that straying from other rivers is occurring (FISHBIO 2010b).

29 Rotary screw trap data indicate that about 99 percent of salmon juveniles migrate
 30 out of the Stanislaus River from January through May (SRFG 2004). Fry
 31 migration generally occurs from January through March, followed by smolt
 32 migration from April through May (Reclamation 2012). Watry et al. (2012)
 33 found that in both 2010 and 2011, peak passage during the pre-smolt period
 34 generally corresponded with flow pulses. Zeug et al. (2014) examined 14 years of
 35 rotary screw trap data on the lower Stanislaus River and found a strong positive
 36 response in survival, the proportion of pre-smolt migrants and the size of smolts
 37 when cumulative flow and flow variance were greater and concluded that the data
 38 suggested that periods of high discharge in combination with high discharge
 39 variance are important for successful emigration as well as migrant size and the
 40 maintenance of diverse migration strategies.

41 Mesick (2001) surmised that when water exports are high relative to San Joaquin
 42 River flows, little, if any, San Joaquin River water reaches San Francisco Bay
 43 where it may be needed to help attract the salmon back to the Stanislaus River.
 44 During mid-October from 1987 through 1989, when export rates exceeded

1 400 percent of Vernalis flows, Mesick (2001) found that straying rates ranged
2 between 11 and 17 percent. In contrast, straying rates were estimated to be less
3 than 3 percent when Delta export rates were less than about 300 percent of
4 San Joaquin River flow at Vernalis during mid-October.

5 One of the limiting factors appears to be the high rates of mortality for juveniles
6 migrating through dredged channels in the Stanislaus River and Delta, particularly
7 the Stockton Deep Water Ship Channel (Newcomb and Pierce 2010). Pickard
8 et al. (1982) reported that the survival of juvenile fish in the deep-water ship
9 channel is highest during flood flows or when a barrier is placed at the head of the
10 Old River that more than doubles the flow in the ship channel. The Stanislaus
11 River Fish Group (SRFG) (2004) noted that escapement is also directly correlated
12 with springtime flows when each brood migrates downstream as smolts.
13 However, the cause of the mortality in the ship channel has not been studied. It is
14 possible that mortality results from the combined effects of warm water
15 temperatures, low dissolved oxygen concentrations, ammonia toxicity, and
16 predation.

17 As discussed earlier, dredging for gravel and gold, regulated flows, and the diking
18 of floodplains for agriculture have substantially limited the availability of
19 spawning and rearing habitat for fall-run Chinook Salmon. Reclamation has
20 conducted spawning gravel augmentation to improve spawning and rearing
21 habitats in the reach between Goodwin Dam and Knights Ferry most years since
22 1999. The dredged areas also contain an abundance of large predatory fish,
23 although the SRFG concluded that there is uncertainty about whether predation is
24 a substantial source of mortality for juvenile salmon.

25 The SRFG also concluded that water diversions for urban and agricultural use in
26 all three San Joaquin River tributaries, which reduce flows and potentially result
27 in unsuitably warm water temperatures during spring and fall, affect fall-run
28 Chinook Salmon juvenile rearing and adult and juvenile migration in the lower
29 San Joaquin River and Delta.

30 *Steelhead*

31 Steelhead were thought to be extirpated from the San Joaquin River system
32 (NMFS 2009a). However, monitoring has detected small self-sustaining
33 (i.e., non-hatchery origin) populations of steelhead in the Stanislaus River and
34 other streams previously thought to be devoid of steelhead (SRFG 2003, McEwan
35 2001). There is a catch-and-release steelhead fishery in the lower Stanislaus
36 River between January 1 and October 15. Surveys of *O. mykiss* (resident trout
37 and the anadromous steelhead) abundance and distribution conducted annually
38 since 2009 have documented a relatively stable population. River-wide
39 abundance estimates from 2009 to 2014 have averaged just over 20,220 (all life
40 stages combined) and have never been estimated to be less than about 14,000
41 (2009). The highest densities and abundances of *O. mykiss* are consistently found
42 in Goodwin Canyon. Key factors that may contribute to higher-than average
43 abundances in the Stanislaus River (relative to other San Joaquin River
44 tributaries) include high gradient reaches that are typically associated with higher
45 amount of fast-water habitats, particularly in Goodwin Canyon (SWRCB 2015).

1 Historically, the distribution of steelhead extended into the headwaters of the
 2 Stanislaus River (Yoshiyama et al. 1996). Steelhead currently can migrate more
 3 than 58 miles up the Stanislaus River to the base of Goodwin Dam. In the
 4 Stanislaus River, there is little data regarding the migration patterns of adult
 5 steelhead since adults generally migrate during periods when river flows and
 6 turbidity are high making fish difficult to observe with standard adult monitoring
 7 techniques. Stanislaus River weir data indicate that steelhead migrate upstream,
 8 through the South Delta and lower San Joaquin river, between September and
 9 March with numbers ranging from 6 to 85³ between 2008-2011 and 2013
 10 (Reclamation 2014e). High Delta export rates relative to San Joaquin River flows
 11 at Vernalis, when adults are migrating through the Delta (presumably December
 12 through May), may result in adults straying to the Sacramento River Basin.

13 It is believed that steelhead spawn primarily between December and March in the
 14 Stanislaus River. Although steelhead few steelhead spawning surveys have been
 15 conducted in the Stanislaus, spawning *O. mykiss* were documented between
 16 Goodwin Dam and Horseshoe Bar in a 2014 spawning survey (Reclamation and
 17 DWR 2015). The spawning adults require holding and feeding habitat with cover
 18 adjacent to suitable spawning habitat. These habitat features are relatively rare in
 19 the lower Stanislaus River because of in-river gravel mining and the scouring of
 20 gravel from riffles in Goodwin Canyon.

21 Juvenile steelhead rear in the Stanislaus River for at least 1 year, and usually
 22 2 years, before migrating to the ocean. As a result, flow, water temperature, and
 23 dissolved oxygen concentration in the reach between Goodwin Dam and the
 24 Orange Blossom Bridge (their primary rearing habitat) are critical during summer
 25 (Reclamation 2012b).

26 Small numbers of steelhead smolts have been captured in rotary screw traps at
 27 Caswell State Park and near Oakdale (FISHBIO 2007; Watry et al. 2007, 2012),
 28 and data indicate that steelhead outmigrate primarily from February through May.
 29 Rotary screw traps are generally not considered efficient at catching fish as large
 30 as steelhead smolts, and the number captured is too small to estimate capture
 31 efficiency, so no steelhead smolt outmigration population estimate has been
 32 calculated. The capture of these fish in downstream migrant traps and the
 33 advanced smolting characteristics exhibited by many of the fish indicate that
 34 some steelhead/rainbow juveniles might migrate to the ocean in spring. However,
 35 it is not known whether the parents of these fish were anadromous or fluvial (they
 36 migrate within fresh water). Resident populations of steelhead/rainbow in large
 37 streams are typically fluvial, and migratory juveniles look much like smolts.

38 *Pacific Lamprey*

39 The Pacific Lamprey is a widely distributed anadromous species that inhabits
 40 accessible reaches of the Stanislaus River (SRFG 2003). Limited information on
 41 Pacific Lamprey status in the Stanislaus River exists, but the species has

³ Numbers presented are for all *O. mykiss* passing upstream of the Stanislaus Weir and do not differentiate between adult steelhead and resident rainbow trout that are moving within the river; therefore, actual numbers of steelhead may be lower than those presented.

1 experienced loss of access to historical habitat and apparent population declines
2 throughout California and the Sacramento and San Joaquin River basins
3 (Moyle et al. 2009). Little information is available on factors influencing
4 Pacific Lamprey populations in the Stanislaus River, but they are likely affected
5 by many of the same factors as salmon and steelhead because of parallels in their
6 life cycles.

7 Ocean stage adults likely migrate into the Stanislaus River in spring and early
8 summer, where they hold for approximately 1 year before spawning (Hanni et al.
9 2006). Hannon and Deason (2008) have documented Pacific Lampreys spawning
10 in the American River from between early January and late May, with peak
11 spawning typically in early April. Spawning time is presumably similar in the
12 Stanislaus River. Pacific Lamprey ammocoetes are expected to rear in the
13 Stanislaus River for all or part of their 5- to 7-year freshwater residence. Data
14 from rotary screw trapping in the nearby Mokelumne and Tuolumne rivers
15 suggest that outmigration of Pacific Lamprey generally occurs from early winter
16 through early summer (Hanni et al. 2006). Catches of juvenile Pacific Lampreys
17 in trawl surveys of the mainstem San Joaquin River, near the mouth of the
18 Stanislaus River at Mossdale, occurred during winter and spring. Some
19 outmigration likely occurs year-round, as observed at sites on the mainstem
20 Sacramento River (Hanni et al. 2006). Significant numbers of lampreys of
21 unknown species and unspecified life stage have been captured during rotary
22 screw trapping on the Stanislaus River at Oakdale (FISHBIO 2007) and Caswell
23 (Watry et al. 2007).

24 *Striped Bass*

25 Striped Bass occur in the Stanislaus River, and they support a sport fishery when
26 adult fish migrate upstream to spawn. Striped Bass have been observed at Lovers
27 Leap and at Knights Ferry from May through the end of June. These adult fish
28 were observed in all habitats (USFWS 2002, Kennedy and Cannon 2005). The
29 distribution of Striped Bass in the Stanislaus River is thought to be limited to
30 downstream of the historic Knights Ferry Bridge due to a set of falls about 3 feet
31 tall in the area (USFWS 2002).

32 *American Shad*

33 American Shad migrate up the Stanislaus River to spawn in the late spring and
34 support a sport fishery during that period. American Shad have been observed on
35 occasion from June through July at Lovers Leap (USFWS 2002, Kennedy and
36 Cannon 2005). American Shad were found primarily in the faster habitats and
37 were observed in schools of 20 or more (USFWS 2002).

38 **9.3.4.17.2 Aquatic Habitat**

39 Schneider et al. (2003) conducted hydrologic analysis of the Stanislaus River and
40 found that New Melones Dam (built in 1979) and more than 30 smaller dams
41 cumulatively impound 240 percent of average annual unimpaired runoff.
42 Schneider et al. (2003) concluded that this has reduced winter floods and spring
43 snow melt runoff, and increased summer base flows to supply irrigation demand.
44 As a result, the frequency and extent of overbank flooding has been reduced.

1 Based on historical data and field measurements, Schneider et al. (2003)
2 suggested that the channel had incised approximately 1 to 3 feet since dam
3 construction, and that the discharge needed for overbank flows has approximately
4 doubled.

5 With respect to the related need for geomorphic flows, Kondolf et al. (2001)
6 estimated bedload mobilization flows in the Stanislaus River to be around
7 5,000 to 8,000 cfs to mobilize the median particle size of the channel bed
8 material. Flows necessary to mobilize the bed material increased downstream
9 from a minimal 280 cfs where gravel had been recently added near Goodwin Dam
10 to about 5,800 cfs at Oakdale Recreation Area (Reclamation 2008a). Before
11 construction of New Melones Dam, a bed-mobilizing flow of 5,000 to 8,000 cfs
12 was equivalent to a 1.5- to 1.8-year return interval flow. Following construction
13 of the dam, 5,000 cfs represents approximately a 5-year return interval flow, and
14 8,000 cfs exceeds all flows within the 21-year study period, 1979 to 1999
15 (maximum flow = 7,350 cfs on January 3, 1997). The probability of occurrence
16 for a daily average flow exceeding 5,330 cfs (the pre-dam bankfull discharge) is
17 0.01 per year.

18 Low dissolved oxygen (DO) levels have been measured in the San Joaquin River,
19 in particular in the Deep Water Ship Channel (DWSC) from the Port of Stockton
20 seven miles downstream to Turner Cut (Lee and Jones-Lee 2003). These
21 conditions are the result of increased residence time of water combined with high
22 oxygen demand in the anthropogenically modified channel, which leads to DO
23 depletion, particularly near the sediment-water interface (SJTA 2012). Despite
24 these conditions, adult salmon and steelhead migration does not appear to be
25 adversely impacted (Pyper et. al 2006). However, during the 1960s, Hallock et al.
26 (1970) found that adult radio-tagged Chinook Salmon delayed their upstream
27 migration whenever dissolved oxygen concentrations were less than 5 mg/L at
28 Stockton. SWRCB D-1422 requires water to be released from New Melones
29 Reservoir to maintain dissolved oxygen standards in the Stanislaus River, as
30 described in Chapter 6, Surface Water Quality. It has been shown that low DO
31 conditions in the San Joaquin River can be ameliorated somewhat through
32 installation of the Head of the Old River Barrier which increases San Joaquin
33 River flows (SJTA 2012).

34 *Spawning and Rearing Habitat*

35 Upstream dams have suppressed channel-forming flows that replenish spawning
36 beds in the Stanislaus River (Kondolf et al. 1996). The physical presence of the
37 dams impedes normal sediment transportation processes. Kondolf (et al. 2001)
38 identified levels of sediment depletion at 20,000 cubic yards per year as a result of
39 a variety of factors, including mining, and geomorphic processes associated with
40 past and ongoing dam operations. In 2011, 5,000 tons of gravel were placed in
41 Goodwin Canyon downstream of Goodwin Dam, of which around 70 percent was
42 transported into nearby downstream areas during high flows (SOG 2012).

43 Extensive instream gravel mining removed large quantities of spawning habitat
44 (Kondolf et al. 2001). Gravel mining also has resulted in instream mine pits that
45 occur in the primary salmonid spawning areas, including a large, approximately

1 1-mile-long pit called the Oakdale Recreation Pond. Instream mine pits trap
2 bedload sediment, store large volumes of sand and silt, and pass sediment-starved
3 water downstream, where it typically erodes the channel bed and banks to regain
4 its sediment load (Kondolf et al. 2001). Reclamation restores and replenishes
5 spawning gravel and rearing habitat lost from the construction and operation of
6 dams in the Stanislaus River to restore spawning habitat and remediate sediment
7 related loss of geomorphic function, such as channel incision.

8 *Floodplain Habitat*

9 Kondolf et al. (2001) identified that floodplain terraces and point bars inundated
10 before operation of New Melones Reservoir have become fossilized with fine
11 material and thick riparian vegetation that is never rejuvenated by scouring flows.
12 Channel forming flows in the 8,000-cfs range have occurred only twice since
13 New Melones Reservoir began operation 28 years ago.

14 Based on historical data and field measurements, Schneider et al. (2003)
15 suggested that the channel incised approximately 1 to 3 feet since dam
16 construction, and that the discharge needed for overbank flows has approximately
17 doubled. Without inundation, the floodplains cannot provide terrestrial food for
18 juvenile salmon or organic matter that helps produce more food within the river.
19 Increased flows required for inundation also have had the effect of further
20 isolating floodplains from the channel, leading to the loss of floodplain habitats.

21 In 2011, a habitat restoration project to increase spawning habitat also restored
22 640 feet of remnant side channel habitat, allowing water to flow at the current
23 1.5-year return interval (575 cfs), in addition to three cross channels designed to
24 inundate at higher flows (SOG 2011).

25 **9.3.4.17.3 Fish Passage and Entrainment**

26 Constructed in 1913, Goodwin Dam was probably the first permanent barrier to
27 significantly affect anadromous fish access to upstream habitat in the Stanislaus
28 River. Goodwin Dam had a fishway, but Chinook Salmon could seldom pass it,
29 and other salmonids may have been similarly affected. Yoshiyama et al. (1996)
30 estimated that historically Chinook Salmon and other salmonids had access to
31 113 miles of habitat, compared with 58 miles under current conditions.

32 There are numerous small, unscreened diversions on the lower Stanislaus River
33 (Herren and Kawasaki 2001). The effects of these diversions on fish is not clear;
34 however, in tracking the fate of 49 radio tagged fish, S.P. Cramer and Associates
35 (1998) did not detect any entrainment at several moderately sized unscreened
36 pumps in the lower Stanislaus River.

37 **9.3.4.17.4 Predation**

38 Areas of the Stanislaus River, including spawning riffles in the active channel,
39 were mined for gravel and gold primarily between 1940 and 1970. The mined
40 areas consist of long, deep ditches and large ponds that provide habitat for
41 predators, such as Striped Bass, Sacramento Pikeminnow, Largemouth Bass, and
42 Smallmouth Bass (Mesick 2002). Studies by S.P. Cramer and Associates (1998)

1 documented predation on juvenile salmonids by bass in the Tuolumne and
2 Stanislaus rivers. However, in its review of information, the SRFG (2004)
3 concluded that the available studies and observations suggest that fish predators in
4 the Stanislaus River may be limited to adult pikeminnow and Riffle Sculpin
5 feeding on newly emerged fry, whereas Smallmouth Bass, Largemouth Bass, and
6 possibly American Shad probably feed on relatively few parr that remain in the
7 river during late spring and summer when water temperatures are high.

8 It is possible that predation is high for juveniles rearing in the deep-water ship
9 channel in the Delta as observed by Pickard et al. (1982). Predation rates on
10 hatchery-reared juveniles and tagged juveniles may be higher than those for
11 naturally produced fish. TID/MID (1992, 2013), and TRTAC et al. (2006), have
12 documented predation on salmonids by nonnative predatory fishes in the
13 Tuolumne River, primarily in run-of-river gravel mining ponds and dredged areas.
14 Sonke and Fuller (2012) reported the number of juvenile Chinook Salmon passing
15 the rotary screw traps at Waterford (2006 to 2012) and Grayson (1995 to 2012) on
16 the Tuolumne River. FISHBIO (2013) calculated the potential consumption of
17 juvenile Chinook Salmon by predators in the reach between the Waterford and
18 Grayson rotary screw traps in 2012 and found that consumption of juvenile
19 Chinook Salmon in this reach could equal or exceed the number passing the
20 Waterford trap. Based on their consumption calculations and the difference in
21 estimated numbers of juvenile Chinook Salmon passing the Waterford and
22 Grayson rotary screw traps, FISHBIO (2013) concluded that it is plausible that
23 the majority of juvenile Chinook Salmon losses in this reach are due to predation.
24 NMFS (2009a) noted that losses on the Stanislaus River have not been similarly
25 quantified, but predation on fall-run Chinook Salmon smolts and steelhead by
26 Striped Bass and Largemouth Bass has been documented.

27 **9.3.4.18 San Luis Reservoir**

28 San Luis Reservoir is located at the base of the foothills on the west side of the
29 San Joaquin Valley in Merced County, as described in Chapter 5, Surface Water
30 Resources and Water Supplies. Water from the Delta is delivered to San Luis
31 Reservoir via the California Aqueduct and Delta-Mendota Canal for storage.

32 San Luis Reservoir and O'Neill Forebay support several species of fish that have
33 become established within the system, either by direct introduction or from the
34 Delta system via pumping from the California Aqueduct and Delta-Mendota
35 Canal. Striped Bass are the predominant species in San Luis Reservoir
36 (DWR 1987) and support a recreational fishery. Other species include
37 Sacramento Blackfish, American Shad, Threadfin Shad, Largemouth Bass,
38 Kokanee Salmon, Green Sunfish, Bluegill, White Sturgeon, and White Crappie.

39 There are no sensitive fish species in the San Luis Reservoir except, possibly,
40 individuals entrained by the CVP and SWP projects in the Delta. These
41 individuals have already been lost to their populations, as they cannot return to the
42 Delta once entrained. Potentially occurring fish species with special status that
43 may have been imported from the Delta include Chinook Salmon, Delta Smelt,
44 Hardhead, and Sacramento Splittail (Reclamation and CSP 2013).

1 **9.3.5 San Francisco Bay Area Region**

2 Fish and aquatic habitat resources in the San Francisco Bay Area Region include
3 habitat through San Francisco Bay and along the Pacific Ocean coast. The
4 anadromous fish species discussed above use the Pacific Ocean as part of their
5 life cycles. In addition, the Pacific Ocean supports the killer whale which relies
6 upon Chinook Salmon (e.g., fall-run Chinook Salmon) for food.

7 The San Francisco Bay Area Region also includes fish habitat within reservoirs
8 that store CVP and SWP water. CVP and SWP water supplies are stored in
9 Contra Loma and San Justo reservoirs; the SWP Bethany Reservoir and Lake
10 Del Valle; the Contra Costa Water District Los Vaqueros Reservoir; and the East
11 Bay Municipal Utility District (EBMUD) Upper San Leandro, San Pablo,
12 Briones, and Lafayette reservoirs and Lake Chabot. Many of these reservoirs also
13 store water from local and regional water supplies. CVP and SWP water is
14 generally not stored in reservoirs within Santa Clara County (SCVWD 2010).

15 **9.3.5.1 Pacific Ocean Habitat of the Killer Whale**

16 The Pacific Ocean along the coast of California is included in this description of
17 the affected environment because of it provides habitat for the Southern Resident
18 killer whale population. The effect of the action, however, is limited to changes
19 in the number of Chinook Salmon produced in the Central Valley entering the
20 Pacific Ocean, which contribute an important component of the killer whale diet.

21 Southern Resident killer whales are found primarily in the coastal waters offshore
22 of British Columbia and Washington and Oregon in summer and fall (NMFS
23 2008). During winter, killer whales are sometimes found off the coast of central
24 California and more frequently off the Washington coast (Independent
25 Hilborn et al. 2012).

26 The 2005 NMFS endangerment listing (70 FR 69903) for the Southern Resident
27 killer whale distinct population segment lists several factors that may be limiting
28 the recovery of killer whales, including the quantity and quality of prey,
29 accumulation of toxic contaminants, and sound and vessel disturbance. In the
30 Recovery Plan for Southern Resident Killer Whales (*Orcinus orca*), NMFS
31 (2008) posits that reduced prey availability forces whales to spend more time
32 foraging, which may lead to reduced reproductive rates and higher mortality rates.
33 Reduced food availability may lead to mobilization of fat stores, which can
34 release stored contaminants and adversely affect reproduction or immune function
35 (NMFS 2008).

36 The Independent Science Panel reported that Southern Resident killer whales
37 depend on Chinook Salmon as a critical food resource (Independent Science
38 Panel and ESSA Technologies 2012). Hanson et al. (2010) analyzed tissues from
39 predation events and feces to confirm that Chinook Salmon were the most
40 frequent prey item for killer whales in two regions of the whale's summer range
41 off the coast of British Columbia and Washington state, representing over
42 90 percent of the diet in July and August. Samples indicated that when Southern
43 Residents are in inland waters from May to September, they consume Chinook
44 Salmon stocks that originate from regions including the Fraser River, Puget

1 Sound, the Central British Columbia Coast, West and East Vancouver Island, and
2 Central Valley California (Hanson et al. 2010).

3 Significant changes in food availability for killer whales have occurred over the
4 past 150 years, largely due to human impacts on prey species. Salmon abundance
5 has been reduced over the entire range of the Southern Resident killer whales,
6 from British Columbia to California. The Recovery Plan for Southern Resident
7 Killer Whales (*Orcinus orca*) (NMFS 2008) indicates that wild salmon have
8 declined primarily due to degraded aquatic ecosystems, overharvesting, and
9 production of fish in hatcheries. The recovery plan supports restoration efforts to
10 rebuild depleted salmon populations and other prey to ensure an adequate food
11 base for Southern Resident killer whales.

12 Central Valley streams produce Chinook Salmon that contribute to the diet of
13 Southern Resident killer whales. The number of Central Valley salmon that
14 annually enter the ocean and survive to a size susceptible to predation by killer
15 whales is not known. However, estimates of total Chinook Salmon production
16 produced by the Comprehensive Assessment and Monitoring Program,
17 administered by USFWS and Reclamation, provide an approximation of the size
18 of the ocean population of Central Valley Chinook Salmon potentially available
19 to killer whales. Since 1992, total production of fall-run Chinook Salmon ranged
20 from 53,129 in 2009 to 1,436,928 in 2002 (Table 9.2). The term “total
21 production” here represents the number of fish that returned from the ocean plus
22 those that were taken as part of the commercial and sport fishery. It does not
23 include natural mortality in the ocean, including salmon taken by killer whales.

1 **Table 9.2 Total Production (Number of Individuals) of Central Valley Fall-run**
 2 **Chinook Salmon in the Pacific Ocean and Ocean Harvest 1992-2011**

Year	Total Production	Ocean Harvest
1992	333,087	203,318
1993	553,617	352,913
1994	711,654	449,060
1995	1,391,357	994,194
1996	891,739	471,865
1997	1,146,471	679,151
1998	557,433	263,935
1999	795,768	316,873
2000	1,156,596	571,829
2001	976,034	218,424
2002	1,436,928	418,785
2003	1,019,686	297,140
2004	977,463	500,929
2005	874,670	356,514
2006	453,274	110,540
2007	202,311	87,528
2008	71,870	0
2009	53,129	0
2010	208,050	13,851
2011	329,092	57,224

3 Source: DOI 2012

4 **9.3.5.2 Contra Loma Reservoir**

5 The Contra Loma Reservoir is a CVP facility in Contra Costa County that
 6 provides offstream storage along the Contra Costa Canal. The 80-acre reservoir is
 7 part of 661-acre Contra Loma Regional Park and Antioch Community Park
 8 (Reclamation 2014b). There are currently 20 known fish species, including
 9 8 species of game fish, in Contra Loma Reservoir. The East Bay Parks and
 10 Recreation District (EBRPD) and CDFW stock Rainbow Trout and Channel
 11 Catfish in the reservoir. The reservoir also supports self-sustaining populations of
 12 Largemouth Bass, crappie, Redear Sunfish, and Bluegill, which are also popular
 13 with anglers (Reclamation 2014b). Other species found include White Catfish,
 14 Threadfin Shad, Bigscale Logperch, Common Carp, Sacramento Blackfish,
 15 Warmouth, Green Sunfish, Goldfish, Prickly Sculpin, and Inland Silversides
 16 (Reclamation 2014b).

1 Many of the fish species present have been unintentionally introduced from the
 2 Delta via the Contra Costa Canal. Recently, the Rock Slough Fish Screen at the
 3 head of Contra Costa Canal was constructed to prevent the entrainment of
 4 federally protected species such as Delta Smelt at the Rock Slough Intake of the
 5 Contra Costa Canal. The new screen also minimizes fish entrainment and
 6 significantly reduces the potential for fish introductions into Contra Loma
 7 Reservoir from the Contra Costa Canal (Reclamation 2014b).

8 **9.3.5.3 San Justo Reservoir**

9 The San Justo Reservoir is a CVP facility in San Benito County that provides
 10 offstream storage as part of the San Felipe Division, as described in Chapter 5,
 11 Surface Water Resources and Water Supplies. Other than stocked Rainbow
 12 Trout, all of the fish and other aquatic organisms that have been observed in
 13 San Justo Reservoir are nonnative species (SBCWD 2012).

14 **9.3.5.4 South Bay Aqueduct Reservoirs**

15 Bethany Reservoir, Patterson Reservoir, and Lake Del Valle are SWP facilities
 16 associated with the South Bay Aqueduct in Alameda County, as described in
 17 Chapter 5, Surface Water Resources and Water Supplies. At Bethany Reservoir,
 18 anglers catch five types of bass (Spotted, White, Largemouth, Smallmouth, and
 19 Striped), crappie, catfish, and trout (CSP 2013). Presumably, many of the same
 20 species would be found in Patterson Reservoir. Lake Del Valle is stocked
 21 regularly with trout and catfish. Largemouth and Smallmouth Bass, Striped Bass,
 22 and panfish are also caught (EBPRD 2014).

23 **9.3.5.5 Los Vaqueros Reservoir**

24 Los Vaqueros Reservoir is a Contra Costa Water District offstream storage
 25 facility in Contra Costa County, as described in Chapter 5, Surface Water
 26 Resources and Water Supplies. Aquatic habitat quality for fish is low to moderate
 27 due to poorly developed cover vegetation along the shoreline. The reservoir has
 28 been stocked with more than 300,000 game fish, primarily Rainbow Trout and
 29 Kokanee Salmon. Other fish introduced to the reservoir include Striped Bass,
 30 Largemouth Bass, sunfish, Brown Bullhead, and Channel Catfish (Reclamation
 31 and CCWD 2011).

32 **9.3.5.6 East Bay Municipal Utility District Reservoirs**

33 The EBMUD reservoirs in Alameda and Contra Costa County used to store water
 34 within and near the EBMUD service area include Briones Reservoir, San Pablo
 35 Reservoir, Lafayette Reservoir, Upper San Leandro Reservoir, and Lake Chabot.
 36 Water stored in these reservoirs includes water from local watersheds, the
 37 Mokelumne River watershed, and CVP water supplies, as described in Chapter 5,
 38 Surface Water Resources and Water Supplies. San Pablo Reservoir is regularly
 39 stocked with trout and catfish (EBMUD 2014). Other species caught in the
 40 reservoir include crappie, Largemouth Bass, Smallmouth Bass, Spotted Bass, and
 41 carp (OEHHA 2009).

1 CDFW annually stocks trout in Lafayette Reservoir. Other species found in the
2 reservoir include Bluegill, black bass, Black Crappie, and several species of
3 catfish (Lafayette Chamber of Commerce 2014).

4 Lake Chabot is stocked with hatchery-raised Rainbow Trout and Channel Catfish
5 by EBRPD and CDFW for recreational fishing. The lake also supports a popular
6 nonnative, warm-water recreational fishery for Largemouth Bass, Bluegill, and
7 Black Crappie. Some native trout escape from the Upper San Leandro Reservoir
8 during spill events and likely end up in Lake Chabot (EBMUD 2013).

9 **9.3.6 Central Coast Region**

10 The Central Coast Region includes portions of San Luis Obispo and Santa
11 Barbara counties served by the SWP. SWP water is delivered to southern Santa
12 Barbara County communities through Cachuma Lake.

13 **9.3.6.1 Cachuma Lake**

14 Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara
15 County. Cachuma Lake provides a variety of habitats for fish species, including
16 deep-water areas, rocky drop-offs, shallow areas, and weed beds (wetland areas).
17 Cachuma Lake and the upper Santa Ynez River are popular fishing areas that
18 have been stocked with game fish by CDFW and the County of Santa Barbara.
19 Native fish species in Cachuma Lake include steelhead/Rainbow Trout, Armored
20 Three-Spine Stickleback, and Prickly Sculpin. Key game fish include
21 Largemouth Bass, Smallmouth Bass, Bluegill, Green Sunfish, Redear Sunfish,
22 Black Crappie, and White Crappie. Other species that have been identified in the
23 lake include Channel Catfish, Black Bullhead, Threadfin Shad, goldfish, carp, and
24 Mosquitofish (Reclamation 2010c).

25 **9.3.7 Southern California Region**

26 The Southern California Region includes portions of Ventura, Los Angeles,
27 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.
28 There are six SWP reservoirs along the main canal, West Branch, and East
29 Branch of the California Aqueduct and many other reservoirs owned and operated
30 by regional and local agencies. The Metropolitan Water District of Southern
31 California's Diamond Valley Lake and Lake Skinner primarily store water from
32 the SWP. Other reservoirs store SWP water, including United Water
33 Conservation District's Lake Piru; City of Escondido's Dixon Lake; City of San
34 Diego's San Vicente Reservoir and Lower Otay Reservoir; Helix Water District's
35 Lake Jennings; and Sweetwater Authority's Sweetwater Reservoir.

36 **9.3.7.1 State Water Project Reservoirs**

37 The SWP reservoirs include Quail Lake, Pyramid Lake, and Castaic Lake in Los
38 Angeles County; Silverwood Lake and Crafton Hills Reservoir in San Bernardino
39 County; and Lake Perris in Riverside County.

1 Although small compared to nearby Pyramid and Castaic lakes, Quail Lake's
 2 290 acres and 3 miles of shoreline offer shoreline fishing. Striped Bass, Channel
 3 Catfish, Blackfish, Tule Perch, Threadfin Shad, and Hitch have been found at
 4 Quail Lake (DWR 1997).

5 Pyramid Lake is located in the Angeles and Los Padres National Forests, about
 6 60 miles northwest of downtown Los Angeles. Largemouth Bass, Smallmouth
 7 Bass, and Striped Bass as well as Bluegill, crappie, Brown Bullhead, Channel
 8 Catfish, and trout are caught by anglers in Pyramid Lake (OEHHA 2013a).
 9 Rainbow Trout, Bluegill, Green Sunfish, Largemouth Bass, catfish, and Prickly
 10 Sculpin are found in Piru Creek below the dam (DWR 2004d).

11 Castaic Lake supports a warm-water fishery for Striped Bass and Largemouth
 12 Bass. Bluegill and assorted minnows provide a forage base for the bass as well as
 13 being caught by anglers. CDFW maintains a Rainbow Trout fishery in Castaic
 14 Lake through stocking (DWR 2007).

15 Silverwood Lake is located in the San Bernardino National Forest and surrounded
 16 by the Silverwood Lake State Recreation Area at the edge of the Mojave Desert
 17 and at the base of the San Bernardino Mountains. Common sport fish caught in
 18 Silverwood Lake include stocked Rainbow Trout, Largemouth Bass, Bluegill,
 19 carp, crappie, catfish, and Striped Bass (CSP 2010, OEHHA 2013b). Other
 20 species found in the lake include blackfish, Brown Bullhead, Tui Chub, and Tule
 21 Perch (OEHHA 2013b).

22 The Crafton Hills Reservoir area includes 4.5 acres of open water and 1.9 acres of
 23 open space. One fish species, Mosquitofish, was observed in the reservoir
 24 (DWR 2009b).

25 Lake Perris is located within the Lake Perris State Recreation Area, which
 26 provides extensive recreational opportunities, as described in Chapter 15,
 27 Recreation Resources. Lake Perris is stocked with Rainbow Trout and managed
 28 as a recreational fishery. Common fish species in the lake include Largemouth
 29 Bass, Channel Catfish, Bluegill, Spotted Bass, Flathead Catfish, Green Sunfish,
 30 Redear Sunfish, and Black Crappie (DWR 2010). Other species found in the lake
 31 include Inland Silversides and Threadfin Shad (DWR 2007).

32 **9.3.7.2 Non-SWP Reservoirs in Riverside County**

33 Diamond Valley Lake and Lake Skinner in Riverside County are offstream
 34 storage facilities owned and operated by Metropolitan Water District of Southern
 35 California. These lakes are major reservoirs used to store SWP water. Diamond
 36 Valley Lake supports Largemouth Bass, Striped Bass, catfish, Redear Sunfish,
 37 Bluegill, and stocked Rainbow Trout (DVM 2014). Fish species found in Lake
 38 Skinner include Striped Bass, Largemouth Bass, carp, and Bluegill. The
 39 Metropolitan Water District also stocks catfish in summer and trout in winter
 40 (Riverside County 2014).

1 **9.3.7.3 Non-SWP Reservoir in Ventura County**

2 Lake Piru, located in Ventura County, is used to store SWP water by United
3 Water Conservation District. Like Pyramid Lake upstream on Piru Creek, sport
4 fish species in Lake Piru include trout, Largemouth Bass, catfish, crappie,
5 Bluegill, and Redear Sunfish (CA Lakes 2014). Other species found there include
6 Bigscale Logperch, Black Bullhead, carp, goldfish, Golden Shiner, Green
7 Sunfish, and Inland Silversides (CalFish 2014).

8 **9.3.7.4 Non-SWP Reservoirs in San Diego County**

9 Reservoirs in San Diego County that are used to store SWP water include the City
10 of Escondido's Dixon Lake; City of San Diego's San Vicente, El Capitan, and
11 Lower Otay reservoirs; Helix Water District's Lake Jennings; and Sweetwater
12 Authority's Sweetwater Reservoir.

13 Dixon Lake is located in the hills above the City of Escondido within the
14 Escondido Multiple Habitat Conservation Plan area (City of Escondido 2012).
15 Fish species found in Dixon Lake include Rainbow Trout, Channel Catfish,
16 Bluegill, Largemouth Bass, Striped Bass, and Black Crappie (SDFish 2014).

17 San Vicente Reservoir has been stocked with various sport fish including sunfish,
18 Largemouth Bass, Black Crappie, catfish, and Rainbow Trout. Other species
19 found in the reservoir include Threadfin Shad and Prickly Sculpin (SDCWA and
20 USACE 2008). El Capitan reservoir is stocked with Largemouth Bass, crappie,
21 Bluegill, Channel Catfish, Blue Catfish, Green Sunfish, and Common Carp (City
22 of San Diego 2014a). Fish species in Lower Otay Reservoir include Largemouth
23 Bass, Bluegill, Black Crappie, White Crappie, Channel Catfish, Blue Catfish,
24 White Catfish, and bullheads (City of San Diego 2014b).

25 Lake Jennings is regularly stocked with trout and Channel Catfish. Other species
26 found in the lake are Bluegill, Largemouth Bass and Blue Catfish (SDFish 2015).

27 Eleven fish species were observed in Sweetwater Reservoir during biological
28 surveys for the wetlands habitat recovery project, all of which were nonnative and
29 typical of southern California warm-water lakes. Species observed include
30 Channel Catfish, Threadfin Shad, Bluegill, and Largemouth Bass (Sweetwater
31 Authority 2013).

32 **9.3.7.5 Non-SWP Reservoir in San Bernardino County**

33 Lake Arrowhead, in San Bernardino County, is used to store SWP water by the
34 Lake Arrowhead Community Services District (County of San Bernardino 2011;
35 LACSD 2014a, 2014b). Lake Arrowhead is a private lake, and its use is restricted
36 to homeowners in a tract of land roughly 1 mile around the perimeter of the lake,
37 known as Arrowhead Woods. Fish species found in the lake include trout,
38 Kokanee Salmon, bass, catfish, crappie, sunfish, and carp.

39 **9.3.7.6 Fish and Aquatic Resources During Drought**

40 California is contending with its fourth consecutive year of drought where
41 significant shortages in water supplies have profoundly influenced water use in
42 the state, including environmental uses. The reduced water availability has

1 depleted reservoir storage and the ability for operations to provide flow levels
2 needed to support fish habitat within the river systems. In addition, the limited
3 cold water held in CVP and SWP reservoirs has impaired the ability to manage
4 water temperatures downstream. Similarly, the reduced flows in the Delta have
5 resulted in shifts in salinity and water quality that influence the availability and
6 quality of habitat for pelagic fishes as well as the factors that influence
7 entrainment. As a consequence, the reduction in runoff and available water has
8 likely compromised an already stressed aquatic ecosystem and may have further
9 imperiled species that are threatened with or in danger of extinction.

10 As described in the sections above, many fish populations have been in decline
11 over the last several years. There are undoubtedly multiple factors influencing
12 this decline; however, the recent drought and actions taken to address the drought
13 are clearly contributors. In the recent conditional approval by the SWRCB of
14 Reclamation's Temporary Urgency Change Petition (SWRCB 2015), the SWRCB
15 summarized the effects of the recent drought conditions on aquatic resources
16 based on a biological review conducted for the purposes of consultation with
17 NMFS and USFWS. The summaries from that document (SWRCB 2015) for
18 several key species are paraphrased below.

19 The population of winter-run Chinook salmon is currently at extreme risk. In
20 2014, due to a lack of ability to regulate water temperatures in September and
21 October, high water temperatures in the Sacramento River reduced early life stage
22 survival from Keswick to Red Bluff from a recent average of approximately
23 27 percent down to 5 percent in 2014. Consequently, 95 percent of the year class
24 of wild winter-run Chinook was lost last year (Reclamation and DWR 2015).
25 Temperature management was difficult again in 2015, which reduces this
26 population's ability to withstand environmental perturbations, especially during a
27 prolonged drought when each of the existing brood years has been already
28 negatively affected by drought conditions.

29 The 2014 spawning run of spring-run Chinook Salmon returning to the upper
30 Sacramento River system also experienced significant impacts due to drought
31 conditions as well as elevated temperatures on the Sacramento River and other
32 tributaries. Similar to winter-run, spring-run Chinook Salmon eggs in the
33 Sacramento River experienced significant and potentially complete mortality
34 starting in early September 2014 due to high water temperatures downstream of
35 Keswick. Extremely few juvenile spring-run Chinook Salmon were observed
36 migrating downstream of the Sacramento River during high winter flows in 2015,
37 when spring-run originating from the upper Sacramento River, Clear Creek, and
38 other northern tributaries are typically observed, indicating that the population
39 was significantly impacted. Similar concerns for spring-run Chinook Salmon exist
40 this year as for winter-run. While spring-run have greater distribution and inhabit
41 locations in addition to the Sacramento River, conditions on those streams are
42 also expected to be poor due to the drought.

43 Steelhead have also likely been affected by the drought, but given the difficulty in
44 sampling for these fish it is difficult to determine exactly how the species have
45 been affected. Adult steelhead abundance is not estimated in the mainstem

1 Sacramento River or any waterways of the Central Valley. The drought conditions
2 are causing increased stress to steelhead populations (with or without water
3 project operations) from low flows causing reduced rearing and migratory habitat,
4 increased water temperatures affecting survival, and likely higher than normal
5 juvenile predation.

6 The effects of the drought are also reflected in Delta species. For example, recent
7 population indices for Delta Smelt are at record low numbers. This is of
8 particular concern given that most Delta Smelt do not survive to spawn more than
9 one season and are thus for the most part an annual species. The fifth Spring
10 Kodiak Trawl survey conducted the week of May 4, 2015, identified 4 adults in
11 the Sacramento Deep Water Ship Channel, and one in Cache Slough. The fourth
12 Spring Kodiak Trawl survey, conducted during the week of April 6, 2015,
13 identified one adult, which was a record low for that survey (Smelt Working
14 Group (SWG); 4 May 13 notes). According to the SWG, it appears fish density
15 has become so low that the Spring Kodiak Trawl has reached or gone below its
16 minimum effective detection ability (SWG; April 13 Notes). Additionally, in the
17 final week (March 30) of supplemental USFWS sampling in the lower San
18 Joaquin River, catch of adult Delta Smelt declined precipitously to zero in the
19 final month of sampling.

20 In response to the drought and its adverse effects on aquatic resources,
21 Reclamation is currently conditionally operating under the terms of a temporary
22 urgency change petition that allows temporary changes to license and permit
23 requirements imposed pursuant to SWRCB D-1641 to meet flow-dependent and
24 water quality objectives to protect fish and wildlife beneficial uses. In
25 compliance with the provisions of the BOs, Reclamation and the SWRCB have
26 received concurrence on the changes from USFWS and NMFS (USFWS 2015,
27 NMFS 2015).⁴

28 **9.4 Impact Analysis**

29 This section describes the potential mechanisms and analytical methods; results of
30 the impact analyses; potential mitigation measures; and cumulative effects.

31 **9.4.1 Potential Mechanisms and Analytical Methods**

32 The impact analysis considers changes in the ecological attributes that affect fish
33 and aquatic resources related to changes in CVP and SWP operations under the
34 alternatives as compared to the No Action Alternative and the Second Basis of
35 Comparison.

⁴ Additional information regarding CVP and SWP operations under a TUC Order issued on July 3, 2015, by the State Water Resources Control Board is provided at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp_order070315.pdf.

1 **9.4.1.1 CVP and SWP Reservoirs**

2 Changes in CVP and SWP operations under the alternatives could result in
3 changes in reservoir storage volumes, elevations, and water temperatures in the
4 primary water supply reservoirs (i.e., Trinity Lake, Shasta Lake, Lake Oroville,
5 Folsom Lake, New Melones Lake, and San Luis Reservoir). Variation in
6 reservoir storage, elevation, and temperature is a function of water demand, water
7 quality requirements, and inflow; these attributes also change based on the
8 water-year type.

9 The downstream reservoirs (i.e., Lewiston Lake, Keswick Reservoir, Thermalito
10 Forebay and Afterbay, Lake Natoma, and Tulloch Reservoir) are operated to
11 maintain relatively stable water elevations. These types of operations would
12 result in similar conditions in the No Action Alternative, Alternatives 1 through 5,
13 and the Second Basis of Comparison. Therefore, changes at these reservoirs are
14 not evaluated in this EIS.

15 **9.4.1.1.1 Changes in CVP and SWP Reservoir Storage Volume**

16 To evaluate changes in operation, changes in reservoir storage and elevation were
17 estimated based upon modeled monthly average storage and reservoir elevation
18 output from CalSim II for the entire 82-year period under the operations defined
19 for each alternative, as described in Appendix 5A, CalSim II and DSM2
20 Modeling. The output of CalSim II served as input to the quantitative procedures
21 described below for evaluation of changes in fish habitat and bass nesting success
22 in CVP and SWP reservoirs.

23 The effects analysis in Chapter 5, Surface Water Resources and Water Supplies,
24 includes a summary of the monthly storage in each major upstream reservoir in
25 combination with a frequency of exceedance analysis for each month. Reservoir
26 storage values are characterized based on results of CalSim II hydrologic
27 modeling and presented as average monthly storage by water year type. Although
28 aquatic habitat within the CVP and SWP water supply reservoirs is not thought to
29 be limiting, storage volume is used as an indicator of how much habitat is
30 available to fish species inhabiting these reservoirs.

31 **9.4.1.1.2 Changes in CVP and SWP Reservoir Elevation**

32 Seasonal temperature stratification is a dominant feature of these reservoirs.
33 There are relatively distinct fish assemblages within the upper (warm water) and
34 lower (cold water) habitat zones, with different feeding and reproductive
35 behaviors. Flood control, water storage, and water delivery operations typically
36 result in declining water elevations during the summer through the fall months,
37 rising or stable elevations during the winter months, and rising elevations during
38 the spring months, while storing precipitation and snowmelt runoff. During
39 summer months, the relatively warm surface layer favors warm water fishes such
40 as bass and catfish. Deeper layers are cooler and are suitable for cold water
41 species. Drawdown of reservoir storage from June through October can diminish
42 the volume of cold water, thereby reducing the amount of habitat for cold water
43 fish species within these reservoirs during these months.

1 Reservoir storage and surface water elevations in the reservoirs from the
2 CalSim II model were used to analyze potential effects on reservoir fishes. Water
3 surface elevation in each reservoir was calculated from storage values and is
4 presented as average end-of-month elevation by water year type.

5 Warm water fish species that inhabit the upper layer of these reservoirs may be
6 affected by fluctuations in storage through changes in reservoir water surface
7 elevations (WSELs). Stable or increasing WSEL during spring months (March
8 through June) can contribute to increased reproductive success, young-of-the-year
9 production, and juvenile growth rate of several warm water species, including the
10 black basses. Conversely, reduced or variable WSEL due to reservoir drawdown
11 during spring spawning months can cause reduced spawning success for warm
12 water fishes through nest dewatering, egg desiccation, and physical disruption of
13 spawning or nest guarding behaviors. Increases in WSEL are not thought to result
14 in adverse effects on these species unless there is a corresponding decrease in
15 water temperatures that can result in nest abandonment.

16 A conceptual approach was used to evaluate the effects of water surface elevation
17 fluctuations on bass nests, based upon a relationship between black bass nest
18 success and water surface elevation reductions developed by CDFW (Lee 1999)
19 from research conducted on five California reservoirs. Lee (1999) examined the
20 relationship between water surface elevation fluctuation rates and nesting success
21 for black bass, and developed nest survival curves for Largemouth, Smallmouth,
22 and Spotted bass. The equations corresponding to the curves are the following:

23 Largemouth Bass $Y = -56.378 \cdot \ln(X) - 102.59$

24 Smallmouth Bass $Y = -46.466 \cdot \ln(X) - 83.34$

25 Spotted Bass $Y = -79.095 \cdot \ln(X) - 94.162$

26 Where: X is the fluctuation rate (m/day) and Y is the percentage of successful
27 nests.

28 Based on the work by Lee (1999), the maximum receding water level rate
29 providing 100 percent successful nesting varied among species, with receding
30 water level rates of <0.02, <0.01, and <0.065 meters per day providing successful
31 nesting of 100 percent of the Largemouth, Smallmouth, and Spotted bass nests,
32 respectively. For this analysis, water surface elevations at the end of each month
33 from the CalSim II model were used to calculate the monthly fluctuation rates,
34 and derive the daily fluctuation rates used to compute the percentage of successful
35 nests using the equations from Lee (1999).

36 CalSim II reports end-of-month (EOM) water surface elevations; therefore, water
37 surface elevations from February to June were used in this analysis (i.e., March
38 fluctuation rate = March EOM elevation – February EOM elevation). It was
39 further assumed that the monthly change in elevation divided by the number of
40 days in that month reflected the average daily fluctuation rate that was used as
41 “X” in the above equations to compute the percentage of successful nests during
42 that month. The percentages of successful bass nests were computed based on the

1 equations from Lee (1999) for each month of the potential spawning season for
2 these species.

3 Review of the available literature suggests that bass nest failure is highly variable
4 between water bodies and between years but it is not uncommon to have up to
5 40 percent of bass nests fail (approximately 60 percent survival) (Scott and
6 Crossman 1973). Many self-sustaining black bass populations in North America
7 experience a nest success (i.e., the nest produces swim-up fry) rate of 21 to
8 96 percent, with many reporting survival rates in the 40 to 60 percent range
9 (Forbes 1981; Hunt and Annett 2002; Steinhart 2004). This would suggest that
10 much less than 100 percent survival is required to have a self-sustaining
11 population. Based on the literature review, bass nest survival probability in
12 excess of 40 percent is assumed to be sufficient to provide for a self-sustaining
13 bass fishery. For this analysis, differences between alternatives were evaluated
14 using the exceedance probability corresponding to the 40 percent level of survival
15 based on the probability of exceedance over the 82-year CalSim II modeling time
16 period.

17 **9.4.1.2 Rivers**

18 By altering reservoir storage and releases, changes in CVP and SWP operations
19 under the alternatives would change flow and temperature regimes in downstream
20 waterways. In turn, these alterations could affect fishery resources and important
21 ecological processes on which the fish community depends.

22 **9.4.1.2.1 Changes in Flows**

23 Changes in flows, in and of themselves, do not constitute an effect on aquatic
24 resources. However, changes in flow can affect the quantity and quality of
25 aquatic habitats in rivers and have direct effects on fish species through stranding
26 or dewatering events that occur when flows are reduced. In addition, changes in
27 flows can result in a reduction in ecologically important geomorphic processes
28 resulting from reduced frequency and magnitude of intermediate to high flows.

29 Changes in flow also can influence the frequency and duration of inundated
30 floodplains (e.g., Yolo Bypass) that support salmonid rearing and conditions for
31 other native fish species. With implementation of the physical actions under
32 NMFS RPA Action I.6.1, the inundation regime in the Yolo Bypass will be
33 modified and managed to better coincide with the presence of juvenile salmonids
34 and with a greater frequency. While this action is included in every alternative,
35 changes in flows in the Sacramento River at the Freemont Weir associated with
36 the various alternatives could result in slight differences in the flows entering the
37 bypass and changes in the amount of habitat available to rearing salmonids and
38 other native fish species.

39 The effects analysis in Chapter 5, Surface Water Resources and Water Supplies,
40 includes a summary of the monthly flows at various points downstream of the
41 reservoirs in each major stream affected by project operations. Instream flows are
42 characterized based on results of CalSim II hydrologic modeling and presented as
43 both average monthly flows by month and water year type and monthly frequency

1 of exceedance plots to allow examination of the entire range of simulation results
2 for each of the alternatives as a means of evaluating differences among
3 alternatives. Because the CalSim II model uses a monthly time step, it was
4 determined that incremental changes of 5 percent or less were related to the
5 uncertainties in the model processing. Therefore, flow changes of 5 percent or
6 less are considered to be not substantially different, or “similar” in this
7 comparative analysis.

8 To compare the operational flow regime and evaluate the potential effects on
9 habitat for anadromous species inhabiting streams, it was necessary to determine
10 the relationships between streamflow and habitat availability for each life stage of
11 these species in the rivers in which flows may be altered by CVP and SWP
12 operations.

13 A number of studies have been conducted using the models and techniques
14 contained within the Instream Flow Incremental Methodology (IFIM) to establish
15 these relationships in streams within the study area. The analytic variable
16 provided by the IFIM is total habitat, in units of Weighted Useable Area (WUA),
17 for each life stage (fry, juvenile and spawning) of each evaluation species (or race
18 as applied to Chinook Salmon). Habitat (WUA) incorporates both macro- and
19 microhabitat features. Macrohabitat features include changes in flow, and
20 microhabitat features include the hydraulic and structural conditions (depth,
21 velocity, substrate or cover) affected by flow which define the actual living space
22 of the organisms. The total habitat available to a species/life stage at any
23 streamflow is the area of overlap between available microhabitat and
24 macrohabitat conditions. Because the combination of depths, velocities, and
25 substrates preferred by species and life stages varies, WUA values at a given flow
26 differ substantially for the species and life stages evaluated.

27 WUA-flow relationships were available only for some rivers for which simulated
28 flows were available. Therefore, flow dependent habitat availability was
29 evaluated quantitatively only for Clear Creek and the Sacramento, Feather, and
30 American rivers, and was not reported for other rivers evaluated in this Draft EIS.
31 Tables of the spawning habitat-discharge relationships used in the calculations of
32 spawning WUA for these rivers are provided in Appendix 9E, Weighted Useable
33 Area Analysis. Because the WUA-flow relationships developed by the most
34 recent IFIM studies present WUA values within particular flow ranges at
35 particular variable steps, it was often the case that the monthly flow for a
36 particular reach fell between two flows for which there were WUA values. In
37 these cases, the value was determined by linear interpolation between the
38 available WUA values for the flows immediately below and above the target
39 flow. When the target flow was lower than the lowermost flow for which a WUA
40 value exists, the corresponding WUA value was determined by linear
41 interpolation between a flow of zero and the lowermost flow for which a WUA
42 value exists. When the target flow was higher than the highest flow for which a
43 WUA value exists, the corresponding WUA value was determined by assuming
44 the WUA value for the highest flow.

1 WUA values are calculated and presented only on a monthly time-step, and not as
2 seasonal or annual values. WUA values based on the monthly CalSim II flows
3 were prepared for detailed evaluation of the alternatives. Monthly WUA values
4 are presented as the average total WUA in each river segment, for the entire
5 82-year simulation period and the average total WUA in each of five water year
6 types for each alternative. Differences between the alternatives and the two bases
7 of comparison (No Action Alternative and Second Basis of Comparison) are used
8 to identify the effects of each alternative on habitat availability (WUA) for each
9 species and life stage in each river. These comparisons were made only for the
10 months in which the species and life stage are anticipated to be present in each
11 river/reach based on the life history timing presented in Appendix 9B.

12 The ability to estimate sub-monthly WUA values is limited due to the monthly
13 time-step of the CalSim II results. The monthly time-step is most limiting during
14 the fall through spring seasons in areas downstream of tributaries, when flows can
15 vary significantly on a daily basis due to hydrologic conditions. Hydrologic
16 variability in the runoff and tributary flows cause significant variability of flows
17 in the areas of interest for the WUA computations. During the periods of low
18 flows, regulated flows from reservoir releases dampen the impact of daily
19 variability of flows on WUA estimates. Because the WUA analysis uses output
20 from the monthly time step CalSim II model, it was determined that incremental
21 changes of 5 percent or less were related to the uncertainties in the model
22 processing. Therefore, changes in WUA values of 5 percent or less are
23 considered to be not substantially different, or “similar” in this comparative
24 analysis.

25 **9.4.1.2.2 Changes in Water Temperatures**

26 Water temperatures in the rivers and streams downstream of the CVP and SWP
27 reservoirs are influenced by factors such as reservoir cold water pool, elevation of
28 reservoir release outlets, and seasonal atmospheric conditions. The level of water
29 storage in a reservoir has a strong effect on the volume of cold water (cold water
30 pool) in the reservoir and, in combination with the elevation of reservoir release
31 outlets, the temperature of water released downstream. Storage levels are often
32 lowest in the late summer and early fall, resulting in warmer waters released from
33 the reservoir. During this time of year, ambient air temperatures contribute
34 substantially to warming instream flows downstream of reservoirs. The summer
35 and early fall are the times of year when river temperatures are most likely to rise
36 above tolerance thresholds for steelhead and salmon.

37 The analysis of the effects of water temperature changes on fish was conducted
38 using two approaches: 1) a comparison of average monthly water temperatures
39 between the alternatives and the two bases of comparison (No Action
40 Alternative and Second Basis), and 2) a comparison of average monthly water
41 temperatures to established temperature objectives intended to be protective of
42 fish. In addition, Reclamation’s salmon mortality model was applied in certain
43 water bodies to examine the effects of temperature on salmon spawning and
44 incubation. These approaches are described below.

1 *Comparison of Average Monthly Water Temperatures between Alternatives*

2 The analysis uses average water monthly temperatures to provide a comparison of
3 the ability of operations considered under alternatives to meet water temperature
4 objectives for various species. As described in Appendix 5A, Section 5A.A.3.6,
5 water temperature modeling is subsequent to CalSim II modeling that simulates
6 operations on a monthly basis; there are certain components in the temperature
7 models that are downscaled to a daily time step (simulated or approximated
8 hydrology). The results of those daily conditions are averaged to a monthly
9 time step.

10 The effects analysis in Chapter 6, Surface Water Quality, includes a summary of
11 the average monthly water temperature in each major stream downstream of CVP
12 and SWP reservoirs in combination with a frequency of temperature exceedance
13 analysis (see below) for each month. Water temperatures at various locations in
14 each river were compared to determine whether mean monthly temperatures by
15 water-year type were different between the alternatives and the two bases of
16 comparison (No Action Alternative and Second Basis). Because the temperature
17 models use inputs from the monthly-time-step CalSim II model, effects of real-
18 time daily temperature management cannot be captured, even though the
19 temperature models are capable of simulating on a sub-monthly timestep.
20 Therefore, the analysis is based on monthly average temperature results. For this
21 monthly analysis that uses two cascading models, it was determined that
22 incremental changes of 0.5°F or less in mean monthly water temperatures would
23 be within the model uncertainty. Therefore, changes of 0.5°F or less are
24 considered to be not substantially different, or “similar” in this comparative
25 analysis.

26 *Comparison to Established Water Temperature Thresholds*

27 The average monthly water temperature output from CalSim II does not allow a
28 direct comparison to the temperature objectives identified in Table 9.3, and the
29 effects of daily (or hourly) temperature swings are likely masked by the averaging
30 process. Nonetheless, the average monthly water temperatures provide the basis
31 for a coarse evaluation of the likelihood that temperature objectives (Table 9.3)
32 would be exceeded. These objectives are used as thresholds in the temperature
33 exceedance analysis where the frequency of exceedance (percent of years) is
34 calculated over the 82-year CalSim II modeling period (Appendix 9N). Because
35 average monthly water temperatures likely mask daily temperatures that could
36 exceed important thresholds, any difference in the frequency of threshold
37 exceedance was considered important and could be indicative of a biological
38 effect on the species/life stage for which the objective was established. While
39 likely effects from temperature on early life stages occur at a shorter temporal
40 scale than can be captured in these models, comparative analyses are useful for
41 looking at long term impacts over numerous water years and types.

1 **Table 9.3 Water Temperature Objectives**

Compliance Location	Year Types	Dates	Temperature Objective (°F)	Purpose
Trinity River				
Lewiston Dam Release	All Year Types	July–Sep	< 60	Spring-run Chinook Salmon holding
		Sep	< 56	Spring-run Chinook Salmon spawning
Lewiston Dam Release	All Year Types	Oct–Dec	< 56	Chinook Salmon, Coho Salmon, and steelhead spawning
Clear Creek				
Igo W	All Year Types	June–Sep 15	60	Spring-run Chinook Salmon holding and rearing
		Sep 15-Oct	56	Spring-run and fall-run Chinook Salmon spawning and egg incubation
Sacramento River				
Keswick Release	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
Balls Ferry	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
Bend Bridge	All Year Types	May–Sep	56	Winter- and spring-run Chinook Salmon spawning and egg incubation
			63	Green sturgeon spawning, incubation, and rearing
Red Bluff	All Year Types	Oct–Apr	56	Spring-, fall-, and late fall–run Chinook Salmon spawning and egg incubation
Hamilton City	All Year Types	Mar–Jun	61 (optimal), 68 (lethal)	White Sturgeon spawning and egg incubation
Feather River				
Robinson Riffle	All Year Types	Sep–Apr	56	Spring-run Chinook Salmon and steelhead spawning and incubation
		May–Aug	63	Spring-run Chinook Salmon and steelhead rearing

Compliance Location	Year Types	Dates	Temperature Objective (°F)	Purpose
Gridley Bridge	All Year Types	Oct–Apr	56	Fall- and late fall–run Chinook Salmon spawning and steelhead rearing
		May–Sep	64	Green sturgeon spawning, incubation, and rearing
American River				
Watt Avenue Bridge	All Year Types	May–Oct	65	Juvenile steelhead rearing
Stanislaus River				
Orange Blossom Bridge	All Year Types	Oct–Dec	56	Adult steelhead migration
		Jan– May	57	Steelhead smoltification
		Jan-May	55	Steelhead spawning and incubation
		Jun-Sep	65	Juvenile steelhead rearing
Knights Ferry	All Year Types	Jan-May	52	Steelhead smoltification

1 *Changes in Egg Mortality*

2 Water temperatures also affect the survival of various life stages of the focal
3 species. Reclamation’s salmon mortality model (Appendix 9C, Reclamation
4 Salmon Mortality Model Analysis Documentation) was used to estimate water
5 temperature induced mortality in the early life stages (pre-spawned eggs,
6 fertilized eggs, and pre-emergent fry) of salmonids in five rivers: Trinity,
7 Sacramento, Feather, American, and Stanislaus, based on output from the
8 temperature models. The salmon mortality model is limited to temperature effects
9 on early life stages of Chinook Salmon. It does not evaluate potential direct or
10 indirect temperature impacts on later life stages, such as emergent fry, smolts,
11 juvenile out-migrants, or adults. Also, it does not consider other factors that may
12 affect salmon mortality, such as in-stream flows, gravel sedimentation, diversion
13 structures, predation, and ocean harvest. Differences between alternatives are
14 assessed based on changes in the percent egg mortality by river over the entire
15 82-year CalSim II simulation period and by water year type (based on 40-30-30
16 indexing). Because the salmon mortality model uses output from the temperature
17 models that are downscaled from the monthly time step CalSim II model, it was
18 determined that incremental changes in egg mortality of 5 percent or less were
19 related to the uncertainties in the model processing. Therefore, changes in egg

1 mortality of 5 percent or less are considered to be not substantially different, or
2 “similar” in this comparative analysis.

3 **9.4.1.3 Delta**

4 Changes in CVP and SWP operations under the alternatives would affect Delta
5 conditions primarily through changes in volume and timing of upstream storage
6 releases and diversions, Delta exports and diversions, and DCC operations.
7 Environmental conditions such as water temperature, predation, food production
8 and availability, competition with introduced exotic fish and invertebrate species,
9 and pollutant concentrations all contribute to interactive, cumulative conditions
10 that have substantial effects on aquatic resources in the Delta.

11 **9.4.1.3.1 Changes in Volume and Timing of Flows through the Delta**

12 Operations of the CVP DCC and intake facilities owned by the CVP, SWP, local
13 agencies, and private parties affect Delta hydrologic flow regimes. The largest
14 effects of flow management in the Delta related to aquatic resources are the
15 modification of winter and spring inflows and outflows of the Delta, and the
16 introduction of net cross-Delta and net reverse flows in some Delta channels that
17 can alter fish movement patterns. Seasonal flows play an especially important
18 role in determining the reproductive success and survival of many estuarine
19 species including salmon, Striped Bass, American Shad, Delta Smelt, Longfin
20 Smelt, and Sacramento Splittail. In addition, changes in Delta outflow influence
21 the abundance and distribution of fish and invertebrates in the bay through
22 changes in salinity, currents, nutrient levels, and pollutant concentrations. Altered
23 flows through the Delta as a result of changes in CVP and SWP operations affect
24 water residence time, an important physical property that can influence the ability
25 of phytoplankton biomass to build up over time, with implications for higher
26 trophic level consumers such as fish.

27 **9.4.1.3.2 Changes in Water Quality**

28 Changes in water quality due to CVP and SWP operations under the alternatives
29 would affect aquatic resources in the Delta primarily through changes in water
30 temperatures, salinity, nutrient levels, pollutant concentrations and turbidity.
31 Changes in CVP and SWP operations can increase Delta water temperatures by
32 warmer reservoir releases and to a lesser extent, by reducing quantities of
33 freshwater inflow and by modifying tidal and ground water hydraulics. Changes
34 in CVP and SWP operations also can affect the location of the low salinity zone
35 (position of X2), especially during periods of low inflows and high water exports
36 (i.e., low outflow conditions) in drier water years. Nutrients, essential
37 components of terrestrial and aquatic environments because they provide a
38 resource base for primary producers, and pollutants such as selenium and mercury
39 could be affected by changes in CVP and SWP operations. Turbidity is an
40 important water quality component in the Delta that could be affected by changes
41 in operation. Changes in turbidity affect food web dynamics through attenuation
42 of light in the water column and altering predation success.

1 The DSM2, a one-dimensional hydrodynamic and water quality simulation
2 model, is used to evaluate changes in salinity (as represented by EC) in the Delta
3 and at the CVP/SWP export locations. CalSim II outputs are used to evaluate
4 changes in location of X2 in the Delta. A more detailed overview of the DSM2
5 model and input assumptions is presented in Appendix 5A, CalSim II and DSM2
6 Modeling.

7 The Delta boundary flows and exports from CalSim II are used as input to the
8 DSM2 Delta hydrodynamic and water quality models to estimate tidally-based
9 flows, stage, velocity, and salt transport within the estuary. Because CalSim II
10 operations are simulated on a monthly basis, the DSM2 model would not be able
11 to capture daily operations and therefore the DSM2 outputs are presented on a
12 monthly basis, as described in Appendix 5A, CalSim II and DSM2 Modeling.

13 DSM2 HYDRO outputs are used to predict changes in flow rates and depths. The
14 QUAL module of DSM2 simulates fate and transport of conservative and non-
15 conservative water quality constituents, including salts, given a flow field
16 simulated by HYDRO. Chloride and bromide concentrations are estimated using
17 relationships based on DSM2 EC results, as described in Appendix 6E, Analysis
18 of Delta Salinity Indicators.

19 The CalSim II outputs described above that estimate the position X2 were used
20 along with temperature to generally assess effects on Striped Bass and American
21 Shad. Kimmerer (2002) noted that Striped Bass survival is negatively correlated
22 with April – June X2 values, although the analysis was inconclusive on the
23 mechanisms contributing to this relationship. Kimmerer (2009) noted that Delta
24 Smelt and Striped Bass had more negative slopes in the habitat-X2 relationship
25 for surveys conducted in spring to early summer months than other surveys. They
26 also noted that the slopes for abundance-X2 and habitat-X2 were similar for
27 American Shad and for Striped Bass, and that the habitat relationships to X2
28 appeared consistent with their relationships of abundance (or survival) to X2.
29 Thus, Kimmerer et al. (2009) contended that this similarity provides some support
30 for the notion that increasing habitat quantity as defined by salinity could be one
31 mechanism to explain the X2 relationship for these species. Based on this
32 relationship, the position of X2 was used as general indicator of habitat for
33 Striped Bass and American Shad. Alternatives that resulted in a more westerly
34 position of X2 relative to the bases of comparison were considered to have less
35 potential for adverse effect, whereas those with a more easterly position would
36 have a greater potential for adverse effect.

37 **9.4.1.3.3 Changes in Fish Entrainment**

38 Changes in CVP and SWP operations can affect through-Delta survival of
39 migratory (e.g., salmonids) and resident (e.g., Delta and Longfin smelt) fish
40 species through changes in the level of entrainment at CVP and SWP export
41 pumping facilities. The south Delta CVP and SWP facilities are the largest water
42 diversions in the Delta and in the past, have entrained large numbers of Delta fish
43 species. Tides, salinity, turbidity, in-flow, meteorological conditions, season,
44 habitat conditions, and project exports all have the potential to influence fish

1 movement, currents, and ultimately the level of entrainment and fish passage
2 success and survival. Entrainment risk for fish also tends to increase with
3 increased reverse flows in Old and Middle rivers.

4 The potential for entrainment of salmonids migrating through the Delta was
5 analyzed using predicted monthly salvage of salmonids from January through
6 June using statistical relationships reported in Zeug and Cavallo (2014). In that
7 analysis, salvage at the State Water Project and Central Valley Project was
8 modeled as a function of physical, biological and hydrologic variables (see
9 Appendix 9M for additional detail).

10 Results of the analysis are presented in box-whisker plots showing the median,
11 central 50 percent probability, and range of simulated data. The comparison
12 between alternatives relied on interpretation of these plots to distinguish
13 differences in the median values as follows: (1) when the medians are nearly
14 identical or the central 50 percent probabilities (i.e., the boxes) overlap
15 completely, the medians were considered “similar;” (2) when the medians and
16 box were offset, but the median values were within the range represented by the
17 contrasting alternative’s box, the medians were considered “slightly” different;
18 (3) when the median of one alternative was outside of the contrasting alternative’s
19 box, but the boxes overlapped, the alternatives were considered “moderately”
20 different; and (4) when the median of one alternative was outside of the
21 contrasting alternative’s box, and the boxes did not overlap, the medians were
22 considered “substantially” different.

23 In evaluating the potential for entrainment of Delta Smelt, as influenced by OMR
24 flows under the alternatives, the USFWS (2008) regression model based on
25 Kimmerer (2008) was used to estimate potential entrainment of Delta Smelt. The
26 equation developed by Kimmerer (2008) is based on the average December
27 through March OMR flow (in units of cfs) as predicted by the CalSim II model,
28 and yields the percentage of adult Delta Smelt that may become entrained in the
29 pumps. Further review by Kimmerer (2011) determined that the above equation
30 has an upward bias, such that the results were reduced by 24 percent to correct
31 this bias. In the event that a negative entrainment percentage was calculated, the
32 result was changed to zero.

33 Changes in CVP and SWP operations under the alternatives could also change
34 entrainment of larvae and early juvenile Delta Smelt. Larvae and early juvenile
35 Delta Smelt are most prevalent in the Delta in the spring months of March
36 through June. The USFWS (2008) regression model based on Kimmerer (2008)
37 was used to calculate the percentage entrainment of larval and early juvenile Delta
38 Smelt in Banks and Jones Pumping Plants. This regression is dependent on two
39 variables: March through June average OMR flow (in cfs) and March through
40 June average X2 position (in km). OMR and X2 values predicted by the
41 CalSim II model for each alternative were used in estimating the entrainment loss.
42 In the event that a negative entrainment percentage was calculated, the result was
43 changed to zero.

1 In this study, the percent entrainment values estimated for Delta Smelt are used as
2 a tool to compare the alternatives, as one of the factors that would indicate
3 conditions that might benefit or contribute to adverse effects on Delta Smelt.
4 Because the regression analysis uses flow output from the monthly time step
5 CalSim II model and the confidence intervals on the regression parameters are
6 somewhat broad, it was determined that incremental changes in entrainment
7 estimates of 5 percent or less were within the model uncertainty. Therefore,
8 changes in entrainment of less than 5 percent are considered to be not
9 substantially different, or “similar” in this comparative analysis. One limitation
10 of this approach is that it does not reflect the benefit that some of the alternatives
11 might realize through adaptive management of OMR flows to further reduce
12 potential entrainment, based on input from the Smelt Working Group.

13 **9.4.1.3.4 Changes in Fish Passage and Routing**

14 Changes in CVP and SWP operations can affect through-Delta survival of
15 migratory (e.g., salmonids) and resident (e.g., Delta and Longfin smelt) fish
16 species through changes in passage conditions and routing. For example, changes
17 in operation of the DCC affects the volume of water diverted into the Mokelumne
18 River distributary channels toward the central and south Delta. Operation of the
19 south Delta intake facilities, including facilities owned by the CVP and SWP and
20 Contra Costa Water District, contribute to reverse flow conditions in Old and
21 Middle rivers.

22 Changes in salmonid passage and routing were evaluated using the Delta Passage
23 Model (DPM) and an analysis of Delta hydrodynamics and junction entrainment,
24 as described below. The DPM is based on a detailed accounting of migratory
25 pathways and reach-specific mortality as Chinook salmon smolts travel through a
26 simplified network of reaches and junctions (see Appendix 9J for additional
27 detail). Model output is expressed as through Delta survival of salmon smolts.

28 The key assumption in the Delta Hydrodynamic analysis is that the proportion of
29 positive velocities in a channel, measured at a monthly time step, is an indicator
30 of the likelihood that juvenile anadromous fish will successfully migrate through
31 that channel towards the ocean (see Appendix 9K for additional detail). The
32 analysis of junction entrainment used a regression based on predicted entrainment
33 into a distributary and the proportion of flow into the distributary to predict the
34 daily probability of fish entrainment (see Appendix 9L for additional detail).

35 Results of the Delta hydrodynamics and junction entrainment analysis are
36 presented in box-whisker plots showing the median, central 50 percent
37 probability, and range of simulated data. The comparison between alternatives
38 relied on interpretation of these plots to distinguish differences in the median
39 values as described above for changes in fish entrainment.

40 **9.4.1.3.5 Changes in Delta Smelt Habitat (X2 Location)**

41 Changes in CVP and SWP operations under the alternatives could change the
42 location of Fall X2 position (in September through December) as an indicator of
43 available habitat for Delta Smelt. Feyrer et al. (2010) used X2 location as an

1 indicator of the extent of habitat available with suitable salinity and water
 2 transparency for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010)
 3 concluded that when X2 is located downstream (west) of the confluence of the
 4 Sacramento and San Joaquin Rivers, at a distance of 70 to 80 km from the Golden
 5 Gate Bridge, there is a larger area of suitable habitat. The overlap of the low
 6 salinity zone (or X2) with the Suisun Bay/Marsh results in a two-fold increase in
 7 the habitat index (Feyrer et al 2010); however others (see Manly et al. 2015) have
 8 questioned the use of outflow and X2 location as an indicator of Delta Smelt
 9 habitat because other factors may be influencing survival.

10 To evaluate fall abiotic habitat availability for Delta Smelt under the alternatives,
 11 X2 values (in km) simulated in the CalSim II model for each alternative were
 12 averaged over September to December, and compared for differences. There are
 13 uncertainties and limitations associated with this approach, e.g., it does not
 14 evaluate other factors that influence the quality or quantity of habitat available for
 15 Delta Smelt (e.g., turbidity, temperature, food availability), nor does it take into
 16 account the relative abundance of Delta Smelt that might benefit from the
 17 available habitat in the simulated X2 areas, in any given year. Other scientists
 18 have developed and described life cycle models to evaluate Delta Smelt
 19 population responses to changes in flow-related variables (e.g., Maunder and
 20 Deriso 2011; Rose et al. 2013 a, b), but these life cycle modeling approaches were
 21 not selected for use in the current study. The life cycle model developed by Rose
 22 et al. (2013a, b) could not be used in this analysis because it uses a wide array of
 23 daily data, many of the assumptions and parameter values were based on
 24 judgment, and the model was not designed for forecasting future Delta Smelt
 25 population abundances. The model was designed mostly for exploring hypothesis
 26 about factors affecting Delta smelt populations dynamics, which is not suitable for
 27 a comparative analysis of operational scenarios under the alternatives. Moreover,
 28 Reed et al. (2014) noted that *“To date, these models have not been fully vetted and*
 29 *evaluated sufficiently to be used for direct management applications.”* In this
 30 study, simulated fall X2 values are used as a tool to compare the alternatives, as
 31 one of the factors that would indicate available suitable habitat to benefit
 32 Delta Smelt.

33 **9.4.1.3.6 Changes in Salmonid Production**

34 Collectively, factors such as flow, temperature, and habitat availability affect the
 35 population dynamics of anadromous fish species during their freshwater life
 36 stages. Three different models were used to assess changes in salmonid
 37 production potential: 1) SALMOD; 2) the Interactive Object-Oriented Simulation
 38 (IOS) model for winter-run Chinook Salmon; and 3) the Oncorhynchus Bayesian
 39 Analysis (OBAN) model for winter-run Chinook Salmon.

40 *Comparison of Annual Production Using SALMOD*

41 The SALMOD model (Appendix 9D, SALMOD Analysis Documentation) was
 42 used to assess changes in the annual production potential of four races of Chinook
 43 Salmon in the Sacramento River. The primary assumption of the model is that
 44 egg and fish mortality is directly proportional to spatially and temporally variable

1 habitat limitations, such as water temperatures, which themselves are functions of
2 operational variables (timing and quantity of flow) and meteorological variables,
3 such as air temperature. SALMOD is a spatially explicit model that characterizes
4 habitat value and carrying capacity using the hydraulic and thermal properties of
5 individual habitat units. Inputs to SALMOD include flow, water temperature,
6 spawning distributions, spawn timing by salmon race, and the number of
7 spawners provided by the user (e.g., recent average escapement).

8 Annual production potential or the number of outmigrants, annual mortality,
9 length, and weight of the smolts are some of the reporting metrics available from
10 SALMOD. The production numbers obtained from SALMOD are best used as an
11 index in comparing to a specified baseline condition rather than absolute values.
12 Differences between alternatives are assessed based on changes in the annual
13 production potential for each species by river by water year type. Because
14 SALMOD uses flows and output from the water temperature models that are
15 downscaled from the monthly time step CalSim II model, it was determined that
16 incremental changes in production of 5 percent or less were related to the
17 uncertainties in the model processing. Therefore, changes in production of
18 5 percent or less are considered to be not substantially different, or “similar” in
19 this comparative analysis.

20 *Comparison of Annual Winter-run Chinook Salmon Escapement Using IOS*

21 IOS is a stochastic life cycle simulation model for winter run Chinook Salmon in
22 the Sacramento River. The IOS model is composed of six model stages that are
23 arranged sequentially to account for the entire life cycle of winter run, from eggs
24 to returning spawners. The primary output from the IOS model is escapement,
25 the total number of winter-run Chinook Salmon that leave the ocean and return to
26 the Sacramento River to spawn. Differences between alternatives are assessed
27 based on changes in the median annual escapement and the range of escapement
28 values encompassed in the first and second quartiles (25 to 75 percent of years)
29 over the 82-year CalSim II simulation period. The IOS model uses scenario-
30 specific daily DSM2, CalSim II, and Sacramento River Basin Water Temperature
31 Model (HEC-5Q) data as model input. Because IOS uses output from the
32 monthly time step CalSim II model, or other models downscaled from CalSim II,
33 as input, it was determined that incremental changes in escapement estimates of
34 5 percent or less in were related to the uncertainties in the model processing.
35 Therefore, changes in escapement of 5 percent or less are considered to be not
36 substantially different, or “similar” in this comparative analysis.

37 *Comparison of Annual Winter-run Chinook Salmon Escapement Using OBAN*

38 The Oncorhynchus Bayesian Analysis (OBAN) is a model that uses statistical
39 relationships between historical patterns in winter-run Chinook salmon abundance
40 and a number of other parameters that covary with abundance to predict future
41 population abundance. The model determines the effects of water temperature,
42 harvest, exports, striped bass abundance, and offshore upwelling using historical
43 abundance data. The set of parameters, called covariates, that provided the best
44 model fit was retained for the full model. The model then uses predicted future
45 values of these parameters, primarily from CalSim II and temperature model

1 outputs, to predict future patterns in Chinook salmon population abundance
2 (escapement). Because OBAN uses output from the monthly time step CalSim II
3 model, or other models downscaled from CalSim II, as input, it was determined
4 that incremental changes in escapement estimates of 5 percent or less were related
5 to the uncertainties in the model processing. Therefore, changes in escapement of
6 5 percent or less are considered to be not substantially different, or “similar” in
7 this comparative analysis.

8 **9.4.1.3.7 Changes in Sturgeon Year Class Strength**

9 Changes in CVP and SWP operations can affect sturgeon species through changes
10 in flows through the Delta that, in turn, affect the year class strength of both
11 Green Sturgeon and White Sturgeon. Estimated Delta outflow from the CalSim II
12 model was used to analyze the potential effects on sturgeon using the
13 hypothesized relationship between Delta outflow and the age-0 Year Class Index
14 (YCI) from the Bay Study in the presentation by Gingras et al. (2014). For this
15 analysis, the mean Delta outflow during the March to July period for each year
16 was calculated from the CalSim II output and used as an indicator of potential
17 year class strength. Because the sturgeon analysis uses flow output from the
18 monthly time step CalSim II model, it was determined that incremental changes in
19 mean (March to July) Delta outflow of 5 percent or less were related to the
20 uncertainties in the model processing. Therefore, changes in Delta outflow of less
21 than 5 percent are considered to be not substantially different, or “similar” in this
22 comparative analysis.

23 Mean (March to July) Delta outflow was also used as an indicator of the
24 likelihood of producing a strong year class of sturgeon by examining the number
25 of years (over the 82-year CalSim II simulation) that mean (March-July) Delta
26 outflow would exceed a threshold of 50,000 cfs. Changes in the number of years
27 exceeding the threshold was considered to have a potential effect on sturgeon.

28 **9.4.1.4 Constructed Water Supply Facilities that Convey and Store CVP 29 and SWP Water**

30 The distribution system for water exported by CVP and SWP includes hundreds
31 of miles of canals and numerous reservoirs designed to help regulate the flow of
32 water to the areas where the water is used. Many of these canals and reservoirs
33 support fish that were entrained into the system or intentionally stocked for
34 recreational purposes, and changes in export deliveries could influence the quality
35 of the aquatic habitat in these constructed water bodies. These constructed water
36 bodies do not support important populations of native fish species and the
37 management of flows is under the control of the entities that receive the water.
38 Because many of the reservoirs also store water from non-CVP and SWP water
39 supplies; it is difficult to predict changes in the aquatic habitat related to changes
40 in CVP and SWP water supplies. Therefore, the potential effects of operation of
41 these facilities on fish and aquatic resources are not addressed further in this EIS.

1 **9.4.1.5 Analysis of Provision of Fish Passage**

2 As described previously in the Affected Environment section, Shasta, Folsom,
3 and New Melones dams and their associated downstream re-regulating reservoirs
4 permanently blocked salmonid access to upper watersheds and effectively
5 removed many miles of suitable habitat. These barriers particularly influenced
6 populations of winter-run and spring-run Chinook Salmon and steelhead because
7 their life history strategies are adapted to accessing higher elevation river reaches
8 and tributaries to successfully spawn and rear, as well as for overwintering.
9 Improving passage would increase the amount of available habitat, including
10 access to colder headwaters, which would be particularly important considering
11 anticipated climate change scenarios. Improved fish passage is not included
12 under the Second Basin of Comparison or Alternative 2.

13 **9.4.1.6 Analysis of Trap and Haul Program**

14 Poor survival of juvenile salmonids in the Sacramento-San Joaquin Delta has
15 been hypothesized as a major contributor to declines in the number of returning
16 adults and may be a significant impediment to the recovery of threatened or
17 endangered populations (NOAA 2009). Alternative 3 and Alternative 4 contain a
18 trap and haul program for juvenile salmonids entering the Delta from the San
19 Joaquin River, similar to the program in place on the Columbia River in Oregon.
20 This action would not be implemented under the No Action Alternative, Second
21 Basis of Comparison, or other action alternatives, with the exception of
22 Alternatives 3 and 4. Background information on the trap and haul program
23 associated with Alternatives 3 and 4 is provided in Appendix 9O and was used in
24 the qualitative assessment of the trap and haul program under Alternatives 3
25 and 4.

26 **9.4.1.7 Analysis of Predator Control Programs**

27 As described in Chapter 3, Description of Alternatives, Alternatives 3 and 4
28 include predator control actions designed to reduce predation on salmonids and
29 Delta Smelt, primarily within the Delta. Predator control measures are included
30 in Alternatives 3 and 4, including an increased bag limit and minimum size limit
31 for Striped Bass and black bass. The proposed bag and size limits are intended
32 and expected to encourage more fishing effort for and greater harvest of Striped
33 Bass and black bass, resulting in a reduction in the Striped Bass and black bass
34 populations throughout the Delta. In addition, a sport reward program for
35 Sacramento Pikeminnow would be implemented to encourage fishing for and
36 removal of this predatory species. These two actions would not be implemented
37 under the No Action Alternative, Second Basis of Comparison, or other action
38 alternatives, with the exception of Alternatives 3 and 4.

39 **9.4.1.8 Analysis of Ocean Salmon Harvest Restrictions**

40 As described in Chapter 3, Description of Alternatives, Alternatives 3 and 4
41 include restrictions on the annual ocean Chinook Salmon harvest, which is
42 intended to minimize harvest mortality of natural origin Central Valley Chinook
43 Salmon, including fall-run Chinook Salmon, by evaluating and modifying ocean

1 harvest for consistency with Viable Salmonid Population⁵ standards. This would
 2 include working with the Pacific Fisheries Management Council (PFMC),
 3 CDFW, and NMFS to impose salmon harvest restrictions to reduce by-catch of
 4 winter-run and spring-run Chinook Salmon to less than 10 percent of age-3 cohort
 5 in all years.

6 The salmon ocean fishery off the coast of California is regulated by the PFMC,
 7 which establishes the annual catch limit to optimize overall benefits, particularly
 8 with regard to food production, recreation, and ecosystem protection. An annual
 9 catch limit generally is based on achieving the maximum sustained yield from the
 10 fishery, but also takes into account the effects of uncertainty; management
 11 imprecision; the need to rebuild stocks; and other relevant economic, social, and
 12 ecological factors. Compliance with the ESA, other laws, and treaties also may
 13 affect the annual catch limit. Each year, the maximum allowable harvest
 14 (i.e., maximum number of fish caught) is determined based on the abundance of
 15 fish spawning in the previous year. Depending on the number of spawning fish,
 16 different formulas for calculating the maximum allowable harvest (i.e., control
 17 rules) are used. These rules calculate the maximum allowable harvest as
 18 a percentage of the number of spawning fish, and are designed to maximize the
 19 yield of fish from a stock while preventing overfishing. The annual catch limit
 20 may be set at or below the maximum allowable harvest.

21 Reduction of the annual catch limit could directly influence the number of adult
 22 salmon reaching their natal streams to spawn, which could affect the number of
 23 salmon annually produced in Central Valley streams and the Trinity River.
 24 Harvest restrictions would be implemented under Alternatives 3 and 4, but would
 25 not be implemented under the No Action Alternative, Second Basis of
 26 Comparison, or other action alternatives.

27 **9.4.1.9 Approach to Analyzing the Effects of Alternatives on Fish**

28 The analysis of the effects of changes in operation of the CVP and SWP on fish
 29 and aquatic resources in this EIS is influenced by numerous factors related to the
 30 complexity of the ecosystem, changes within the system (e.g., climate change and
 31 species population trends), and the imprecision of operational controls and
 32 resolution in modeling tools. These factors are further complicated by the
 33 scientific uncertainty about some fundamental aspects of aquatic species life
 34 history and how these species respond to changes in the system, as well as
 35 sometimes competing points of view on the interpretation of biological and
 36 physical data within the scientific community. In light of these factors, the
 37 analysis takes an approach that presents available information and model outputs,
 38 synthesizes the results, and draws logical conclusions on likely effects of the
 39 various alternatives. Where relevant and appropriate, the analysis attempts to

⁵ "A viable salmonid population (VSP)² is an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame" (McElhany et al. 2000, pg. 2).

1 identify the level of uncertainty and qualify effect conclusions where competing
2 hypotheses may exist.

3 Many modeling tools have been developed to evaluate changes in CVP and SWP
4 water management, and as a result, multiple sources of information are available
5 to characterize conditions (e.g., water temperature, flows, reservoir storage).
6 Most of these modeling tools explain or provide insight on one or two of the
7 factors affecting the species, while some tools are more integrative
8 (e.g., SALMOD) and capture multiple relationships among physical conditions
9 and biological responses. Where integrative models were available, these were
10 relied upon more than evaluation of the individual components. For species
11 where these tools were not available, the analysis used a preponderance of
12 evidence approach that drew conclusions based on trends indicated by the
13 majority of the information. This approach assembled the full range of available
14 information and model outputs and determined the direction (neutral, positive, or
15 negative) of effect supported by the information.

16 For each focal species where sufficient information was available, the analysis
17 includes an effects summary that presents the EIS authors' conclusions for that
18 species and describes the rationale for the conclusion. It also presents a general
19 indication of the level of uncertainty regarding the conclusion and presents
20 qualifying information where disagreement in the scientific community may exist
21 for more complete disclosure.

22 Because of the multiple model outputs, the body of the impact analysis contains a
23 considerable amount of information, which is intended to summarize for the
24 benefit of the reader, while leaving most of the detail in the appendices. The
25 narrative contained in the body of the document and the model results in the
26 appendices are intended to be used in concert in reviewing this EIS.

27 **9.4.2 Conditions in Year 2030 without Implementation of** 28 **Alternatives 1 through 5**

29 This EIS includes two bases of comparison, as described in Chapter 3,
30 Description of Alternatives: the No Action Alternative and the Second Basis of
31 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that
32 would occur over the next 15 years without implementation of the alternatives are
33 not analyzed in this EIS. However, the changes to aquatic resources that are
34 assumed to occur by 2030 under the No Action Alternative and the Second Basis
35 of Comparison are summarized in this section. Many of the changed conditions
36 would occur in the same manner under both the No Action Alternative and the
37 Second Basis of Comparison.

38 **9.4.2.1 Common Changes in Conditions under the No Action** 39 **Alternative and Second Basis of Comparison**

40 Conditions in 2030 would be different than existing conditions due to:

- 41 • Climate change and sea level rise

- 1 • General plan development throughout California, including increased water
2 demands in portions of Sacramento Valley
- 3 • Implementation of reasonable and foreseeable water resources management
4 projects to provide water supplies

5 It is anticipated that climate change would result in more short-duration high-
6 rainfall events and less snowpack in the winter and early spring months. The
7 reservoirs would be full more frequently by the end of April or May by 2030 than
8 in recent historical conditions. However, as the water is released in the spring,
9 there would be less snowpack to refill the reservoirs. This condition would
10 reduce reservoir storage and available water supplies to downstream uses in the
11 summer. The reduced end of September storage also would reduce the ability to
12 release stored water to downstream regional reservoirs. These conditions would
13 occur for all reservoirs in the California foothills and mountains, including non-
14 CVP and SWP reservoirs.

15 These changes would result in a decline of the long-term average CVP and SWP
16 water supply deliveries by 2030 as compared to recent historical long-term
17 average deliveries under the No Action Alternative and the Second Basis of
18 Comparison. However, the CVP and SWP water deliveries would be less under
19 the No Action Alternative as compared to the Second Basis of Comparison, as
20 described in Chapter 5, Surface Water Resources and Water Supplies, which
21 could result in more crop idling.

22 Under the No Action Alternative and the Second Basis of Comparison, land uses
23 in 2030 would occur in accordance with adopted general plans. Development
24 under the general plans would change aquatic resources, especially near
25 municipal areas.

26 The No Action Alternative and the Second Basis of Comparison assumes
27 completion of water resources management and environmental restoration
28 projects that would have occurred without implementation of Alternatives
29 1 through 5, including regional and local recycling projects, surface water and
30 groundwater storage projects, conveyance improvement projects, and desalination
31 projects, as described in Chapter 3, Description of Alternatives. The No Action
32 Alternative and the Second Basis of Comparison also assumes implementation of
33 actions included in the 2008 USFWS BO and 2009 NMFS BO that would have
34 been implemented without the BOs by 2030, as described in Chapter 3,
35 Description of Alternatives. These projects would include several projects that
36 would affect aquatic resources, including:

- 37 • Habitat Restoration includes restoration of more than 10,000 acres of
38 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;
39 and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo
40 Bypass.
 - 41 – 2008 USFWS BO RPA Component 4 (Action 6). Habitat Restoration.
 - 42 – 2009 NMFS BO RPA Action I.6.1. Restoration of Floodplain Habitat.

- 1 – 2009 NMFS BO RPA Action I.6.2. Near-Term Actions at Liberty
2 Island/Lower Cache Slough and Lower Yolo Bypass.
- 3 – 2009 NMFS BO RPA Action I.6.3. Lower Putah Creek Enhancements.
- 4 – 2009 NMFS BO RPA Action I.6.4. Improvements to Lisbon Weir.
- 5 – 2009 NMFS BO RPA Action I.7. Reduce Migratory Delays and Loss of
6 Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in
7 the Yolo Bypass.
- 8 • 2009 NMFS BO RPA Action I.1.3. Clear Creek Spawning Gravel
9 Augmentation.
- 10 • 2009 NMFS BO RPA Action I.1.4. Spring Creek Temperature Control
11 Curtain Replacement.
- 12 • 2009 NMFS BO RPA Action I.2.6. Restore Battle Creek for Winter-Run,
13 Spring-Run, and Central Valley Steelhead.
- 14 • 2009 NMFS BO RPA Action I.3.1. Operate Red Bluff Diversion Dam with
15 Gates Out.
- 16 • 2009 NMFS BO RPA Action I.5. Funding for CVPIA Anadromous Fish
17 Screen Program.
- 18 • 2009 NMFS BO RPA Action II.1. Lower American River Flow Management.
- 19 Implementation of these common actions are described in more detail in this
20 section under the No Action Alternative and referred under the discussion of the
21 Second Basis of Comparison.

22 **9.4.2.2 No Action Alternative**

23 As described in Chapter 3, Description of Alternatives, the No Action
24 Alternative includes implementation of the 2008 USFWS BO and the 2009
25 NMFS BO Reasonable and Prudent Alternative (RPA) actions. It also includes
26 changes not related to the coordinated long-term operation of the CVP and SWP,
27 specifically changes in CVP and SWP operations caused by climate change and
28 sea level rise, increased CVP and water rights water demand in portions of the
29 Sacramento Valley, and implementation of reasonable and foreseeable non-CVP
30 or SWP water resources management projects to provide water supplies. The
31 resulting changes in ecological attributes and subsequent effects on fish and
32 aquatic resources would vary geographically, as described below.

33 As described in Chapter 5, Surface Water Resources and Water Supplies, it is
34 anticipated that climate change would result in more short-duration, high-rainfall
35 events and less snowpack in the winter and early spring months. By 2030, the
36 reservoirs would be full more frequently by the end of April or May than in recent
37 historical conditions. However, as the water is released in the spring, there would
38 be less snowpack to refill the reservoirs. This condition would reduce reservoir
39 storage and available water supplies to downstream uses in the summer. The
40 reduced storage in fall (end of September storage) would reduce the ability to

1 release stored water to downstream regional reservoirs. These conditions would
 2 occur for all reservoirs in the California foothills and mountains, including non-
 3 CVP and SWP reservoirs. Sea level rise also would result in reduced CVP and
 4 SWP reservoir storage because the CVP and SWP must continue to meet the
 5 salinity criteria to protect Delta water users and Delta aquatic resources, including
 6 the SWRCB D-1641 and other salinity criteria to protect Delta water users. To
 7 meet these criteria, the amount of water released from CVP and SWP reservoirs
 8 must be increased as compared to recent historical conditions.

9 **9.4.2.2.1 Trinity River Region**

10 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

11 As described in Chapter 5, Surface Water Resources and Water Supplies, end of
 12 September reservoir storage in Trinity Lake would be lower by 2030 as compared
 13 to recent historical conditions due to climate change and related lower snowfall.
 14 Lewiston Reservoir, a regulating reservoir, would be operated with daily changes
 15 similar to historical conditions. These changes are not anticipated to substantially
 16 affect aquatic resources in Trinity Lake or Lewiston Reservoir relative to recent
 17 historical conditions.

18 *Aquatic Habitat Conditions in Trinity and Lower Klamath Rivers*

19 Under the No Action Alternative, flow, water temperature, and aquatic habitat
 20 conditions in the Trinity River would continue to be influenced by CVP and SWP
 21 operations as described in the Affected Environment. Due to the increased
 22 potential for reduced Trinity Lake surface water storage (see above), there could
 23 be an increased potential for reduced Trinity River flows during the summer and
 24 fall months under the No Action Alternative as compared to recent historical
 25 conditions. The influence of climate change could result in higher water
 26 temperatures in Trinity Lake that could translate to higher release temperatures in
 27 the flow releases from Lewiston Dam and a reduction in habitat quality within the
 28 Trinity River for salmonids and other native species.

29 By 2030, implementation of 2009 NMFS BO RPA Action II.6, Preparation of
 30 Hatchery Genetic Management Plans for spring- and fall-run Chinook Salmon at
 31 the Trinity River Fish Hatchery, which is not currently being implemented, could
 32 reduce the adverse influence of recent hatchery operations on naturally produced
 33 fall-run and spring-run Chinook Salmon, and increase genetic diversity and
 34 diversity of run timing for these stocks.

35 *Effects Related to Water Transfers*

36 It is not anticipated that water would be transferred to or from the Trinity River
 37 Region. It also not anticipated that water transfers would result in changes to
 38 Trinity Lake operations. Therefore, there would be no change in aquatic habitat
 39 conditions as a result of water transfers.

1 **9.4.2.2.2 Central Valley Region**

2 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

3 Seasonal changes in reservoir surface elevations, storage volumes, and the volume
4 of cold water held within the reservoirs would continue under the No Action
5 Alternative. Conditions for reservoir fishes would continue to change seasonally
6 in response to inflow and downstream flow releases to meet demand. Recent
7 historical averages for reservoir storage and surface elevations in Shasta Lake,
8 Lake Oroville, and Folsom Lake generally show increases in March and April,
9 with a reduction in storage occurring in many years during May and June in
10 response to releases to meet downstream demands. Water surface elevations in
11 New Melones Reservoir generally decline throughout the spring period in many
12 years, with reductions typically occurring from April through June.

13 As described in Chapter 5, Surface Water Resources and Water Supplies, end of
14 September reservoir storage would be lower by 2030 as compared to recent
15 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones
16 Lake, and San Luis Reservoir due to climate change and related lower snowfall.
17 Whiskeytown Lake, Keswick Reservoir, Thermalito Forebay and Afterbay, and
18 Lake Natoma are regulating reservoirs and would be operated with daily changes
19 similar to historical conditions.

20 Under the No Action Alternative, the magnitude of changes in seasonal surface
21 elevation and reservoir storage could be more pronounced because of changes in
22 the timing and intensity of storm events due to climate change and an overall
23 reduction in snow pack. A smaller snowpack could result in less water entering
24 the reservoirs during the spring months and an increased frequency of reservoir
25 elevation declines during the spring months. By 2030, fish in these reservoirs that
26 spawn in shallow water (e.g., various species of black bass) could be subject to a
27 hydrologic regime that increases the frequency of reductions in surface elevation
28 during the spring spawning period, reducing spawning success. In addition,
29 reduced storage volumes and reduction of the cold water pools could reduce the
30 amount and suitability of habitat for cold water fishes (e.g., trout) within the
31 reservoirs relative to recent historical conditions.

32 *Aquatic Habitat Conditions in Rivers Downstream of CVP and SWP Facilities*

33 As described in Chapter 5, Surface Water Resources and Water Supplies, surface
34 water flows are anticipated to increase during the winter months as a result of an
35 increase in rainfall and decrease in snowfall, and to decrease in other months
36 because of the diminished snowmelt flows in the spring and early summer
37 months. In wetter years, fall flows may be increased relative to recent conditions
38 to meet downstream targets for Fall X2, which would lead to reduced reservoir
39 storage in the following months and less carryover storage in May of the
40 following year.

41 As described in Chapter 6, Surface Water Quality, climate change is anticipated to
42 result in higher water temperatures during portions of the year, with a
43 corresponding reduction in habitat quality for salmonids and other cold water
44 fishes. Increased downstream water demands and climate change are anticipated

1 to contribute to an inability to maintain an adequate cold water pool in critical dry
2 years and extended dry periods in the future.

3 Implementation of the 2008 USFWS BO and the 2009 NMFS BO Reasonable and
4 Prudent Alternative (RPA) actions under the No Action Alternative are
5 anticipated to benefit aquatic species. The resulting changes in ecological
6 attributes and subsequent effects on fish and aquatic resources would vary from
7 river to river, as described below.

8 *Aquatic Habitat Conditions in the Clear Creek from Whiskeytown Dam to*
9 *Sacramento River*

10 Under the No Action Alternative, flow, water temperature, and aquatic habitat
11 conditions in Clear Creek would continue to be influenced by CVP and SWP
12 operations as described in the Affected Environment. Whiskeytown Reservoir
13 would continue to be operated to convey water from the Trinity River to the
14 Sacramento River via the Spring Creek tunnel and to release flows to Clear Creek
15 to support anadromous fish.

16 The No Action Alternative includes a suite of six 2009 NMFS BO RPA actions,
17 intended to improve conditions for salmonids. These actions individually or in
18 combination could influence conditions in Clear Creek by 2030. These include:

- 19 • 2009 NMFS BO RPA Action I.1. Spring Attraction Flows
- 20 • 2009 NMFS BO RPA Action I.2. Channel Maintenance Flows
- 21 • 2009 NMFS BO RPA Action I.3. Spawning Gravel Augmentation
- 22 • 2009 NMFS BO RPA Action I.4. Spring Creek Temperature Control Curtain
- 23 • 2009 NMFS BO RPA Action I.5. Thermal Stress Reduction
- 24 • 2009 NMFS BO RPA Action I.6. Adaptively Manage to Habitat
25 Suitability/IFIM Study Results

26 Two of the actions involve additional flow releases to Clear Creek. 2009 NMFS
27 BO RPA Action I.1, requires at least two pulse flows in May and June to attract
28 adult spring-run Chinook Salmon holding in the Sacramento River. The pulse
29 flows would be continued annually, and are expected to improve conditions for
30 spring-run Chinook Salmon into the future. In addition, 2009 NMFS BO RPA
31 Action I.1.2, requires the release of channel maintenance flows of a minimum of
32 3,250 cfs into Clear Creek seven times in a ten-year period. These channel
33 maintenance flows are intended to provide the higher flows necessary to move
34 spawning gravels downstream from injection sites (locations where gravel
35 augmentation is implemented) for the purpose of increasing the amount of
36 spawning habitat available to spring-run Chinook Salmon and steelhead.
37 However, as described in Chapter 5, Surface Water Resources and Water
38 Supplies, the feasibility of releasing these flows is influenced by dam safety
39 considerations and operational constraints, and the delivery of flows of this
40 frequency may not be possible, thus the movement of gravel through mechanical
41 means may be required to achieve this objective.

1 2009 NMFS BO RPA Action I.1.3 addresses the limited availability of spawning
2 habitat in Clear Creek through the placement of gravel in selected sites in the
3 creek. This program is expected to continue under the No Action Alternative,
4 with ongoing improvements to spawning habitat for steelhead, and spring-run and
5 fall-run Chinook Salmon.

6 Water temperatures in Clear Creek are influenced by the temperature of water in
7 the Whiskeytown Reservoir and, to some extent, the magnitude of the release
8 flows. As described in the Affected Environment, Reclamation has managed
9 releases since 2002 to meet a daily average water temperature target of 56°F at the
10 Igo Gauge (4 miles downstream of Whiskeytown Dam) from September 15
11 through October 30 to support spring-run Chinook Salmon spawning. Beginning
12 in 2004, an additional daily average temperature target of 60°F was implemented
13 from June 1 to September 15 to protect over-summering juvenile steelhead and
14 holding adult spring-run Chinook Salmon. 2009 NMFS BO RPA Action I.1.5
15 continues these temperature targets; however, recent real time operations have
16 experienced difficulty in meeting the temperature objectives, and by 2030, it may
17 not be possible to meet the temperature targets as often. The Spring Creek
18 Temperature Control Curtain in Whiskeytown Lake repaired in 2011 (and also
19 included in the 2009 NMFS BO RPA) improves this condition by retaining cold
20 water that is released to reduce water temperatures during the summer for over-
21 summering juvenile steelhead and holding adult spring-run Chinook Salmon and
22 during the fall for spring- and winter-run Chinook Salmon spawning and
23 incubation.

24 2009 NMFS BO RPA Action I.1.6 requires adaptive management of flows in
25 Clear Creek based on results of habitat suitability/IFIM studies. If warranted by
26 the studies and if sufficient water is available, this action could result in modified
27 minimum flows in Clear Creek during the fall and winter to improve conditions
28 for spawning and incubating salmonids. Whether flow requirements would be
29 modified by 2030 and the extent of any changes are currently unknown.

30 *Aquatic Habitat Conditions in the Sacramento River from Keswick to*
31 *Freeport*

32 Under the No Action Alternative, flow, water temperature, and aquatic habitat
33 conditions in the Sacramento River downstream of Keswick Dam would continue
34 to be influenced by CVP and SWP operations as described in the Affected
35 Environment. Shasta Lake would continue to be operated to convey water from
36 the Sacramento River to the Delta and release flows to the Sacramento River to
37 support anadromous fish.

38 The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or
39 action suites intended to improve conditions for salmonids. These actions
40 individually or in combination could influence conditions in the Sacramento River
41 (and Battle Creek) by 2030. These include:

- 42 • 2009 NMFS BO RPA Action Suite I.2.1. Shasta Operations
- 43 – 2009 NMFS BO RPA Action Suite I.2.1. Performance Measures

- 1 – 2009 NMFS BO RPA Action I.2.2 (including I.2.2.A–I.2.2.C). November
2 through February Keswick Release Schedule (Fall Actions)
- 3 – 2009 NMFS BO RPA Action I.2.3 (including I.2.3.A–I.2.3.C). February
4 Forecast; March – May 14 Keswick Release Schedule (Spring Actions)
- 5 – 2009 NMFS BO RPA Action I.2.4. May 15 Through October Keswick
6 Release Schedule (Summer Action)
- 7 – 2009 NMFS BO RPA Action I.2.5. Winter-Run Chinook Salmon Passage
8 and Reintroduction Program at Shasta Dam – See “Conditions for Fish
9 Passage”
- 10 – 2009 NMFS BO RPA Action I.2.6. Restore Battle Creek for Winter-Run,
11 Spring-Run, and CV Steelhead
- 12 • 2009 NMFS BO RPA Action Suite I.3. Red Bluff Diversion Dam (RBDD)
13 Operations
- 14 • 2009 NMFS BO RPA Action I.4. Wilkins Slough Operations
- 15 • 2009 NMFS BO RPA Action I.5. Funding for CVPIA Anadromous Fish
16 Screen Program

17 Action Suite I.2 (Shasta Operations) was aimed at maintaining suitable
18 temperatures for egg incubation, fry emergence, and juvenile rearing in the
19 Sacramento River for the survival and recovery of the winter-run Chinook
20 Salmon ESU. Spring-run Chinook Salmon and steelhead are also affected by
21 temperature management actions from Shasta Lake. This suite of actions is
22 designed to ensure that Reclamation uses maximum discretion to reduce adverse
23 impacts of the projects to Chinook Salmon and steelhead in the Sacramento River
24 by maintaining sufficient carryover storage and optimizing use of the cold water
25 pool. Because Reclamation already operates Shasta Lake to optimize use of the
26 cold water pool and maintain carryover storage for temperature control in the
27 Sacramento River downstream of Shasta and Keswick dams, implementation of
28 this suite of actions would have little effect on habitat conditions for winter-run
29 Chinook Salmon and other fish species in the Sacramento River under the No
30 Action Alternative.

31 A temperature control device has been in operation at Shasta Dam since 1998,
32 with operations capable of maintaining a water temperature of 56°F downstream
33 to Balls Ferry Bridge in most years through the summer spawning period for
34 winter-run. Under the No Action Alternative, the ability to control water
35 temperatures depends on a number of factors and management flexibility usually
36 ends in October when the cold water pool in Shasta Lake is depleted. With
37 climate change, cold water storage at the end of May in Shasta Lake is expected
38 to be reduced under the No Action Alternative for all water year types. This
39 would further reduce the already limited cold water pool in late summer. With
40 the anticipated increase in demands for water by 2030 and less water being
41 diverted from the Trinity River, it is expected that it would become increasingly

1 difficult to meet water temperature targets at the various temperature compliance
2 points.

3 It is likely that severe temperature-related effects will be unavoidable in some
4 years under the No Action Alternative. Due to these unavoidable adverse effects,
5 RPA Action Suite I.2 also specifies other actions that Reclamation must take,
6 within its existing authority and discretion, to compensate for these periods of
7 unavoidably high temperatures. These actions include restoration of habitat at
8 Battle Creek (see below) which may support a second population of winter-run
9 Chinook Salmon, and a fish passage program at Keswick and Shasta dams to
10 partially restore winter-run Chinook Salmon to their historical cold water habitat.

11 2009 NMFS BO RPA Action Suite I.3 addresses mortality and delay of adult and
12 juvenile migration of winter-run, spring-run, steelhead, and green sturgeon caused
13 by the presence of the RBDD and the configuration of the operable gates. As
14 described in the Affected Environment, the Red Bluff Pumping Plant and fish
15 screen, which diverts water to the Tehama Colusa Canal and Corning Canal, was
16 constructed to allow year-round opening of the gates at the RBDD, and is
17 included in the 2009 NMFS BO as Action Suite I.3. Allowing the dam gates at
18 RBDD to remain open allows salmonids, sturgeon, and other fish species to pass
19 unimpeded all year. These passage improvements are completed and are
20 anticipated to benefit fish species that migrate upstream of the RBDD location
21 through improved access to spawning and rearing areas and a reduction in
22 predation due to dispersal of predator species like Striped Bass and Sacramento
23 Pikeminnow.

24 Implementation of 2009 NMFS BO RPA Action I.4 is anticipated to enhance the
25 ability to manage temperatures for anadromous fish downstream of Shasta Dam
26 through adjusting Wilkins Slough flow criteria in a manner that best conserves the
27 cold water pool for summer releases. In years other than critical dry years, the
28 need for a variance from the 5,000 cfs navigation criterion will be considered
29 during the process of developing the Keswick release schedules (Action I.2.2-4).
30 Reclamation has stated that it is no longer necessary to maintain 5,000 cfs at
31 Wilkins Slough for navigation (CVP/SWP operations BA, page 2-39), however,
32 the 5,000 cfs flow criterion is now used to support long-time water diversions that
33 have set their intake pumps just below this level. Under the No Action
34 Alternative, operating to a minimal flow level at Wilkins Slough based on fish
35 needs, rather than on outdated navigational requirements, could enhance the
36 ability to use cold water releases to maintain cooler summer temperatures in the
37 Sacramento River.

38 The No Action Alternative includes implementation of the CVPIA AFSP to
39 reduce entrainment of juvenile anadromous fish from unscreened diversions. This
40 program is also addressed in the 2009 NMFS BO RPA Action I.5. By providing
41 funding to screen priority diversions as identified in the CVPIA AFSP, the loss of
42 listed fish in water diversion channels by 2030 could be reduced. In addition, if
43 new fish screens can be constructed so that diversions can occur at low water
44 surface elevations to allow diversions below a flow of 5,000 cfs at Wilkins
45 Slough, then cold water at Shasta Lake could be conserved during critical dry

1 years for release to support winter-run and spring-run Chinook Salmon needs
2 downstream.

3 As described in the Affected Environment, implementation of the Battle Creek
4 Restoration Program is underway in accordance with implementation of the
5 CVPIA. This action, also included in the 2009 NMFS BO RPA Action I.2.6, is
6 being implemented to partially compensate for unavoidable adverse effects of
7 project operations by restoring winter-run and spring-run Chinook Salmon to the
8 Battle Creek watershed. Full implementation of the Battle Creek Restoration
9 Program under the No Action Alternative would substantially improve passage
10 conditions for adult Chinook Salmon and steelhead by 2030 and would result in
11 newly accessible anadromous fish habitat and improved water quality for the
12 Coleman National Fish Hatchery (Reclamation and SWRCB 2003).
13 Implementation of the RPA helps ensure that the Battle Creek experimental
14 winter-run Chinook Salmon re-introduction program will proceed in a timely
15 fashion. The Battle Creek Restoration Program is critical in creating a second
16 population of winter-run Chinook Salmon. A second population of winter-run
17 Chinook Salmon would reduce the risk that lost resiliency and increased
18 vulnerability to catastrophic events might result in extinction of the species.

19 *Aquatic Habitat Conditions in the Feather River from Oroville Dam to*
20 *Sacramento River*

21 As described in Chapter 5, Surface Water Resources and Water Supplies, and
22 Chapter 6, Surface Water Quality, the NMFS and 2008 USFWS BO RPAs did not
23 specifically recommend actions for Feather River operations. However,
24 Reclamation and DWR operate the Shasta-Oroville-Folsom coordinated releases
25 pursuant to 2009 NMFS BO RPA Actions 1.2.2C and 1.2.3B. The following two
26 RPA actions for operations in the Sacramento River influence Feather River
27 operations required to meet Delta outflow, X2, or other legal requirements:

- 28 • Action I.2.2. (including I.2.2.A–I.2.2.C) November through February
29 Keswick Release Schedule (Fall Actions)
- 30 • Action I.2.3. (including I.2.3.A–I.2.3.C) February Forecast; March – May 14
31 Keswick Release Schedule (Spring Actions).

32 Under the No Action Alternative, Feather River flows in the high flow channel
33 downstream of Thermalito Dam would be influenced by releases for Fall X2
34 Delta outflow requirements, regulation to meet water temperature criteria, and to
35 time Lake Oroville releases and Delta export operations as described for the
36 Affected Environment. Flows in the low flow channel downstream of Lake
37 Oroville would remain similar to recent conditions. As part of the ongoing FERC
38 relicensing process for the Oroville facilities, DWR has entered into a Settlement
39 Agreement (DWR 2006) that includes actions to be implemented and included as
40 terms of the anticipated FERC license. Depending on the progress of the
41 relicensing process, these actions could be implemented by 2030 and would
42 change fish habitat conditions in the Feather River relative to recent conditions.

1 Under the terms of the Settlement Agreement, DWR will develop a
2 comprehensive Lower Feather River Habitat Improvement Plan. The Plan will
3 provide an overall strategy for managing the various environmental measures
4 developed for implementation in the plan area. The following programs and plans
5 will be included in the comprehensive Lower Feather River Habitat Improvement
6 Plan:

- 7 1) Gravel Supplementation and Improvement Program
- 8 2) Channel Improvement Program
- 9 3) Structural Habitat Supplementation and Improvement Program
- 10 4) Fish Weir Program
- 11 5) Riparian and Floodplain Improvement Program including the evaluation of
12 pulse/flood flows
- 13 6) Feather River Fish Hatchery Improvement Program
- 14 7) Comprehensive Water Quality Monitoring Program
- 15 8) Oroville Wildlife Area Management Plan
- 16 9) Instream Flow and Temperature Improvement for Anadromous Fish.

17 Implementation of these programs and plans under the terms of the Settlement
18 Agreement as incorporated into the new license are anticipated to improve habitat
19 conditions and water quality for salmonids and other fishes using the channels of
20 the Feather River above the confluence with the Sacramento River.

21 *Aquatic Habitat Conditions in the American River from Nimbus Dam to*
22 *Sacramento River*

23 As described in the Affected Environment section, Reclamation releases water to
24 the lower American River consistent with flood control requirements; existing
25 water rights; CVP operations; the Lower American River Flow Management
26 Standard flow recommendations developed by Reclamation, the Sacramento Area
27 Water Forum, USFWS, NMFS, DFW, and other interested parties; SWRCB
28 Decision 893 (D-893); and requirements of the 2009 NMFS BO RPA. The
29 following two RPA actions for operations in the Sacramento River influence
30 American River operations required to meet Delta outflow, X2, or other legal
31 requirements:

- 32 • Action I.2.2. (including I.2.2.A–I.2.2.C) November through February
33 Keswick Release Schedule (Fall Actions)
- 34 • Action I.2.3. (including I.2.3.A–I.2.3.C) February Forecast; March – May 14
35 Keswick Release Schedule (Spring Actions).

36 The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or
37 action suites intended to improve conditions for salmonids in the lower American
38 River. These actions individually or in combination could influence conditions in
39 the American River by 2030. These include:

- 1 • 2009 NMFS BO RPA Action II.2.1. Lower American River Flow
2 Management
- 3 • 2009 NMFS BO RPA Action II.2. Lower American River Temperature
4 Management
- 5 • 2009 NMFS BO RPA Action II.3. Structural Improvements
- 6 • 2009 NMFS BO RPA Action II.4. Minimize Flow Fluctuation Effects
- 7 • 2009 NMFS BO RPA Action II.5. Fish Passage at Nimbus and Folsom dams
- 8 • 2009 NMFS BO RPA Action II.6.1. Preparation of Hatchery Genetic
9 Management Plan (HGMP) for Steelhead
- 10 • 2009 NMFS BO RPA Action II.6.2. Interim Actions Prior to Submittal of
11 Draft HGMP for Steelhead.

12 Under the No Action Alternative, American River flows would be influenced by
13 releases for Fall X2 Delta outflow requirements, regulation to meet water
14 temperature criteria, and to time Folsom Dam releases and Delta exports.
15 However, by 2030, increasing water demands and the influence of climate change
16 could worsen conditions for fish in the lower American River, particularly for
17 salmonids.

18 Reclamation releases water from Folsom Lake to implement the flow schedule
19 specified in the American River Flow Management Standard. The flow schedule
20 was developed and implemented prior to issuance of the 2009 NMFS BO
21 (Action II.1) to establish required minimum flows for anadromous salmonids in
22 the lower American River. The flow schedule specifies minimum flows and does
23 not preclude Reclamation from making higher releases at Nimbus Dam. The flow
24 schedule was developed to require more protective minimum flows in the lower
25 American River in consideration of the river's aquatic resources, particularly
26 steelhead and fall-run.

27 Reclamation manages the Folsom/Nimbus Dam complex and the water
28 temperature control shutters at Folsom Dam to maintain a daily average water
29 temperature of 65°F or lower at Watt Avenue Bridge from May 15 through
30 October 31, to provide suitable conditions for juvenile steelhead rearing in the
31 lower American River. Water temperature is the physical factor with the greatest
32 influence on salmonids in the American River. The inability to maintain suitable
33 water temperatures for all life history stages of steelhead in the American River is
34 a chronic issue because of operational (e.g., Folsom Lake operations to meet
35 Delta water quality objectives and demands and deliveries to M&I users in Placer,
36 El Dorado, and Sacramento County) and structural (e.g., limited reservoir water
37 storage and cold water pool) factors. Under the No Action Alternative, increased
38 water demand and climate change are expected to lead to further reductions in
39 suitable habitat conditions and increased water temperatures.

40 2009 NMFS BO RPA Action II.3 requires Reclamation to evaluate physical and
41 structural modifications that may improve temperature management capability in
42 the lower American River. Structural improvements to be further evaluated and

1 potentially implemented include: improvements to the Folsom Dam TCD, cold
2 water transport through Lake Natoma, installation of a TCD at El Dorado
3 Irrigation District's intake or its functional equivalent, and improved temperature
4 management decision-support tools. If one or more of these actions are
5 implemented by 2030, they could increase the likelihood that water temperatures
6 would be suitable for steelhead more frequently.

7 2009 NMFS BO RPA Action II.4 addresses stranding and isolation of juvenile
8 steelhead through implementation of flow ramping protocols. Implementation of
9 this action, including the continued monitoring for stranding and isolation of
10 salmonids in conjunction with flow fluctuations under the No Action Alternative,
11 could help to better predict the potential for steelhead redd dewatering and
12 isolation, fry stranding, and fry and juvenile isolation and to potentially avoid
13 adverse effects to salmonids.

14 As described above, temperature-related effects are likely during some years
15 under the No Action Alternative. Because of these unavoidable effects, RPA
16 Action II.5 requires Reclamation to evaluate options for providing steelhead
17 access their historic cold water habitat above Nimbus and Folsom dams and to
18 provide access if feasible.

19 Under the No Action Alternative, 2009 NMFS BO RPA Action Suite II.6, which
20 addresses project effects related to the Nimbus Fish Hatchery related to
21 introgression of out-of-basin hatchery stock with wild steelhead populations in the
22 Central Valley, would be implemented. Implementation of an HGMP prior to
23 2030 should minimize the effects of the ongoing steelhead hatchery program on
24 the Central Valley steelhead DPS.

25 Implementation of the HGMP also would reduce operational effects on Killer
26 Whale prey over the long term by improving the genetic diversity and diversity of
27 run timing of Central Valley fall-run Chinook Salmon, decreasing the potential
28 for localized prey depletions and increasing the likelihood that fall-run Chinook
29 Salmon could withstand stochastic events, such as poor ocean conditions. By
30 2030, implementation of this action could begin to contribute to a more consistent
31 food source for Killer Whales, even in years with overall poor Chinook Salmon
32 productivity.

33 *Aquatic Habitat Conditions in the San Joaquin River from Friant Dam to the*
34 *Stanislaus River*

35 Under the No Action Alternative, operations at Friant Dam would remain similar
36 to those described under the Affected Environment. Therefore, fish and aquatic
37 habitat conditions in the San Joaquin River downstream of Friant Dam would
38 remain similar to those described under the Affected Environment, although water
39 temperatures could increase as a result climate change.

1 *Aquatic Habitat Conditions in the Stanislaus River from Goodwin Dam to San*
 2 *Joaquin River*

3 Under the No Action Alternative, flow, water temperature, and aquatic habitat
 4 conditions in the Stanislaus River downstream of Goodwin Dam would continue
 5 to be influenced by CVP operations as described in Chapter 5, Surface Water
 6 Resources and Water Supplies. Flows in the lower Stanislaus River are primarily
 7 controlled by releases from New Melones Lake. Water released from New
 8 Melones Dam and Powerplant is re-regulated at Tulloch Reservoir and is either
 9 diverted at Goodwin Dam or released from Goodwin Dam to the lower
 10 Stanislaus River.

11 The No Action Alternative includes a variety of 2009 NMFS BO RPA actions or
 12 action suites intended to improve conditions for salmonids in the Stanislaus River.
 13 These actions individually or in combination could influence conditions in the
 14 Stanislaus River by 2030. These include:

- 15 • 2009 NMFS BO RPA Action III.1.1. Establish Stanislaus Operations Group
 16 (SOG) for real-time operational decision-making
- 17 • 2009 NMFS BO RPA Action III.1.2. Provide cold water releases to maintain
 18 suitable steelhead temperatures
- 19 • 2009 NMFS BO RPA Action III.1.3. Operate the East Side Division dams to
 20 meet minimum flows
- 21 • 2009 NMFS BO RPA Action Suite III.2. Stanislaus River CV Steelhead
 22 Habitat Restoration
 - 23 – 2009 NMFS BO RPA Action III.2.1. Increase and improve quality of
 24 spawning habitat with addition of gravel
 - 25 – 2009 NMFS BO RPA Action III.2.2. Conduct floodplain restoration and
 26 inundation flows in winter or spring to inundate steelhead juvenile rearing
 27 habitat
 - 28 – 2009 NMFS BO RPA Action III.2.3. Restore freshwater migratory habitat
 29 for juvenile steelhead
 - 30 – 2009 NMFS BO RPA Action III.2.4. Evaluate Fish Passage at New
 31 Melones, Tulloch, and Goodwin dams

32 Under the No Action Alternative, Stanislaus River flows would be influenced by
 33 regulations to meet water quality and flow criteria. However, by 2030, conditions
 34 for fish, particularly salmonids, in the Stanislaus River fish are expected to
 35 worsen because of increased temperatures due to the influence of climate change.

36 In accordance with 2009 NMFS BO RPA Action III.1.1, Reclamation has
 37 convened a Stanislaus Operations Group (SOG) to provide a forum for real-time
 38 operational flexibility implementation of the actions defined in the 2009 NMFS
 39 BO RPA. This group includes representatives from Reclamation, NMFS,
 40 USFWS, DWR, CDFW, SWRCB, and outside expertise at the discretion of
 41 NMFS and Reclamation. The SOG provides direction and oversight to ensure

1 that the East Side Division actions are implemented, monitored for effectiveness
2 and evaluated.

3 Under the No Action Alternative, Reclamation will continue, where feasible, to
4 manage the cold water supply within New Melones Reservoir as described in
5 2009 NMFS BO RPA Action III.1.2. The objective of these temperature criteria
6 is to provide suitable temperatures for Central Valley steelhead rearing, spawning,
7 egg incubation, smoltification, and adult migration in the Stanislaus River
8 downstream of Goodwin Dam. There are no temperature control devices at New
9 Melones, Goodwin, or Tulloch dams; thus, temperature management flexibility is
10 limited to storage and flow management under certain conditions. Access to
11 resources to offset operational temperature effects on steelhead in the Stanislaus
12 River will continue to be limited, particularly in Conference Years and in drier
13 Mid-Allocation Years. Under the No Action Alternative, steelhead would
14 continue to be vulnerable to elevated temperatures in dry and critical dry years,
15 even if actions are taken to improve temperature management. The frequency of
16 these occurrences is expected to increase with climate change-related temperature
17 increases.

18 Under the No Action Alternative, Reclamation would continue to meet the
19 minimum flow schedule, to the best of their ability, as described in 2009 NMFS
20 BO RPA Action III.1.3. The objective of the minimum flow schedule is to
21 maintain minimum base flows to provide habitat for all life history stages of
22 steelhead and to incorporate habitat maintaining geomorphic flows in a flow
23 pattern that would provide migratory cues to smolts and facilitate out-migrant
24 smolt movement. The flow schedule specifies minimum flows and does not
25 preclude higher releases for other operational criteria. However, due to limited
26 availability of water under the CVP water rights, it would be difficult to fully
27 implement this action. Therefore, habitat conditions for steelhead and other fish
28 species in the Stanislaus River would be similar or reduced relative to recent
29 conditions in the near term. The value of this habitat also may be adversely
30 influenced by higher temperatures associated with climate change.

31 Ongoing implementation of 2009 NMFS BO RPA Action Suite III.2 through
32 2030 is anticipated to improve the physical habitat conditions for steelhead,
33 although climate change may affect the types and cover rates of vegetation
34 upslope of the river, and potentially increase the rate of fine sediment transport to
35 the river and to spawning areas.

36 RPA Action III.2.4 requires Reclamation to evaluate options for providing
37 steelhead access to their historic cold water habitat upstream of New Melones,
38 Tulloch, and Goodwin dams and to provide access if feasible. As described
39 above, temperature-related effects will be unavoidable in some years under the No
40 Action Alternative. Lindley et al. (2007) identified the need for upstream habitat
41 for salmonids, given predicted climate change in the next century. This may be
42 particularly relevant for steelhead and salmon in the Stanislaus River where
43 Goodwin Dam blocks all access to historical spawning and rearing habitat and
44 where the remaining population survives as a result of dam operations in
45 downstream reaches that were historically unsuitable habitat because of high

1 summertime temperatures. To the extent that preliminary fish passage efforts are
2 underway by 2030, this could improve conditions for Stanislaus River salmonids.

3 *Aquatic Habitat Conditions in the Yolo Bypass (including Cache Slough,*
4 *Lower Putah Creek, and Fremont Weir)*

5 As described in Chapter 5, Surface Water Resources and Water Supplies, climate
6 change would increase the frequency of high flow events that would result in
7 flows into the Yolo Bypass by 2030 as compared to recent historical conditions.
8 Implementation of the operable gates at the Fremont Weir also would increase the
9 frequency of flows into the Yolo Bypass.

10 Under the No Action Alternative, it is assumed that aquatic habitat conditions in
11 the Yolo Bypass would improve by 2030 as a result of the following 2009 NMFS
12 BO RPA actions:

- 13 • 2009 NMFS BO RPA Action I.6.1. Restoration of Floodplain Rearing
14 Habitat.
- 15 • 2009 NMFS BO RPA Action I.6.2. Near-Term Actions at Liberty
16 Island/Lower Cache Slough and Lower Yolo Bypass.
- 17 • 2009 NMFS BO RPA Action I.6.3. Lower Putah Creek Enhancements.
- 18 • 2009 NMFS BO RPA Action I.6.4. Improvements to Lisbon Weir.
- 19 • 2009 NMFS BO RPA Action I.7. Reduce Migratory Delays and Loss of
20 Salmon, Steelhead, and Sturgeon at Fremont Weir and Other Structures in the
21 Yolo Bypass

22 Under the No Action Alternative, it is assumed that the elements of 2009 NMFS
23 BO RPA Action Suite I.6.1 would be implemented in the Yolo Bypass, including
24 up to 20,000 acres of shallow, low-velocity inundated floodplain. Actions in the
25 Yolo Bypass also would include improvements in fish passage at Fremont Weir
26 for anadromous salmonids, sturgeon, and other native fish species.

27 Passage at Fremont Weir would be facilitated by correcting a variety of passage
28 issues within the bypass, including modification of agricultural structures in the
29 northern Tule Canal that impede flow and cause fish passage delays.
30 Modification of these structures under the No Action Alternative could
31 substantially reduce fish passage delays through the Tule Canal. Similarly,
32 replacement or modification of Lisbon Weir could allow unimpeded fish passage,
33 reduced maintenance of the weir, and at the same time be managed to impound
34 water for agriculture. In addition, the Knights Landing Ridge Cut could be
35 modified to provide an exit path for upstream-migrating fish. These actions,
36 along with the grading of downstream channels to improve connectivity to the
37 Tule Canal when water levels fall as inundations recede and provide exit points
38 for fish that would otherwise be stranded when inundations recede, are expected
39 to improve conditions for salmonid rearing and fish passage by 2030.

40 Implementation of these ecosystem restoration actions and improvements under
41 the No Action Alternative could increase growth and survival of juvenile Chinook
42 Salmon, steelhead, and other native fish by providing increased seasonal access to

1 productive foraging and high quality rearing habitat, depending on the extent and
2 duration of restoration and inundation. These actions may also reduce migratory
3 delays or losses by reducing predation, straying, and delays for salmonids and
4 other migratory native fish species.

5 *Aquatic Habitat Conditions in the Delta*

6 Under the No Action Alternative, flows, water quality, and aquatic habitat
7 conditions in the Delta would continue to be influenced by CVP and SWP
8 operations as described in Chapter 5, Surface Water Resources and Water
9 Supplies and Chapter 6, Surface Water Quality. Overall, long-term average CVP
10 and SWP water supply deliveries in 2030 through the Delta would decline as
11 compared to historical long-term average deliveries. Because entrainment of fish
12 in the Delta export facilities is related to the amount of water exported,
13 entrainment would decline relative to recent conditions as a result of reduced
14 water supply delivery.

15 Under the No Action Alternative, climate change is anticipated to have more of an
16 effect on Delta flows during wetter years than during drier years because CVP
17 and SWP operations occur with more flexibility during wet years, within the
18 constraints of flood control requirements, compared to drier years when the CVP
19 and SWP operations may be more frequently constrained to maintain instream
20 flows and other environmental objectives. Overall, it is anticipated that due to
21 climate change, sea level rise, and increased water demands in the Sacramento
22 Valley, there would be less CVP and SWP water available for export in the Delta
23 and CVP and SWP exports would decline. The reduction in Delta exports would
24 result in more positive OMR flows by 2030 as compared to recent historical
25 conditions. In other words, it is expected that fish in the channels surrounding the
26 CVP and SWP projects will be exposed to lower entrainment risks than under
27 recent historical conditions as a result of changes in operation due to factors
28 described above (i.e., climate change, sea level rise, and increased water demands
29 in the Sacramento Valley) climate change by 2030.

30 The No Action Alternative includes a variety of RPA actions or action suites from
31 both the USFWS and NMFS biological opinions intended to improve conditions
32 in the Delta for Delta Smelt, Longfin Smelt, salmonids and sturgeon. These
33 actions individually or in combination could influence aquatic habitat conditions
34 in the Delta by 2030. These include:

- 35 • 2008 USFWS BO RPA Component 1 (Actions 1 and 2). Protection of the
36 Adult Delta Smelt Life Stage.
- 37 • 2008 USFWS BO RPA Component 2 (Actions 3 and 5). Protection of Larval
38 and Juvenile Delta Smelt.
- 39 • 2008 USFWS BO RPA Component 3 (Action 4). Improve Habitat for Delta
40 Smelt Growth and Rearing (Fall X2).
- 41 • 2008 USFWS BO RPA Component 4 (Action 6). Habitat Restoration.

- 1 • 2009 NMFS BO RPA Action Suite IV.1. Modify DCC gate operations and
2 evaluate methods to control access to Georgiana Slough and the Interior Delta
3 to reduce diversion of listed fish from the Sacramento River into the southern
4 or central Delta.
- 5 • 2009 NMFS BO RPA Action Suite IV.2. Control the net negative flows
6 toward the export pumps in Old and Middle rivers to reduce the likelihood
7 that fish will be diverted from the San Joaquin or Sacramento River into the
8 southern or central Delta.
- 9 • 2009 NMFS BO RPA Action IV.3. Curtail exports when protected fish are
10 observed near the export facilities to reduce mortality from entrainment and
11 salvage.
- 12 • 2009 NMFS BO RPA Action Suite IV.4. Improve fish screening and salvage
13 operations to reduce mortality from entrainment and salvage.

14 Component 1 of the 2008 USFWS BO RPA is designed to reduce entrainment of
15 pre-spawning adult Delta Smelt during December to March by controlling OMR
16 flows during vulnerable periods, including adaptive management of OMR flows
17 based on input and guidance from the Smelt Working Group to further reduce
18 entrainment. Action 1 is designed to protect upmigrating Delta Smelt and
19 Action 2 is designed to protect adult Delta Smelt that have migrated upstream and
20 are residing in the Delta prior to spawning. Overall, RPA Component 1 is
21 expected to increase the suitability of spawning habitat for Delta Smelt by
22 decreasing the amount of Delta habitat affected by export pumping prior to, and
23 during, the critical spawning period.

24 Component 2 is intended to improve flow conditions in the Central and South
25 Delta such that larval and juvenile Delta Smelt could successfully rear in the
26 Central Delta and move downstream when appropriate. The spring HORB would
27 be installed only if the USFWS determines Delta Smelt entrainment is not a
28 concern.

29 Implementation of Component 3 of the 2008 USFWS BO RPA requires the
30 provision of sufficient Delta outflow to maintain a monthly average X2 no greater
31 than 74 km in Wet water year types and 81 km in Above Normal water years.
32 The objective of this component is to improve fall habitat for Delta Smelt through
33 increasing Delta outflow during fall. Increases in fall habitat quality and quantity
34 are anticipated to improve conditions for Delta Smelt under the No Action
35 Alternative. However, implementation of this action would result in reduced
36 storage in upstream reservoirs which could adversely affect temperature
37 management in the Sacramento, Feather, and American rivers.

38 Component 4 of the 2008 USFWS BO RPA is intended to improve conditions for
39 Delta Smelt habitat to supplement the improvements resulting from the flow
40 actions described above. DWR is required to implement a program to create or
41 restore a minimum of 8,000 acres of intertidal and associated subtidal habitat in
42 the Delta and Suisun Marsh. It is assumed under the No Action Alternative that
43 this requirement would be met by the Suisun Marsh Restoration Program and

1 would result in the restoration of more than 10,000 acres of intertidal and
2 associated subtidal wetlands in Suisun Marsh and Cache Slough.

3 Implementation of the 2008 USFWS BO RPA would increase the likelihood that
4 Delta Smelt habitat conditions and attributes for migration, spawning,
5 recruitment, growth, and survival would be provided under the No Action
6 Alternative. Implementation of actions under the 2008 USFWS BO RPA to
7 restore tidally influenced habitat also is expected to increase salmonid and
8 sturgeon rearing habitat and potentially food production for salmonids and Delta
9 Smelt. Depending on the amount and type of restoration that would occur in
10 brackish estuarine areas, restoration could increase rearing habitat for Sacramento
11 Splittail, and alter conditions for predators and non-native fish species. Spawning
12 habitat for roach, Hardhead, Sacramento Splittail, and Delta Smelt could be
13 increased depending on whether restoration occurs in freshwater areas or in
14 brackish estuarine areas. In addition, habitat restoration has the potential to alter
15 habitat conditions for some invasive aquatic macrophyte species during some
16 seasons, and in some locations, which could have indirect effects on predation.

17 Action Suite IV.1 of the 2009 NMFS BO RPA requires continued funding of
18 monitoring programs at the RBDD, in spring-run Chinook Salmon tributaries to
19 the Sacramento River, on the Sacramento River at Knights Landing and
20 Sacramento, and sites within the Delta. In addition, salvage and loss of juvenile
21 Chinook Salmon would be monitored at the Delta fish collection facilities
22 operated by the CVP and SWP. A working group, composed of representatives
23 from Reclamation, DWR, NMFS, USFWS, and CDFW, would develop and
24 evaluate engineering solutions to reduce adverse impacts on listed fish and their
25 critical habitat.

26 The DCC gate operations would be modified to reduce loss of emigrating
27 salmonids and green sturgeon. The operating criteria provide for longer periods
28 of gate closures during the outmigration season to reduce direct and indirect
29 mortality of yearling spring-run and winter-run Chinook Salmon, and juvenile
30 steelhead. Although route selection by Chinook Salmon and the mechanisms
31 governing selection are complex (Perry et al. (2015), the closure of the DCC gates
32 may increase the survival of salmonid emigrants through the Delta, and the early
33 closures could reduce loss of fish with unique and valuable life history strategies
34 in the spring-run Chinook Salmon and Central Valley steelhead populations.

35 Conditions under the No Action Alternative would be influenced by
36 implementation of Action Suite IV.2 of the 2009 NMFS BO RPA. This action
37 suite requires the maintenance of adequate flows in both the Sacramento River
38 and San Joaquin River basins to increase survival of steelhead emigrating to the
39 estuary from the San Joaquin River, and of Chinook Salmon, steelhead, and
40 Green Sturgeon emigrating from the Sacramento River through the Delta to
41 Chipps Island. This action suite includes actions to reduce the vulnerability of
42 emigrating steelhead within the lower San Joaquin River to entrainment into the
43 channels of the South Delta and at the export facilities by increasing the inflow to
44 export ratio. Cunningham et al. (2015) found a negative influence of the
45 export/inflow ratio on the survival of fall-run Chinook populations and a negative

1 influence of increased total Delta exports on the survival of spring-run Chinook
2 populations. In addition, there are actions to enhance the likelihood of salmonids
3 successfully exiting the Delta at Chipps Island by creating more suitable hydraulic
4 conditions in the main stem of the San Joaquin River for emigrating fish,
5 including greater net downstream flows. Historical data suggest that high San
6 Joaquin River flows in the spring result in higher survival of outmigrating
7 Chinook Salmon smolts and greater returns of adults. The data also suggest that
8 when the ratio between spring flows and exports increase, Chinook Salmon
9 production increases. Increased flows within the San Joaquin River portion of the
10 Delta could also enhance the survival of Sacramento River salmonids. Those fish
11 from the Sacramento River that have been diverted through the interior Delta to
12 the San Joaquin River could benefit by the increased net flow towards the ocean
13 caused by the higher flows in the San Joaquin River from upstream and the
14 reduced influence of the export pumps.

15 2009 NMFS BO RPA Action Suite IV.2 also includes flow management for the
16 Old and Middle rivers that would be implemented in conjunction with the
17 restrictions on exports under the 2008 USFWS BO RPA. Old and Middle river
18 flow management is designed to ensure that emigrating steelhead from the San
19 Joaquin Basin and the east-side tributaries remain in the mainstem of the San
20 Joaquin River to the greatest extent possible and reduce their exposure to the
21 adverse effects that are present in the channels leading south toward the export
22 facilities. This is anticipated to increase the likelihood of survival of steelhead
23 emigrating from the San Joaquin River. Reducing the risk of diversion into the
24 central and southern Delta waterways also could increase survival of listed
25 salmonids and Green Sturgeon entering the San Joaquin River via Georgiana
26 Slough and the lower Mokelumne River. However, recent coded wire tagging
27 and acoustic studies have shown survival to be reach specific for both Chinook
28 Salmon and steelhead and that survival of hatchery-origin (Feather River) juvenile
29 Chinook Salmon was higher through the south Delta via the Old River route than
30 via the San Joaquin River (Buchanan et al. 2013, 2015). However, most fish in
31 the Old River that survived to the end of the Delta had been salvaged from the
32 federal water export facility on the Old River and trucked around the remainder of
33 the Delta (Buchanan et al. 2013, SJRGA 2013). Zeug and Cavallo (2014) suggest
34 that entrainment losses at the diversions may be small relative to overall migration
35 mortality.

36 The 2009 NMFS BO RPA Action IV.3 requires operations of the Tracy and
37 Skinner Fish Collection Facilities to be modified according to monitoring data
38 from upstream of the Delta. In conjunction with the two alerts for closure of the
39 DCC (Action IV.1.1), a third alert would be used to signal that export operations
40 may need to be altered due to large numbers of juvenile Chinook Salmon
41 migrating into the upper Delta region, increasing their risk of entrainment into the
42 central and south Delta and then to the export pumps. When more fish are
43 present, more fish are at risk of diversion and losses would be higher. The third
44 alert is important for real-time operation of the export facilities because the
45 collection and dissemination of field data to the resource agencies and
46 coordination of response actions could take several days. This action is designed

1 to work in concert with the Old and Middle River flow management in action
2 suite IV.2. Under the No Action Alternative, implementation of this action is
3 anticipated to reduce losses of winter-run and spring-run Chinook Salmon,
4 steelhead, and Green Sturgeon by reducing exports when large numbers of
5 juvenile Chinook Salmon are migrating into the upper Delta region.

6 Action Suite IV.4 of the 2009 NMFS BO RPA is designed to increase the
7 efficiency of the Tracy and Skinner Fish Collection Facilities to improve the
8 overall salvage survival of winter-run and spring-run Chinook Salmon, steelhead,
9 and Green Sturgeon to achieve a 75 percent performance goal for whole facility
10 salvage at both state and Federal facilities. Reclamation and DWR will (1)
11 conduct studies to evaluate current operations and salvage criteria to reduce take
12 associated with salvage, (2) develop new procedures and modifications to
13 improve the current operations, and (3) implement changes to the physical
14 infrastructure of the facilities where information indicates such changes need to
15 be made. In addition, Reclamation would continue to fund and implement the
16 CVPIA Tracy Fish Facility Program. Reclamation and DWR would fund quality
17 control and quality assurance programs, genetic analysis, louver cleaning loss
18 studies, release site studies and predation studies. Funding would also be
19 provided for new studies to estimate Green Sturgeon screening efficiency at both
20 facilities and survival through the trucking and handling process. Under the No
21 Action Alternative, implementation of measures to fund fish screens, reduce pre-
22 screen loss, improve screening efficiency, and improve reporting could reduce
23 entrainment and salvage, and result in improved survival for juvenile Salmonids
24 migrating downstream through the Delta, as well as for Sacramento Splittail,
25 Delta Smelt, and other native fish species.

26 Abundance and habitat conditions for Delta Smelt and other fish species in the
27 Delta under the No Action Alternative in 2030 are difficult to predict. Abundance
28 levels for Delta Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and
29 American Shad under recent conditions are very low compared to pre-POD levels,
30 as evidenced by the number of fish collected in sampling programs such as the
31 FMWT surveys conducted by the IEP. Numbers of fish collected have continued
32 to decline in recent years, even with implementation of the RPAs. Annual
33 reviews conducted by the Delta Science Program Independent Review Panel
34 (IRP) for the Long-Term Operations Biological Opinions have called for better
35 metrics to measure the effects of the BO RPAs on the protected species (IRP
36 2011, 2013, 2014) to allow more informed decision-making, while
37 acknowledging challenges, constraints, and the complexity of the issues.

38 Currently low levels of relative abundance do not bode well for the Delta Smelt or
39 other fish species in the Delta in 2030. Challenges to fish species in the Delta are
40 many, and would continue in the future under the No Action Alternative,
41 including high water temperatures, reduced flows, habitat degradation, barriers,
42 predation, low DO, contamination, entrainment, salvage, poaching, disease,
43 competition, non-native species, and lack of available food. Use of observations
44 on current conditions to predict future long-term changes for Delta fish is
45 especially challenging when combined with other potentially adverse future

1 changes foreseen for the Delta, e.g., altered hydrology due to drought, rising
2 temperatures, and potential sea level rise (Sommer and Meija, 2013).

3 **9.4.2.2.3 Special Status Species and Critical Habitat**

4 *Clear Creek*

5 Clear Creek is designated critical habitat for spring-run Chinook Salmon and
6 Central Valley steelhead. The Primary Constituent Element (PCEs) of critical
7 habitat for both species include freshwater spawning sites, freshwater rearing
8 areas, and freshwater migration corridors. Spawning and rearing habitat for
9 spring-run Chinook Salmon in Clear Creek has been negatively affected by flow
10 and water temperature conditions associated with current operations. As
11 described above, it is anticipated minimum flows in Clear Creek would be
12 increased during the fall and winter to improve conditions for spawning
13 salmonids as a result of recently completed IFIM studies. Continuation of spring
14 pulse flows (RPA Action I.1.1) and implementation of channel maintenance flows
15 (RPA Action I.1.2), in conjunction with ongoing gravel augmentation in Clear
16 Creek, is expected to result in improvements in the PCEs of critical habitat for
17 spring-run Chinook Salmon and steelhead relative to recent conditions.

18 *Sacramento River*

19 The Sacramento River provides three of the six PCEs essential to support one or
20 more life stages, including freshwater spawning sites, rearing sites, and migration
21 corridors for winter-run and spring-run Chinook Salmon and steelhead. The
22 Sacramento River is also designated critical habitat for the Southern DPS of
23 Green Sturgeon. Flow and temperature changes under the No Action
24 Alternative and the effects on spawning and rearing habitat quality were described
25 previously.

26 Climate change is likely to reduce the conservation value of the spawning habitat
27 PCE of critical habitat by increasing water temperatures, which would reduce the
28 availability of suitable spawning habitat. Cold water in Shasta Lake is expected
29 to be depleted sooner in the summer, impacting winter-run and spring-run
30 Chinook Salmon spawning habitat. This reduction in an essential feature of the
31 spawning habitat PCE could reduce the spatial structure, abundance, and
32 productivity of salmonids. Similarly, as described above, climate change is likely
33 to reduce availability of rearing habitat, and in turn, the value of the rearing
34 habitat PCE of critical habitat, by increasing water temperatures.

35 The year-round opening of the gates at the RBDD in accordance with Action
36 Suite I.3 of the 2009 NMFS BO RPA allows salmonids to pass unimpeded,
37 enhancing the conservation value of the PCE for migration. Critical habitat for
38 Green Sturgeon would also improve from unimpeded access to suitable spawning
39 habitat upstream of the RBDD. The improved passage at the RBDD location is
40 expected to increase the number of deep holding pools that adult Green Sturgeon
41 can access, thereby increasing the conservation value of the water depth PCE. In
42 addition, predation on salmon, steelhead, and sturgeon would be reduced relative
43 to conditions when the RBDD was operational.

1 *American River*

2 The lower American River downstream of Nimbus Dam is designated critical
3 habitat for Central Valley steelhead. The PCEs of critical habitat in the lower
4 American River include freshwater spawning sites, freshwater rearing areas, and
5 freshwater migration corridors. Flow and temperature changes under the No
6 Action Alternative and the effects on spawning and rearing habitat quality were
7 described previously. In addition, the influence of climate change is expected to
8 alter hydrologic and temperature conditions in the region and could adversely
9 affect the PCEs for Central Valley steelhead critical habitat in the American
10 River, primarily through increased water temperatures.

11 *Stanislaus River*

12 The lower Stanislaus River downstream of Goodwin Dam is designated critical
13 habitat for Central Valley steelhead. The PCEs of critical habitat in the Stanislaus
14 River include freshwater spawning sites, freshwater rearing areas, and freshwater
15 migration corridors. Flow and temperature changes under the No Action
16 Alternative and the effects on spawning and rearing habitat quality were described
17 previously. The PCEs for spawning and rearing habitat have been adversely
18 affected by elimination of geomorphic processes that replenish and rejuvenate
19 spawning riffles and inundate floodplain terraces to provide nutrients and rearing
20 habitat for juvenile salmonids. In addition, moderation of flood events also
21 eliminates or reduces the intensity and duration of freshets and storm flows,
22 which adversely affects the PCE for migration corridors. The influence of climate
23 change could begin to alter hydrologic and temperature conditions in the region
24 and adversely affect the PCEs for Central Valley steelhead critical habitat in the
25 Stanislaus River, primarily through increased water temperatures.

26 *Delta*

27 Critical habitat for both winter-run and spring-run Chinook Salmon is designated
28 in the Sacramento River adjacent to the location of the DCC gates. The DCC is
29 specifically not included in designated critical habitat for winter-run Chinook
30 Salmon because the biological opinions issued by NMFS in 1992 and 1993
31 included measures on the operations of the gates that were designed to exclude
32 winter-run Chinook Salmon from the channel and the waters of the Central Delta.
33 However, for spring-run Chinook Salmon, designated critical habitat does include
34 the DCC from its point of origin on the Sacramento River to its terminus at
35 Snodgrass Slough, including the location of the gates. Designated critical habitat
36 for Central Valley steelhead includes most of the Delta and its waterways, but not
37 the DCC waterway.

38 Operation of the DCC gates affects the PCEs for critical habitat designated for
39 these species. Primarily, DCC gate operations interfere with the use of the
40 Sacramento River as a migratory corridor for Chinook Salmon and steelhead
41 juveniles during their downstream migration from spawning grounds upstream of
42 the Delta to San Francisco Bay and the Pacific Ocean. The operation of the gates
43 permits fish to enter habitat and waterways they would not normally access, with
44 substantially higher predation risks than the migratory corridor available in the
45 Sacramento River channel. Under the No Action Alternative, operation of the

1 gates could have a direct effect on the entrainment rate and hence the functioning
2 of the Sacramento River as a migratory corridor.

3 **9.4.2.2.4 Effects Related to Cross Delta Water Transfers**

4 Because all water transfers would be required to avoid adverse impacts to other
5 water users and biological resources (see Section 3.A.6.3, Transfers), including
6 impacts associated with changes in reservoir storage and river flow patterns.
7 Potential effects to aquatic resources could be similar to those identified in a
8 recent environmental analysis conducted by Reclamation for long-term water
9 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
10 Potential effects were identified as changes to fish in the reservoirs and in the
11 rivers downstream of the reservoirs and the Delta. The analysis indicated that the
12 reservoirs did not support primary populations of fish species of management
13 concern, and that the reservoirs would continue to be operated within the
14 historical range of operations. The analysis also indicated that mean monthly
15 flows in the major rivers or creeks in the Sacramento and San Joaquin rivers
16 watersheds would be similar (less than 10 percent change) with water transfers as
17 compared to without water transfers; and therefore, changes to aquatic resources
18 would be less than substantial. Delta conditions also would be similar with water
19 transfers as compared to without water transfers, including less than 5 percent
20 changes in Delta exports and less than 1.3 percent changes in Delta outflow and
21 X2 position. Therefore, changes to aquatic resources would be less than
22 substantial. For the purposes of this EIS, it is anticipated that similar conditions
23 would occur due to cross Delta water transfers under the No Action
24 Alternative and the Second Basis of Comparison.

25 Under the No Action Alternative, the timing of cross Delta water transfers would
26 be limited to July through September in accordance with the 2008 USFWS BO
27 and 2009 NMFS BO. The maximum amount of water to be transferred would be
28 600,000 acre-feet/year in critical dry years or in dry years following a dry or
29 critical dry year. In all other water year types, the maximum amount of water
30 would be 360,000 acre-feet/year.

31 **9.4.2.2.5 Conditions for Fish Passage**

32 As described in Chapter 3, Description of Alternatives, the No Action
33 Alternative includes a suite of RPA actions intended to examine the
34 reintroduction of salmonids into historical habitats upstream of currently
35 impassable artificial barriers. The actions include consideration for passage of
36 winter-run and spring-run Chinook Salmon, and steelhead above Shasta Dam on
37 the Sacramento River, steelhead above Nimbus and Folsom dams on the
38 American River, and steelhead above Goodwin, Tulloch, and New Melones dams
39 on the Stanislaus River. The action suite outlines multiple planning and
40 implementation steps to evaluate the efficacy of passage before long-term fish
41 passage is provided. However, for the purposes of the describing the No Action
42 Alternative, fish passage at each of these facilities (likely through interim means)
43 is assumed to be functional by 2030.

1 As described in the Affected Environment, Reclamation is currently developing
2 near-term and long-term fish passage solutions to provide access by anadromous
3 salmonids to habitat upstream of Shasta Lake (2009 NMFS BO RPA
4 Action I.2.5). The evaluation includes assessments of amount, suitability, and
5 location of potential habitat, potential risks (e.g., predation by resident fish,
6 disease transmission), as well as feasibility of providing upstream and
7 downstream passage. There are approximately 60 mainstem miles and the
8 McCloud River upstream of Shasta Lake. Reclamation (2014c) estimated
9 approximately 9 river-miles of suitable winter-run Chinook Salmon spawning
10 habitat in the upper Sacramento River below Box Canyon Dam, and
11 approximately 12 river-miles of suitable spawning habitat for winter-run Chinook
12 Salmon in the McCloud River below McCloud Dam. By 2030, access to this
13 habitat could not only expand the amount of habitat available for winter-run
14 Chinook Salmon relative to recent conditions, but provide access to areas of
15 temperature refuge at a time when water temperatures in the river downstream of
16 Keswick Dam are anticipated to increase. This could be particularly beneficial as
17 winter-run Chinook Salmon are currently at high risk of extinction. Extinction
18 factors include: winter-run Chinook Salmon is composed of only one population,
19 which has been blocked from all of its historic spawning habitat; the potential for
20 catastrophic risks associated with proximity to Mt. Lassen and the population's
21 dependency on the cold water management of Shasta Lake; and the population
22 has a "high" hatchery influence (Lindley et al. 2007). Combined with
23 improvements on Battle Creek that are expected to support a second population
24 component of winter-run Chinook Salmon, the provision for fish passage
25 upstream of Shasta Dam may support a third population, which is consistent with
26 the NMFS Recovery Plan for this species (NMFS 2014b).

27 Similarly, conditions for steelhead in the American River could be influenced by
28 fish passage at Nimbus and Folsom dams afforded by implementation of 2009
29 NMFS BO RPA Action II.5. As described in the Affected Environment, water
30 temperature conditions in the lower American River downstream of Nimbus Dam
31 currently present challenges for steelhead, especially rearing juveniles. Under the
32 No Action Alternative, anticipated increases in temperature related to climate
33 change could increase the vulnerability of steelhead to serious effects of elevated
34 temperatures in most years, particularly in dry and critical dry years, even if
35 actions are taken to improve temperature management. The provision of passage
36 to upstream reaches of the American River, including tributaries, would give
37 steelhead access to former spawning and rearing habitat higher in the system
38 where water temperatures are cooler and remain cooler during the summer
39 months. Assuming this action results in fish passage by 2030, conditions for
40 steelhead are expected to improve because of the increased amount of available
41 habitat and the ability to access cooler water temperatures.

42 Relative to recent conditions, substantial improvements also would be expected
43 for steelhead on the Stanislaus River under the No Action Alternative, if 2009
44 NMFS BO RPA Action II.2.4 is determined feasible and is implemented by 2030.
45 As described in the Affected Environment, steelhead in the Stanislaus River are
46 exposed to multiple stressors, including high water temperatures during adult

1 immigration, embryo incubation, juvenile rearing, and smolt outmigration. In
 2 addition, flow-dependent habitat availability is limited, particularly for the
 3 spawning, juvenile rearing, and smolt outmigration life stages. Access to former
 4 habitat in upstream areas under the No Action Alternative are anticipated to
 5 reduce many of the stressors associated with recent conditions and could provide
 6 improved resilience to climate change.

7 **9.4.2.2.6 Ocean Conditions**

8 Operation of the CVP and SWP would not directly affect ocean conditions;
 9 however, operations have the potential to affect Southern Resident Killer Whales
 10 indirectly by influencing the number of Chinook Salmon (produced in the
 11 Sacramento-San Joaquin River and associated tributaries) that enter the Pacific
 12 Ocean and become available as a food supply for the whales. The No Action
 13 Alternative would not directly affect critical habitat for Killer Whales. However,
 14 under the No Action Alternative, production of wild Chinook Salmon could
 15 increase with increased area and quality of habitat for Chinook Salmon, as
 16 discussed previously. Chinook Salmon from the Central Valley rivers and
 17 streams likely represent only a very small proportion of the diet of this Killer
 18 Whale population because most of their feeding is on Fraser River and Puget
 19 Sound stocks (Hanson et al. 2010). Therefore, any increase in the population of
 20 Chinook Salmon originating from the Central Valley under the No Action
 21 Alternative is not expected to substantially influence the Southern Resident Killer
 22 Whale population.

23 **9.4.2.3 Second Basis of Comparison**

24 As described in Chapter 3, Description of Alternatives, the Second Basis of
 25 Comparison is based upon:

- 26 • Coordinated long-term operation of the CVP and SWP in 2030 without
 27 implementation of the 2008 USFWS BO and the 2009 NMFS BO RPAs
- 28 • Changes in CVP and SWP operations due to climate change and sea level rise,
 29 and increased CVP and water rights water demand in portions of the
 30 Sacramento Valley
- 31 • Implementation of reasonable and foreseeable non-CVP and -SWP water
 32 resources projects to provide additional water supplies, as described in
 33 Section 7.4.3.1, No Action Alternative
- 34 • Implementation of RPA actions that address programs and projects that were
 35 ongoing prior to issuance of the 2008 USFWS BO and 2009 NMFS BO,
 36 including restoration of Battle Creek for salmonids; replacement of the Red
 37 Bluff Diversion Dam; restoration of more than 10,000 acres of intertidal and
 38 associated subtidal wetlands in Suisun Marsh and Cache Slough; and
 39 17,000 to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass.

40 Overall, under the Second Basis of Comparison, long-term average CVP and
 41 SWP water supply deliveries by 2030 through the Delta would increase, and late
 42 summer and fall reservoir storage probably would decrease as compared to recent

1 historical conditions without consideration for climate change. However, the
2 Second Basis of Comparison also includes changes not related to the coordinated
3 long-term operation of the CVP and SWP, including changes in CVP and SWP
4 operations due to climate change and sea level rise, increased CVP and water
5 rights water demand in portions of the Sacramento Valley, and implementation of
6 reasonable and foreseeable non-CVP or SWP water resources management
7 projects to provide water supplies, as described under the No Action Alternative.
8 Therefore, primarily due to climate change, both CVP and SWP reservoir storage
9 and long-term average CVP and SWP water supply deliveries would decrease by
10 2030 as compared to historical long-term average deliveries.

11 Under the Second Basis of Comparison it is assumed that fish and aquatic
12 resources in 2030 would continue to be influenced by CVP and SWP operations.
13 The resulting changes in ecological attributes and subsequent effects on aquatic
14 resources would vary geographically, as described below.

15 **9.4.2.3.1 Trinity River Region**

16 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

17 End of September reservoir storage in Trinity Lake would be lower by 2030 as
18 compared to recent historical conditions due to climate change and related lower
19 snowfall. Lewiston Reservoir, a regulating reservoir, would be operated with
20 daily changes similar to historical conditions. These changes are not anticipated
21 to substantially affect aquatic resources in Trinity Lake or Lewiston Reservoir
22 relative to recent historical conditions.

23 *Fish Habitat Conditions in Trinity and Lower Klamath Rivers*

24 Under the Second Basis of Comparison, flow, water temperature, and aquatic
25 habitat conditions in the Trinity River would continue to be influenced by CVP
26 and SWP operations as described in the Affected Environment. Due to the
27 increased potential for lower Trinity Lake surface water storage (see above), there
28 could be an increased potential for reduced Trinity River flows during the summer
29 and fall months under the Second Basis of Comparison as compared to recent
30 historical conditions. The influence of climate change could result in higher
31 water temperatures in Trinity Lake that could translate to higher release
32 temperatures in the flow releases from Lewiston Dam and a reduction in habitat
33 quality within the Trinity River for salmonids and other native species.

34 *Effects Related to Water Transfers*

35 It is not anticipated that water would be transferred to or from the Trinity River
36 Region. It also not anticipated that water transfers would result in changes to
37 Trinity Lake operations. Therefore, there would be no change in aquatic habitat
38 conditions as a result of water transfers.

39 **9.4.2.3.2 Central Valley Region**

40 *Aquatic Habitat Conditions in CVP and SWP Reservoirs*

41 Seasonal changes in reservoir surface elevations, storage volumes, and the volume
42 of cold water held within the reservoirs would continue under the Second Basis of

1 Comparison. Conditions for reservoir fishes would continue to change seasonally
 2 in response to inflow and downstream flow releases to meet demand. End of
 3 September reservoir storage would be lower by 2030 as compared to recent
 4 historical conditions in Shasta Lake, Lake Oroville, Folsom Lake, New Melones
 5 Reservoir, and San Luis Reservoir due to climate change and related lower
 6 snowfall. Whiskeytown Lake, Keswick Reservoir, Thermalito Forebay and
 7 Afterbay, and Lake Natoma are regulating reservoirs and would be operated with
 8 daily changes similar to historical conditions.

9 Under the Second Basis of Comparison, the magnitude of changes in seasonal
 10 surface elevation and reservoir storage could be more pronounced because of
 11 changes in the timing and intensity of storm events due to climate change and an
 12 overall reduction in snow pack. By 2030, fish in these reservoirs that spawn in
 13 shallow water (e.g., various species of black bass) could be subject to a
 14 hydrologic regime that increases the frequency of reductions in surface elevation
 15 during the spring spawning period, reducing spawning success. In addition,
 16 reduced storage volumes and reduction of the cold water pools could reduce the
 17 amount and suitability of habitat for cold water fishes (e.g., trout) within the
 18 reservoirs relative to recent historical conditions.

19 *Aquatic Habitat Conditions in Rivers Downstream of CVP and SWP Facilities*

20 Surface water flows are anticipated to increase during the winter months as a
 21 result of an increase in rainfall and decrease in snowfall, and to decrease in other
 22 months because of the diminished snowmelt flows in the spring and early summer
 23 months. Climate change is anticipated to result in higher water temperatures
 24 during portions of the year, with a corresponding reduction in habitat quality for
 25 salmonids and other cold water fishes. Increased downstream water demands and
 26 climate change are anticipated to contribute to an inability to maintain an
 27 adequate cold water pool in critical dry years and extended dry periods in the
 28 future.

29 *Aquatic Habitat Conditions in Clear Creek from Whiskeytown Dam to*
 30 *Sacramento River*

31 Under the Second Basis of Comparison, flow, water temperature, and aquatic
 32 habitat conditions in Clear Creek would continue to be influenced by CVP and
 33 SWP operations. Whiskeytown Reservoir would continue to be operated to
 34 convey water from the Trinity River to the Sacramento River via the Spring Creek
 35 tunnel and to release flows to Clear Creek to support anadromous fish.

36 The Second Basis of Comparison assumes that one of the 2009 NMFS BO RPA
 37 actions intended to improve conditions for salmonids would be implemented,
 38 2009 NMFS BO RPA Action I.3 Spawning Gravel Augmentation, which is
 39 currently being implemented as part of the CVPIA. This action addresses the
 40 limited availability of spawning habitat in Clear Creek through the placement of
 41 gravel in selected sites in the creek. The gravel augmentation program is
 42 expected to continue under the Second Basis of Comparison, resulting in
 43 continued improvements to physical spawning habitat for steelhead, and spring-
 44 run and fall-run Chinook Salmon by 2030.

1 Water temperatures in Clear Creek are influenced by the temperature of water in
2 the Whiskeytown Reservoir, ambient air temperatures, and solar radiation, and to
3 some extent the magnitude of Whiskeytown Dam release flows. As described
4 above for the No Action Alternative, Whiskeytown Dam has limited temperature
5 control capabilities; however, the Spring Creek Temperature Control Curtain
6 continues to be operated under the Second Basis of Comparison. With increasing
7 ambient air temperature and changes in precipitation patterns as result of global
8 warming, it may not be possible to meet the temperature targets as often in 2030
9 under the Second Basis of Comparison relative to recent conditions.

10 *Aquatic Habitat Conditions in the Sacramento River from Keswick to*
11 *Freeport*

12 Under the Second Basis of Comparison, flow, water temperature, and aquatic
13 habitat conditions in the Sacramento River downstream of Keswick Dam would
14 continue to be influenced by CVP and SWP operations. Shasta Lake would
15 continue to be operated to convey water from the Sacramento River to the Delta
16 and release flows to the Sacramento River to support anadromous fish.
17 Reclamation would continue to operate Shasta Lake to optimize use of the cold
18 water pool and maintain carryover storage for temperature control in the
19 Sacramento River downstream of Shasta and Keswick dams. As described above
20 for the No Action Alternative, it is likely that temperature-related effects in the
21 Sacramento River under the Second Basis of Comparison also would be
22 unavoidable in some years; however, restoration of habitat in Battle Creek (see
23 below) may compensate for these periods of unavoidably high temperatures by
24 providing passage and habitat conditions to support a second population of
25 winter-run Chinook Salmon.

26 The Red Bluff Pumping Plant and fish screen, which diverts water to the Tehama
27 Colusa Canal and Corning Canal, was constructed to allow year-round opening of
28 the gates at the RBDD. Allowing the dam gates at RBDD to remain open allows
29 salmonids, sturgeon, and other fish species to pass unimpeded all year. These
30 passage improvements are anticipated to improve conditions for fish species that
31 spawn upstream of RBDD through improved access to spawning and rearing
32 areas and a reduction in predation due to dispersal of predator species like Striped
33 Bass and Sacramento Pikeminnow.

34 As described above for the No Action Alternative, it is anticipated that worsening
35 temperature conditions under the Second Basis of Comparison would occur in
36 some years as a result of increased demands for water by 2030, climate change,
37 and less water being diverted from the Trinity River. Continued implementation
38 of the Battle Creek Restoration Program would partially compensate for
39 unavoidable adverse effects by restoring winter-run and spring-run Chinook
40 Salmon habitat to the Battle Creek watershed. Full implementation of the Battle
41 Creek Restoration Program is expected to substantially improve passage
42 conditions for adult Chinook Salmon and steelhead relative to recent conditions.
43 The Battle Creek Restoration Program has a goal of improving habitat for a
44 second population component of winter-run Chinook Salmon, which could reduce

1 the risk of extinction of the species from lost resiliency and increased
2 vulnerability to catastrophic events.

3 *Aquatic Habitat Conditions in the Feather River from Oroville Dam to*
4 *Sacramento River*

5 Feather River flows in the high flow channel downstream of Thermalito Dam
6 under the Second Basis of Comparison would be influenced by regulation to meet
7 water temperature criteria and to coordinate Lake Oroville releases and Delta
8 export operations. Flows in the low flow channel downstream of Lake Oroville
9 would remain similar to recent conditions. As part of the ongoing FERC
10 relicensing process for the Oroville facilities, DWR has entered into a Settlement
11 Agreement (DWR 2006) that includes actions to be implemented and included as
12 terms of the anticipated FERC license. Depending on the progress of the
13 relicensing process, these actions could be implemented by 2030 under the
14 Second Basis of Comparison and could improve fish habitat conditions in the
15 Feather River relative to recent conditions.

16 Under the terms of the Settlement Agreement, DWR will develop a
17 comprehensive Lower Feather River Habitat Improvement Plan. Implementation
18 of the habitat improvement plan and other actions under the terms of the
19 Settlement Agreement is anticipated to improve habitat conditions and water
20 quality for salmonids and other fishes using the channels of the Feather River
21 above the confluence with the Sacramento River under the Second Basis of
22 Comparison.

23 *Aquatic Habitat Conditions in the American River from Nimbus Dam to*
24 *Sacramento River*

25 Reclamation releases water to the lower American River consistent with flood
26 control requirements; existing water rights; CVP operations; the Lower American
27 River Flow Management Standard; and SWRCB Decision 893 (D-893). Under
28 the Second Basis of Comparison, American River flows would be influenced by
29 releases for regulation to meet water temperature criteria, and to coordinate timed
30 Folsom Lake releases and Delta exports. It is anticipated that conditions for fish
31 in the lower American River under the Second Basis of Comparison would
32 worsen relative to recent past operations of the American River Division of the
33 CVP because of continued operation of the American River Division through
34 2030 to meet increasing water demands. In addition, the influence of climate
35 change could alter hydrologic conditions in the region and affect habitat
36 conditions for fish in the American River.

37 Through 2030, Reclamation would implement the flow schedule specified in the
38 American River Flow Management Standard. The flow schedule specifies
39 minimum flows and does not preclude Reclamation from making higher releases
40 at Nimbus Dam. The flow schedule was developed to require more protective
41 minimum flows in the lower American River in consideration of the river's
42 aquatic resources, particularly steelhead and fall-run Chinook Salmon.

1 *Aquatic Habitat Conditions in the San Joaquin River from Friant Dam to the*
2 *Stanislaus River*

3 Under the Second Basis of Comparison, fish and aquatic habitat conditions in the
4 San Joaquin River downstream of Friant Dam would remain similar to those
5 described under the Affected Environment, although water temperatures could
6 increase as a result climate change.

7 *Aquatic Habitat Conditions in the Stanislaus River from Goodwin Dam to San*
8 *Joaquin River*

9 Under the Second Basis of Comparison, flow, water temperature, and aquatic
10 habitat conditions in the Stanislaus River downstream of Goodwin Dam would
11 continue to be influenced by CVP and SWP operations as described in Chapter 5,
12 Surface Water Resources and Water Supplies. However, by 2030, conditions for
13 fish in the Stanislaus River fish are expected to worsen relative to recent
14 conditions because of continued operation to meet increasing water demands.
15 In addition, the influence of climate change is expected to begin to alter
16 hydrologic conditions in the region and affect habitat conditions for fish in the
17 Stanislaus River.

18 Under the Second Basis of Comparison, management of the cold water supply
19 within New Melones Reservoir would continue, as would cold water releases
20 from the reservoir to provide suitable temperatures for steelhead rearing,
21 spawning, egg incubation smoltification, and adult migration in the Stanislaus
22 River downstream of Goodwin Dam. There are no temperature control devices at
23 New Melones, Goodwin, or Tulloch dams, so the only mechanism for temperature
24 management is direct flow management. This has been achieved in the recent
25 past through a combination of augmenting baseline water operations for meeting
26 senior water right deliveries and D-1641 water quality standards with additional
27 flows from: 1) the CDFW fish agreement, and 2) from b(2) or b(3) water
28 acquisitions. Access to these resources to offset operational temperature effects
29 on steelhead in the Stanislaus River would continue to be limited, particularly in
30 Conference Years and in drier Mid-Allocation Years. Under the Second Basis of
31 Comparison, steelhead would likely continue to be vulnerable to the effects of
32 elevated temperatures in dry and critical dry years. The frequency of these
33 occurrences is expected to increase with climate change and increased water
34 demands.

35 Reclamation would continue to operate releases from the East Side Division
36 reservoirs to achieve the minimum flow schedule specified in the 1997 New
37 Melones Interim Plan of Operations as described in Chapter 5, Surface Water
38 Resources and Water Supplies. Because this flow schedule has been in place for
39 a number of years, habitat conditions for steelhead and other fish species in the
40 Stanislaus River are not anticipated to improve under the Second Basis of
41 Comparison relative to recent conditions.

42 Dam operations would continue to suppress channel-forming flows that replenish
43 spawning beds. The physical presence of the dams impedes normal sediment
44 transportation processes. Climate change may affect the types and cover rates of

1 vegetation upslope of the river, potentially increasing the rate of fine sediment
 2 transport to the river and to spawning areas Ongoing gravel augmentation through
 3 2030 is anticipated to maintain or improve physical spawning habitat conditions
 4 for steelhead.

5 *Aquatic Habitat Conditions in the Yolo Bypass (including Cache Slough,*
 6 *Lower Putah Creek, and Fremont Weir)*

7 Similar to the No Action Alternative, it is assumed under the Second Basis of
 8 Comparison that restoration of up to 20,000 acres of seasonal floodplain
 9 restoration in the Yolo Bypass would occur by 2030. Actions in the Yolo Bypass
 10 also would include improvements in fish passage at Fremont Weir for
 11 anadromous salmonids, sturgeon, and other native fish species. Implementation
 12 of these ecosystem restoration actions and improvements could increase winter
 13 and spring growth and survival (relative to recent conditions) of juvenile Chinook
 14 Salmon, steelhead, and other native fish by providing increased seasonal access to
 15 productive foraging and high quality rearing habitat, depending on the extent and
 16 duration of restoration and inundation. These actions are also expected to reduce
 17 migratory delays or losses by reducing predation, straying, and delays for
 18 salmonids and other migratory native fish species.

19 *Aquatic Habitat Conditions in the Delta*

20 As described in Chapter 3, Description of Alternatives, the Second Basis of
 21 Comparison is based on coordinated long-term operation of the CVP and SWP in
 22 2030 without implementation of the 2008 USFWS BO and the 2009 NMFS BO
 23 RPAs. Similar to the No Action Alternative, reasonable and foreseeable non-
 24 CVP and -SWP water resources projects to provide additional water supplies
 25 would be implemented, in addition to restoration of more than 10,000 acres of
 26 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;
 27 and up to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass.

28 Under the Second Basis of Comparison, flows, water quality, and aquatic habitat
 29 conditions in the Delta would continue to be influenced by CVP and SWP
 30 operations. Climate change would result in increased stream flows in the winter
 31 and spring months during storm events due to precipitation primarily occurring as
 32 rain instead of snowfall. The increased stream flows also would increase Delta
 33 outflow. Delta outflow also would be increased in the spring and summer months
 34 as more water is released from the CVP and SWP reservoirs to maintain salinity
 35 criteria in the western Delta in response to sea level rise.

36 Under the Second Basis of Comparison in 2030, many years will have passed
 37 without seasonal limitations on OMR reverse (negative) flow rates, with the
 38 anticipated result that fish entrainment would occur at levels comparable to recent
 39 historical conditions. Future pumping operations would continue to expose fish to
 40 the salvage facilities and entrainment losses into the future. As described above
 41 for the No Action Alternative, recent coded wire tagging and acoustic studies
 42 have shown that survival of hatchery-origin juvenile Chinook Salmon was higher
 43 through the south Delta via the Old River route than via the San Joaquin River
 44 and that this may be due to increased survival during salvage at the facilities

1 (Buchanan et al. 2013, 2015; SJRGA 2013). Zeug and Cavallo (2014) suggest
2 that entrainment losses at the diversions may be small relative to overall migration
3 mortality.

4 Furthermore, operation of the permanent gates would lead to losses associated
5 with predation at the physical structures and the local and far-field hydraulic
6 conditions created by the barriers. Under the Second Basis of Comparison,
7 significant reductions in the abundance of steelhead and fall-run Chinook Salmon
8 originating in the San Joaquin River basin, (as well as the Calaveras River and
9 Mokelumne River basins) are likely to continue.

10 As described above for the No Action Alternative, abundance levels for Delta
11 Smelt, Longfin Smelt, Striped Bass, Threadfin Shad, and American Shad are
12 currently very low, and abundance and habitat conditions for fish in the Delta in
13 future years are difficult to predict. It is not likely that operations of the CVP and
14 SWP under the Second Basis of Comparison would result in improvement of
15 habitat conditions in the Delta or increases in populations for these fish by 2030,
16 and the recent trajectory of loss would likely continue.

17 **9.4.2.3.3 Special Status Species and Critical Habitat**

18 *Clear Creek*

19 Clear Creek is designated critical habitat for spring-run Chinook Salmon and
20 Central Valley steelhead. The PCEs of critical habitat for both species include
21 freshwater spawning sites, freshwater rearing areas, and freshwater migration
22 corridors. Spawning and rearing habitat for spring-run Chinook Salmon in Clear
23 Creek has been negatively affected by flow and water temperature conditions
24 associated with current operations. Under the Second Basis of Comparison, there
25 would be little change in the PCEs of critical habitat for spring-run Chinook
26 Salmon and Central Valley steelhead relative to recent conditions. Ongoing
27 gravel augmentation in Clear Creek will likely result in improvements to Chinook
28 Salmon and steelhead physical spawning habitat in Clear Creek. However, due to
29 climate change, the conservation value of critical habitat for these species will
30 likely be reduced under the Second Basis of Comparison by 2030, particularly in
31 drier years when cold water releases cannot be maintained from
32 Whiskeytown Dam.

33 *Sacramento River*

34 The Sacramento River provides three of the six PCEs essential to support one or
35 more life stages, including freshwater spawning sites, rearing sites, and migration
36 corridors for winter-run Chinook Salmon, spring-run Chinook Salmon, and
37 Central Valley steelhead. The Sacramento River is also designated critical habitat
38 for the Southern DPS of green sturgeon. Flow and temperature changes under the
39 Second Basis of Comparison and the effects on spawning and rearing habitat
40 quality were described previously.

41 As described above for the No Action Alternative, climate change is likely to
42 reduce the conservation value of the spawning and rearing habitat PCEs of critical
43 habitat by increasing water temperatures. The reduction in essential features of

1 the spawning and rearing habitat PCEs could reduce the spatial structure,
2 abundance, and productivity of salmonids.

3 The year-round opening of the gates at the RBDD allows salmonids to pass
4 unimpeded, enhancing the conservation value of the PCE for migration. Critical
5 habitat for green Sturgeon would also improve from unimpeded access to suitable
6 spawning habitat upstream of the RBDD. The improved passage at the RBDD
7 will increase the number of deep holding pools that adult Green Sturgeon can
8 access, thereby increasing the conservation value of the water depth PCE. In
9 addition, as described above, predation on salmon, steelhead, and sturgeon would
10 be reduced relative to recent conditions when the RBDD was operational.

11 The No Action Alternative includes implementation of the CVPIA AFSP to
12 reduce entrainment of juvenile anadromous fish from unscreened diversions. By
13 providing funding to screen priority diversions as identified in the CVPIA AFSP,
14 the loss of listed fish in water diversion channels by 2030 could be reduced. In
15 addition, if new fish screens can be constructed so that diversions can occur at
16 low water surface elevations to allow diversions below a flow of 5,000 cfs at
17 Wilkins Slough, then cold water at Shasta Lake could be conserved during critical
18 dry years for release to support winter-run and spring-run Chinook Salmon needs
19 downstream.

20 *American River*

21 The lower American River downstream of Nimbus Dam is designated critical
22 habitat for Central Valley steelhead. The PCEs of critical habitat in the lower
23 American River include freshwater spawning sites, freshwater rearing areas, and
24 freshwater migration corridors. Flow and temperature changes under the Second
25 Basis of Comparison and the effects on spawning and rearing habitat quality were
26 described previously. In addition, the influence of climate change is expected to
27 alter hydrologic and temperature conditions in the region and adversely affect the
28 PCEs for Central Valley steelhead critical habitat in the American River,
29 primarily through increased water temperatures.

30 *Stanislaus River*

31 The lower Stanislaus River downstream of Goodwin Dam is designated critical
32 habitat for Central Valley steelhead. The PCEs of critical habitat in the Stanislaus
33 River include freshwater spawning sites, freshwater rearing areas, and freshwater
34 migration corridors. Flow and temperature changes under the Second Basis of
35 Comparison and the effects on spawning and rearing habitat quality were
36 described previously. The PCEs for spawning and rearing habitat have been
37 adversely affected by elimination of geomorphic processes that replenish and
38 rejuvenate spawning riffles and inundate floodplain terraces to provide nutrients
39 and rearing habitat for juvenile salmonids. In addition, moderation of flood
40 events also eliminates or reduces the intensity and duration of freshets and storm
41 flows, which adversely affects the PCE for migration corridors. The influence of
42 climate change could begin to alter hydrologic and temperature conditions in the
43 region and adversely affect the PCEs for Central Valley steelhead critical habitat
44 in the Stanislaus River, primarily through increased water temperatures.

1 *Delta*

2 As described above for the No Action Alternative, designated critical habitat for
3 both winter-run and spring-run Chinook Salmon lies adjacent to the location of
4 the DCC gates and designated critical habitat for spring-run Chinook Salmon
5 includes the DCC from its point of origin on the Sacramento River to its terminus
6 at Snodgrass Slough. Designated critical habitat for Central Valley steelhead
7 includes most of the Delta and its waterways; however, the DCC waterway was
8 not included in designated critical habitat for this species.

9 Operation of the DCC gates under the Second Basis of Comparison will continue
10 to affect the PCEs for critical habitat designated for spring-run Chinook Salmon
11 and steelhead, primarily, the use of the Sacramento River as a migratory corridor.
12 The operation of the gates permits fish to enter habitat and waterways they would
13 not normally have access to with substantially higher predation risks than the
14 migratory corridor available in the Sacramento River channel. Operation of the
15 gates can have a direct effect on the entrainment rate and hence the functioning of
16 the Sacramento River as a migratory corridor. Without the modifications to DCC
17 gate operations to reduce loss of emigrating salmonids and green sturgeon
18 described for the No Action Alternative, entrainment in the DCC will continue to
19 be similar to recent historical conditions.

20 **9.4.2.3.4 Effects Related to Cross Delta Water Transfers**

21 As described under the No Action Alternative, all water transfers would be
22 required to avoid adverse impacts to other water users and biological resources
23 (see Section 3.A.6.3, Transfers), including impacts associated with changes in
24 reservoir storage and river flow patterns. Potential effects to aquatic resources
25 could be similar to those identified in a recent environmental analysis conducted
26 by Reclamation for long-term water transfers from the Sacramento to San Joaquin
27 valleys (Reclamation 2014d). Potential effects were identified as changes to fish
28 in the reservoirs and in the rivers downstream of the reservoirs and the Delta. The
29 analysis indicated that the reservoirs did not support primary populations of fish
30 species of management concern, and that the reservoirs would continue to be
31 operated within the historical range of operations. The analysis also indicated that
32 mean monthly flows in the major rivers or creeks in the Sacramento and San
33 Joaquin rivers watersheds would be similar (less than 10 percent change) with
34 water transfers as compared to without water transfers; and therefore, changes to
35 aquatic resources would be less than substantial. Delta conditions also would be
36 similar with water transfers as compared to without water transfers, including less
37 than 5 percent changes in Delta exports and less than 1.3 percent changes in Delta
38 outflow and X2 position. Therefore, changes to aquatic resources would be less
39 than substantial. For the purposes of this EIS, it is anticipated that similar
40 conditions would occur due to cross Delta water transfers under the No Action
41 Alternative and the Second Basis of Comparison.

42 Under the Second Basis of Comparison, water transfers could occur throughout
43 the year depending upon limitations of available conveyance capacity and
44 regulatory requirements.

1 **9.4.2.3.5 Conditions for Fish Passage**

2 Conditions for fish passage at Shasta, Folsom, and New Melones dams under the
3 Second Basis of Comparison would be the same as described in the Affected
4 Environment because passage of fish to river reaches above these dams would not
5 be provided. Populations of anadromous fish under the Second Basis of
6 Comparison would continue to be restricted to the river reaches downstream of
7 these dams and subjected to increasing water temperatures associated primarily
8 with climate change.

9 **9.4.2.3.6 Ocean Conditions**

10 Conditions for the Southern Resident Killer Whale under the Second Basis of
11 Comparison would differ from those for the No Action Alternative, but the effects
12 on Killer Whales would be the same.

13 **9.4.3 Evaluation of Alternatives**

14 Alternatives 1 through 5 have been compared to the No Action Alternative; and
15 the No Action Alternative and Alternatives 1 through 5 have been compared to
16 the Second Basis of Comparison.

17 **9.4.3.1 No Action Alternative Compared to the Second Basis of**
18 **Comparison**

19 The No Action Alternative is compared to the Second Basis of Comparison.

20 **9.4.3.1.1 Trinity River Region**

21 *Coho Salmon*

22 The analysis of effects associated with changes in operation on Coho Salmon was
23 conducted using temperature model outputs for Lewiston Dam to anticipate the
24 likely effects on conditions in the Trinity River downstream of Lewiston Dam for
25 Coho Salmon.

26 Long term average monthly water temperatures in the Trinity River at Lewiston
27 Dam under No Action Alternative generally would be similar to the temperatures
28 that would occur under the Second Basis of Comparison (Appendix 6B,
29 Table B-1-4). Average monthly temperatures under the Second Basis of
30 Comparison generally would be similar to those predicted under the No Action
31 Alternative in most water year types, except from November through January in
32 above- and below-normal water years when water temperatures under the No
33 Action Alternative could be up to 1.5°F warmer than under the Second Basis of
34 Comparison. In November of critical years, water temperatures under the No
35 Action Alternative could be as much as 2.4°F cooler than under the Second Basis
36 of Comparison (Appendix 6B, Table B-1-4). Average monthly water
37 temperatures generally would be similar (less than 0.5°F difference) under the No
38 Action Alternative and Second Basis of Comparison from July through
39 September, except in September of wet years when temperatures would be
40 slightly lower (0.6°F) and in August of critical years when temperatures could be

1 slightly (0.7°F) higher under the No Action Alternative (Appendix 6B,
2 Table B-1-4).

3 Overall, the temperature differences between the No Action Alternative and
4 Second Basis of Comparison would be relatively minor and likely would have
5 little effect on Coho Salmon in the Trinity River. The substantially lower water
6 temperatures in November of critical dry years (and higher temperatures in
7 December) under the No Action Alternative would likely have little effect on
8 Coho Salmon as water temperatures in the Trinity River are typically low during
9 this time period.

10 The USFWS established a water temperature threshold of 56°F for Coho Salmon
11 spawning in the reach of the Trinity River from Lewiston Dam to the confluence
12 with the North Fork Trinity River from October through December. Although not
13 entirely reflective of water temperatures throughout the reach, the temperature
14 model provides average monthly water temperature outputs for releases from
15 Lewiston Dam, which may provide perspective on temperature conditions in the
16 reach below. In October and November, average monthly water temperatures
17 under both the No Action Alternative and Second Basis of Comparison would
18 exceed 56°F at Lewiston Dam in some years (Appendix 9N). Under the No
19 Action Alternative, the threshold would be exceeded about 8 percent of the time
20 in October, about 1 percent more frequently than under the Second Basis of
21 Comparison. In November, both scenarios would result in an exceedance
22 frequency of about 2 percent. There would be no exceedance of the threshold in
23 December under both the No Action Alternative and the Second Basis of
24 Comparison.

25 Overall, the temperature model outputs for each of the Coho Salmon life stages
26 suggest that the temperature of water released at Lewiston Dam generally would
27 be similar under both scenarios, although the exceedance of water temperature
28 thresholds would be slightly more frequent (1 percent) under the No Action
29 Alternative. Given the similarity of the results and the inherent uncertainty
30 associated with the resolution of the temperature model (average monthly
31 outputs), it is concluded that the No Action Alternative and Second Basis of
32 Comparison are likely to have similar effects on the Coho Salmon population in
33 the Trinity River.

34 *Spring-run Chinook Salmon*

35 As described above for Coho Salmon, the temperature differences between the No
36 Action Alternative and Second Basis of Comparison (Appendix 6B, Table B-1-4)
37 would be relatively minor (less than 0.5°F) and likely would have little effect on
38 spring-run Chinook Salmon in the Trinity River. The lower water temperatures in
39 November of critical dry years (and higher temperatures in December) under the
40 No Action Alternative would likely have little effect on spring-run Chinook
41 Salmon as water temperatures in the Trinity River are typically low during this
42 time period.

1 Under both the No Action Alternative and the Second Basis of Comparison,
2 average monthly water temperatures in the Trinity River at Lewiston Dam would
3 infrequently (1 percent to 2 percent of the time) exceed 60°F (Appendix 9N), the
4 threshold for spring-run Chinook Salmon holding. There would be no difference
5 in the frequency of exceedance of the 60°F threshold under the No Action
6 Alternative as compared to the Second Basis of Comparison. In September,
7 however, the threshold for spawning (56°F) would be exceeded 9 percent of the
8 time under the No Action Alternative, which is 2 percent less frequently than
9 under the Second Basis of Comparison (11 percent).

10 The differences in the frequency of threshold exceedance between the No Action
11 Alternative and Second Basis of Comparison would be relatively minor, although
12 temperature conditions under the No Action Alternative could be less likely to
13 affect spring-run Chinook Salmon spawning than under the Second Basis of
14 Comparison because of the slightly (2 percent) reduced frequency of exceedance
15 of the 56°F threshold at Lewiston Dam in September.

16 Overall, water temperature differences could adversely influence spring-run
17 Chinook Salmon in the Trinity River under the Second Basis of Comparison;
18 however, these effects would not occur in every year and are not anticipated to be
19 substantial based on the relatively small differences in water temperatures under
20 the No Action Alternative as compared to the Second Basis of Comparison. In
21 addition, the implementation of the Hatchery Management Plan (RPA
22 Action II.6.3) under the No Action Alternative could reduce the impacts of
23 hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity
24 River and increase the genetic diversity and diversity of run-timing for these
25 stocks relative to the Second Basis of Comparison. However, the potential
26 magnitude of these benefits is uncertain. Thus, given these relatively minor
27 changes in temperature and temperature threshold exceedance, the inherent
28 uncertainty associated with the resolution of the temperature model (average
29 monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that
30 the No Action Alternative and Second Basis of Comparison are likely to have
31 similar effects on the spring-run Chinook Salmon in the Trinity River.

32 *Fall-Run Chinook Salmon*

33 The potential effects of operations on fall-run Chinook Salmon were evaluated
34 based on water temperature differences and threshold comparisons as described
35 above for Coho and spring-run Chinook Salmon. In addition, the Reclamation
36 Salmon Mortality Model (Appendix 9C) was applied to examine the anticipated
37 effects of water temperature on egg mortality.

38 The water temperature differences in the Trinity River at Lewiston Dam between
39 the No Action Alternative and Second Basis of Comparison (Appendix 6B,
40 Table B-1-4) would be relatively minor (less than 0.5°F) and likely would have
41 little effect on fall-run Chinook Salmon. The lower water temperatures in
42 November of critical years (and higher temperatures in December) under the No
43 Action Alternative would likely have little effect on fall-run Chinook Salmon as
44 water temperatures in the Trinity River are typically low during this time period.

1 The temperature threshold and months during which it applies for fall-run
2 Chinook Salmon are the same as those for Coho Salmon. Under the No Action
3 Alternative, the threshold would be exceeded about 8 percent of the time in
4 October, about 1 percent more frequently than under the Second Basis of
5 Comparison. In November, both conditions would result in an exceedance
6 frequency of about 2 percent. There would be no exceedance of the threshold in
7 December under either the No Action Alternative or the Second Basis of
8 Comparison.

9 The water temperatures in the Trinity River downstream of Lewiston Dam are
10 reflected in the analysis the Reclamation Salmon Mortality Model. For fall-run
11 Chinook Salmon in the Trinity River, the long-term average egg mortality rate is
12 predicted to be relatively low (around 4 percent), with higher mortality rates
13 (nearly 15 percent) occurring in critical years under the No Action
14 Alternative (Appendix 9C, Table B-1-1). Overall, egg mortality under the No
15 Action Alternative and the Second Basis of Comparison would be similar.

16 In summary, the temperature threshold exceedance suggests that temperature
17 conditions under the No Action Alternative could be slightly more likely to affect
18 fall-run Chinook Salmon spawning than under the Second Basis of Comparison
19 because of the slightly (1 percent) increased frequency of exceedance of the 56°F
20 threshold at Lewiston Dam in October. However, this would occur prior to the
21 peak spawning period for fall-run Chinook Salmon.

22 Although the combined analysis based on water temperature suggests that
23 operations under the No Action Alternative could be slightly more adverse than
24 under the Second Basis of Comparison, these effects would not occur in every
25 year and are not anticipated to be substantial based on the relatively small
26 differences in water temperatures (as well as egg mortality) between the No
27 Action Alternative as compared to the Second Basis of Comparison. In addition,
28 these potential adverse effects could be offset by implementation of the Hatchery
29 Management Plan (RPA Action II.6.3) under the No Action Alternative, which
30 could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook
31 Salmon in the Trinity River, and increase the genetic diversity and diversity of
32 run-timing for these stocks relative to the Second Basis of Comparison. Overall,
33 given the small differences in the numerical model results and the inherent
34 uncertainty in the temperature model, as well as the potential for offsetting
35 benefits associated with actions that were not modeled, it is concluded that the No
36 Action Alternative and Second Basis of Comparison are likely to have similar
37 effects on the fall-run Chinook Salmon population in the Trinity River.

38 *Steelhead*

39 The temperature differences between the No Action Alternative and Second Basis
40 of Comparison (Appendix 6B) would be relatively minor (less than 0.5°F) and
41 likely would have little effect on steelhead in the Trinity River. The substantially
42 lower water temperatures in November of critical years (and higher temperatures
43 in December) under the No Action Alternative would likely have little effect on

1 steelhead as water temperatures in the Trinity River are typically low during this
2 time period.

3 The temperature threshold for spawning and the months during which it applies
4 for steelhead are the same as those for Coho Salmon. Thus, the frequency of
5 average monthly water temperatures in the Trinity River at Lewiston Dam
6 exceeding the spawning threshold of 56°F for steelhead would be the same as
7 those described above for Coho Salmon. The differences in the frequency of
8 threshold exceedance between the No Action Alternative and Second Basis of
9 Comparison would be relatively minor, although temperature conditions under the
10 No Action Alternative could be more likely to affect steelhead spawning than
11 under the Second Basis of Comparison because of the slightly (1 percent)
12 increased frequency of exceedance of the 56°F threshold at Lewiston Dam in
13 October.

14 Although the combined analysis based on water temperature suggests that
15 operations under the No Action Alternative could be slightly more adverse than
16 under the Second Basis of Comparison, these effects would not occur in every
17 year and are not anticipated to be substantial based on the relatively small
18 differences in water temperatures between the No Action Alternative as compared
19 to the Second Basis of Comparison. Overall, given these small differences and
20 the inherent uncertainty in the temperature model, the No Action Alternative and
21 Second Basis of Comparison are likely to have similar effects on the steelhead
22 population in the Trinity River.

23 *Green Sturgeon*

24 As described in the Affected Environment and species accounts (Appendix 9B)
25 Green Sturgeon spawn in the lower reaches of the Trinity River from April
26 through June, and water temperatures above about 63°F are believed stressful to
27 embryos (Van Eenennaam et al. 2005). Average monthly water temperature
28 conditions from April through June in the Trinity River at Lewiston Dam under
29 the No Action Alternative would be similar to temperatures under the Second
30 Basis of Comparison and would not exceed 58°F during this period
31 (Appendix 6B, Table B-1-4). In addition, water temperatures in the reach of the
32 river where Green Sturgeon spawn are likely controlled by other factors
33 (e.g., ambient air temperatures and tributary inflows) more than water operations
34 at Trinity and Lewiston dams.

35 Overall, given the similarities between average monthly water temperatures at
36 Lewiston Dam under the No Action Alternative and the Second Basis of
37 Comparison, it is likely that temperature conditions for Green Sturgeon in the
38 Trinity River or lower Klamath River and estuary would be similar under both
39 scenarios.

40 *Reservoir Fishes*

41 The analysis of effects associated with changes in operation on reservoir fishes in
42 Trinity Lake relied on evaluation of changes in available habitat (reservoir
43 storage) and anticipated changes in black bass nesting success.

1 Changes in CVP water supplies and operations under the No Action
2 Alternative as compared to the Second Basis of Comparison would result in lower
3 reservoir storage in Trinity Lake. Storage in Trinity Lake could be reduced up to
4 around 10 percent in some months of some water year types. Additional
5 information related to monthly reservoir elevations is provided in Appendix 5A,
6 CalSim II and DSM2 Modeling. Using storage volume is an indicator of how
7 much habitat is available to fish species inhabiting these reservoirs, the amount of
8 habitat for reservoir fishes could be reduced under the No Action Alternative as
9 compared to the Second Basis of Comparison.

10 As shown in Appendix 9F, bass nest survival in Trinity Lake is near 100 percent
11 in March and April in response to increasing reservoir elevations. For May, the
12 likelihood of survival for Largemouth Bass in Trinity Lake being in the 40 to
13 100 percent range is slightly (about 1-2 percent) lower under the No Action
14 Alternative as compared to the Second Basis of Comparison. For June, the
15 likelihood of survival being greater than 40 percent for Largemouth Bass is lower
16 than in May and is slightly (about 3 percent) higher under the No Action
17 Alternative than the Second Basis of Comparison. For Spotted Bass, the
18 likelihood of survival being greater than 40 percent is 100 percent in May and
19 June under both the No Action Alternative and the Second Basis of Comparison.

20 Overall, the comparison of storage and the analysis of nesting suggest that effects
21 of the No Action Alternative on reservoir fishes would be similar to those under
22 the Second Basis of Comparison.

23 *Pacific Lamprey*

24 Little information is available on factors that influence populations of Pacific
25 Lamprey in the Trinity River, but they are likely affected by many of the same
26 factors as salmon and steelhead because of the parallels in their life cycles. On
27 average, the temperature of water released at Lewiston Dam under the No Action
28 Alternative would be similar to (within 0.5°F) water temperatures under the
29 Second Basis of Comparison. Changes in CVP water supplies and operations
30 under the No Action Alternative would result in lower reservoir storage in Trinity
31 Lake and somewhat reduced Trinity River flows in December through February
32 in wetter years as compared to the Second Basis of Comparison. The highest
33 reductions in flow would be less than 10 percent in the Trinity River
34 (Appendix 5A), with a smaller relative reduction in the lower Klamath River
35 and Klamath River estuary.

36 Overall, given the similarities between average monthly water temperatures at
37 Lewiston Dam under the No Action Alternative and the Second Basis of
38 Comparison, it is likely that the No Action Alternative would have a similar
39 potential to affect Pacific Lamprey in the Trinity River as the Second Basis of
40 Comparison. This conclusion likely applies to other species of lamprey that
41 inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).

1 *Eulachon*

2 As described in the Affected Environment, the last noticeable runs of Eulachon
3 were observed in 1988 and 1989 by Yurok tribal fishers. It is unclear whether this
4 species has been extirpated from the Klamath River. Given that the highest
5 reductions in flow would be less than 10 percent in the Trinity River, which
6 would represent even a smaller proportion in the lower Klamath River and
7 Klamath River estuary, and that water temperatures in the Klamath River are
8 unlikely to be affected by changes upstream at Lewiston Dam, it is likely that the
9 No Action Alternative would have a similar potential to influence Eulachon in the
10 Klamath River as would the Second Basis of Comparison.

11 **9.4.3.1.2 Sacramento River System**

12 *Winter-run Chinook Salmon*

13 Changes in operations that influence temperature and flow conditions in the
14 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
15 Salmon. The following describes those changes and their potential effects.

16 *Changes in Water Temperature*

17 Long-term average monthly water temperatures in the Sacramento River at
18 Keswick Dam under the No Action Alternative would generally be similar (less
19 than 0.5°F difference) to water temperatures under the Second Basis of
20 Comparison. An exception is during September and October of critical dry years
21 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,
22 under the No Action Alternative as compared to the Second Basis of Comparison
23 and up to 1°F cooler in September of wetter years (Appendix 6B, Table B-5-4).
24 A similar temperature pattern generally would be exhibited downstream at Ball's
25 Ferry, Jelly's Ferry, and Bend Bridge, although average monthly temperatures
26 would increase with average monthly temperature differences between the
27 scenarios progressively decreasing, except in September (up to 2.8°F cooler at
28 Bend Bridge) during wetter years under the No Action Alternative (Appendix 6B,
29 Table B-8-4).

30 Overall, the temperature differences between the No Action Alternative and
31 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
32 likely would have similar effects on winter-run Chinook Salmon in the
33 Sacramento River. Spawning for winter-run Chinook Salmon in the Sacramento
34 River takes place from mid-April to mid-August with incubation occurring over
35 the same time period and extending into October. The somewhat higher water
36 temperatures in September and October of critical dry years under the No Action
37 Alternative could increase the likelihood of adverse effects on winter-run Chinook
38 Salmon egg incubation during this water year type. Whereas, the reduced water
39 temperatures during September and October under the No Action Alternative in
40 wetter years could reduce the likelihood of adverse effects on egg incubation
41 relative to the Second Basis of Comparison.

1 *Changes in Exceedances of Water Temperature Thresholds*

2 With the exception of April, average monthly water temperatures from April to
3 September under both the No Action Alternative and Second Basis of
4 Comparison would show exceedances of the water temperature threshold of 56°F
5 established in the Sacramento River at Ball's Ferry for winter-run Chinook
6 Salmon spawning and egg incubation (Appendix 9N). Under the No Action
7 Alternative, the temperature threshold generally would be exceeded more
8 frequently than under the Second Basis of Comparison (by about 1 percent to
9 3 percent) in the April through August period, with the temperature threshold in
10 September exceeded in 42 percent of the simulated years, about 10 percent less
11 frequently under the No Action Alternative than the Second Basis of Comparison
12 (52 percent).

13 Farther downstream at Bend Bridge, the frequency of exceedances would
14 increase, with exceedances under both the No Action Alternative and Second
15 Basis of Comparison as high as about 90 percent in some months. Under the No
16 Action Alternative, temperature exceedances generally would be more frequent
17 (by up to 8 percent) than under the Second Basis of Comparison, with the
18 exception of September, when threshold exceedances under the No Action
19 Alternative would be about 29 percent less frequent.

20 Overall, there would be substantial differences in the frequency of threshold
21 exceedance between the No Action Alternative and Second Basis of Comparison,
22 particularly in September. Water temperature conditions under the No Action
23 Alternative could be more likely to result in adverse effects on winter-run
24 Chinook Salmon spawning than under the Second Basis of Comparison because
25 of the increased frequency of exceedance of the 56°F threshold from April
26 through August. However, the substantial reduction in the frequency of
27 exceedance in September under the No Action Alternative may reduce the
28 likelihood of adverse effects on winter-run Chinook Salmon egg incubation
29 during this limited portion of the spawning and egg incubation period.

30 *Changes in Egg Mortality*

31 The temperatures described above for the Sacramento River downstream of
32 Keswick Dam are reflected in the analysis of egg mortality using the Reclamation
33 salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the
34 Sacramento River, the long-term average temperature induced egg mortality rate
35 is predicted to be relatively low (around 5 percent), with higher mortality rates
36 (exceeding 20 percent) occurring in critical dry years under the No Action
37 Alternative. In critical dry years the average egg mortality rate would be
38 5.4 percent greater under the No Action Alternative compared to the Second Basis
39 of Comparison (Appendix 9C, Table B-4). Overall, egg mortality in the
40 Sacramento River under the No Action Alternative and the Second Basis of
41 Comparison would be similar, except in critical dry water years.

1 *Changes in Weighted Usable Area*

2 As described above for the assessment methodology, Weighted Usable Area
3 (WUA) is a function of flow, but the relationship is not linear due to differences
4 in depths and velocities present in the wetted channel at different flows. Because
5 the combination of depths, velocities, and substrates preferred by species and life
6 stages varies, WUA values at a given flow can differ substantially for the life
7 stages evaluated.

8 As an indicator of the amount of suitable spawning habitat for winter-run Chinook
9 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
10 in general, there would be similar amounts of spawning habitat available from
11 May through September under the No Action Alternative and the Second Basis of
12 Comparison (Appendix 9E).

13 Modeling results indicate that, in general, there would be similar amounts of
14 suitable fry rearing habitat available from June through October under the No
15 Action Alternative and the Second Basis of Comparison (Appendix 9E).

16 Similar to the results for fry rearing WUA, modeling results indicate that there
17 would be similar amounts of suitable juvenile rearing habitat available during the
18 juvenile rearing period from September through August under the No Action
19 Alternative and the Second Basis of Comparison (Appendix 9E).

20 *Changes in SALMOD Output*

21 SALMOD results indicate that potential juvenile production would be similar
22 (less than 5 percent differences) under the No Action Alternative and Second
23 Basis of Comparison in all water year types (Appendix 9D, Table B-4-16).

24 *Changes in Delta Passage Model Output*

25 The Delta Passage Model predicted similar estimates of annual Delta survival
26 across the 81-year time period for winter-run Chinook Salmon between the No
27 Action Alternative and the Second Basis of Comparison
28 Alternative (Appendix 9J). Median Delta survival was 0.349 for the No Action
29 Alternative and 0.352 for the Second Basis of Comparison
30 Alternative (Appendix 9J) indicating that Delta survival of winter-run Chinook
31 Salmon would be similar under the No Action Alternative and the Second Basis
32 of Comparison.

33 *Changes in Oncorhynchus Bayesian Analysis Output*

34 Escapement of winter-run Chinook Salmon and Delta survival was modeled by
35 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook
36 salmon. Escapement was generally higher under the No Action Alternative as
37 compared to the Second Basis alternative (Appendix 9I). The median escapement
38 under the No Action Alternative was higher in 19 of the 22 years of simulation
39 (1971 to 2002), and there was typically greater than a 25 percent chance that the
40 No Action Alternative values would be greater than under the Second Basis of
41 Comparison. Median delta survival was approximately 12 percent higher under
42 the No Action Alternative as compared to the Second Basis of Comparison.

1 However, the probability intervals indicated that no difference between scenarios
2 was a highly probable outcome (Appendix 9I).

3 *Changes in Interactive Object-Oriented Simulation Output*

4 The IOS model predicted similar adult escapement trajectories for winter-run
5 Chinook Salmon between the No Action Alternative and the Second Basis of
6 Comparison across the 81 years (Appendix 9H). Under the No Action
7 Alternative, median adult escapement was 3,935 and under the Second Basis of
8 Comparison median escapement was 4,042.

9 Similar to adult escapement, the IOS model predicted similar egg survival
10 trajectories for winter-run Chinook Salmon under the No Action Alternative and
11 the Second Basis of Comparison Alternative across the 81 water years. Under the
12 No Action Alternative, median egg survival was 0.990 and under the Second
13 Basis of Comparison median egg survival was 0.987 (Appendix 9H).

14 *Changes in Delta Hydrodynamics*

15 Winter-run Chinook Salmon smolts are most abundant in the Delta during
16 January, February, and March. On the Sacramento River near the confluence of
17 Georgiana Slough, the median proportion of positive velocities under the No
18 Action Alternative was indistinguishable from the Second Basis of Comparison.
19 On the San Joaquin River near the Mokelumne River confluence, the
20 median percent of positive velocities was slightly higher in January and February
21 but similar in March. In Old River downstream of the facilities, the
22 median percent of positive velocities was substantially higher under the No
23 Action Alternative during January, moderately higher in February and slightly
24 higher in March. On Old River upstream of the facilities, median percent of
25 positive velocities were moderately lower under No Action Alternative relative to
26 Second Basis of Comparison in January but similar in February and March. On
27 the San Joaquin River downstream of Head of Old River, the median percent of
28 positive velocities was similar for both scenarios in January, February and March.
29 See Appendix 9K for detailed results.

30 *Changes in Junction Entrainment*

31 Entrainment at Georgiana Slough was similar under both scenarios during
32 January, February, and March when winter-run Chinook Salmon smolts are most
33 abundant in the Delta. At the Head of Old River, median entrainment
34 probabilities were moderately lower under the No Action Alternative during
35 January, slightly lower during February and similar in March. At the Turner Cut
36 junction, median entrainment probabilities under the No Action Alternative were
37 slightly lower than the Second Basis of Comparison in January and February, and
38 similar in March. Overall, entrainment patterns at the Columbia Cut junction
39 were similar to those observed at Turner Cut. Patterns at the Middle River and
40 Old River junctions were similar to those observed at Columbia and Turner Cut
41 junctions. See Appendix 9L for detailed results.

1 *Changes in Salvage*

2 The median proportion salvaged of Sacramento River-origin Chinook salmon is
 3 predicted to be greater under Second Basis of Comparison relative to No Action
 4 Alternative in every month. Winter-run Chinook Salmon smolts migrating
 5 through the Delta would be most susceptible in the months of January, February,
 6 and March. Predicted values in January and February indicated a moderately
 7 reduced proportion of fish salvaged under the No Action Alternative relative to
 8 the Second Basis of Comparison. See Appendix 9M for detailed results.

9 *Changes in Fish Passage on the Sacramento and American Rivers*

10 The No Action Alternative includes provision for passage of winter-run Chinook
 11 Salmon at Shasta Dam. Similar actions are underway at some locations in the
 12 Pacific Northwest, but none have been attempted for large storage and flood
 13 control reservoirs such as Shasta Lake. There is considerable uncertainty about
 14 whether such a program could be effective. For example, the size of the reservoir
 15 would require that adults be transported not just into the lake, but possibly to the
 16 river many miles upstream. Also because of the size of the reservoir, successful
 17 volitional passage of juveniles through the reservoir is unlikely. Thus, in order
 18 for juvenile salmonid emigrants to contribute to the population, they must be
 19 captured in the river (or at the entrance to the lake) and provided with safe
 20 transport downstream. A high level of capture efficiency for emigrating
 21 juveniles is essential for the program to be successful at generating a self-
 22 sustaining population.

23 If a fish passage program could establish self-sustaining populations of winter-run
 24 Chinook Salmon, spring-run Chinook Salmon, and steelhead, it would contribute
 25 substantially to satisfaction of the spatial diversity viability standard. The passage
 26 program could also contribute to abundance and productivity, if average returns
 27 consistently exceeded approximately 500 individuals. However, the passage
 28 program could also function as a population sink if fish transported above the
 29 reservoir achieved a cohort replacement rate of less than 1.

30 Insufficient information is available currently the on the productivity of habitat
 31 upstream of these impoundments. Given the technical uncertainties discussed
 32 previously, it is not possible to determine if (or how much) fish passage at Shasta
 33 Dam would be likely to affect the status of Central Valley winter-run Chinook
 34 Salmon populations.

35 *Summary of Effects on Winter-Run Chinook Salmon*

36 The multiple model and analysis outputs described above characterize the
 37 anticipated conditions for winter-run Chinook Salmon and their response to
 38 change under the No Action Alternative as compared to the Second Basis of
 39 Comparison. For the purpose of analyzing effects on winter-run Chinook Salmon
 40 and developing conclusions, greater reliance was placed on the outputs from the
 41 two life cycle models, IOS and OBAN because they each integrate the available
 42 information to produce single estimates of winter-run Chinook Salmon
 43 escapement. The output from IOS indicated that winter-run Chinook Salmon
 44 escapement would be similar under both scenarios, whereas the OBAN results

1 indicated that production escapement under the No Action Alternative would be
2 higher than under the Second Basis of Comparison, although there would be some
3 chance (less than a 25 percent) that escapement under the Second Basis of
4 Comparison could be greater than the No Action Alternative in some years.

5 The model results suggest that effects on winter-run Chinook Salmon would be
6 similar under both the No Action Alternative and Second Basis of Comparison,
7 with a small likelihood that winter-run Chinook Salmon escapement would be
8 higher under the No Action Alternative. This distinction, however, likely would
9 be greater because of the potential benefits of providing fish passage under the
10 No Action Alternative intended to address the limited availability of suitable
11 habitat for winter-run Chinook Salmon in the Sacramento River reaches
12 downstream of Keswick Dam. This potential beneficial effect and its magnitude
13 would depend on the success of the fish passage program. In addition, benefits to
14 winter-run Chinook Salmon may accrue under the No Action Alternative as a
15 result of implementation of the 2009 NMFS BO RPA action suite (IV.4), which is
16 intended to increase the efficiency of the Tracy and Skinner Fish Collection
17 Facilities to improve the overall salvage survival of listed salmonids, including
18 winter-run Chinook Salmon.

19 Overall, the quantitative results from the numerical models suggest that operation
20 under the No Action Alternative would be less likely to result in adverse effects
21 on winter-run Chinook Salmon than would operation under the Second Basis of
22 Comparison. However, in consideration of the potentially beneficial effects
23 resulting from the RPA actions that are not included in the numerical models (see
24 Appendix 5A, Section B), the No Action Alternative has a much greater potential
25 to address the long-term sustainability of winter-run Chinook Salmon than does
26 the Second Basis of Comparison. The No Action Alternative includes provisions
27 for fish passage upstream of Shasta Dam to address long-term temperature
28 increases associated with climate change. The Second Basis of Comparison does
29 not include fish passage provisions. Even though the success of fish passage is
30 uncertain, it is concluded that the potential for adverse effects on winter-run
31 Chinook Salmon under the No Action Alternative would be less than potential
32 effects under the Second Basis of Comparison, principally because the Second
33 Basis of Comparison does not include a fish passage strategy to address water
34 temperatures that NMFS (2009) indicates is critical to winter-run Chinook
35 Salmon sustainability over the long term with climate change by 2030.

36 *Spring-run Chinook Salmon*

37 Changes in operations that influence temperature and flow conditions in the
38 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
39 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect
40 spring-run Chinook Salmon. The following describes those changes and their
41 potential effects.

1 *Changes in Water Temperature*

2 Changes in water temperature that could affect spring-run Chinook Salmon could
3 occur in the Sacramento River, Clear Creek, and Feather River. The following
4 describes temperature conditions in those water bodies.

5 *Sacramento River*

6 Long-term average monthly water temperatures in the Sacramento River at
7 Keswick Dam under the No Action Alternative would generally be similar (less
8 than 0.5°F difference) to water temperatures under the Second Basis of
9 Comparison. An exception is during September and October of critical dry years
10 when water temperatures could be up to 1.1°F and 0.8°F higher respectively,
11 under the No Action Alternative as compared to the Second Basis of Comparison
12 and up to 1°F cooler in September of wetter years under the No Action
13 Alternative (Appendix 6B, Table B-5-4). A similar pattern in water temperatures
14 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend
15 Bridge and Red Bluff, with average monthly temperatures increasing in a
16 downstream direction and temperature differences between scenarios
17 progressively decreasing except in September (up to 3.2°F cooler at Red Bluff)
18 during wetter years under the No Action Alternative (Appendix 6B, Table B-9-4).

19 Overall, the temperature differences between the No Action Alternative and
20 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
21 likely would have little effect on spring-run Chinook Salmon in the Sacramento
22 River. The somewhat lower water temperatures in September of wetter years may
23 reduce the likelihood of adverse effects on spring-run Chinook Salmon spawning,
24 although the increased temperatures in September of critical dry years under the
25 No Action Alternative may increase the likelihood of adverse effects on spring-
26 run Chinook Salmon spawning in this water year type. There would be little
27 difference in potential effects on spring-run Chinook Salmon holding over the
28 summer due to the similar water temperatures during this time period under the
29 No Action Alternative and the Second Basis of Comparison.

30 *Clear Creek*

31 Average monthly water temperatures in Clear Creek at Igo under the No Action
32 Alternative relative to the Second Basis of Comparison are generally predicted to
33 be similar (less than 0.5°F differences) from September through April and June
34 through August (Appendix 6B, Table B-3-4). Average monthly water
35 temperatures during May under the No Action Alternative would be lower by up
36 to 0.8°F compared to the Second Basis of Comparison. The lower water
37 temperatures in May associated with the No Action Alternative reflect the effects
38 of additional water discharged from Whiskeytown Dam to meet the spring
39 attraction flow requirements to promote attraction of spring-run Chinook Salmon
40 into the creek. While the reduction in May water temperatures indicated by the
41 modeling could improve thermal conditions for spring-run Chinook Salmon, the
42 duration of the two pulse flows may not be of sufficient duration (3 days each) to
43 provide biologically meaningful temperature benefits. Overall, thermal

1 conditions for spring-run Chinook Salmon in Clear Creek would be similar under
2 the No Action Alternative and the Second Basis of Comparison.

3 *Feather River*

4 Average monthly water temperatures in the Feather River in the low flow channel
5 generally were predicted to be similar (less than 0.5°F differences) under the No
6 Action Alternative and Second Basis of Comparison, except during November
7 and December when average monthly water temperatures could be up to 1.4°F
8 higher in some water year types (Appendix 6B, Table B-20-4). Average monthly
9 water temperatures in September under the No Action Alternative could be up to
10 1.3°F lower than under the Second Basis of Comparison in wetter years.

11 Although temperatures in the river generally become progressively higher in the
12 downstream direction, the differences between the No Action Alternative and
13 Second Basis of Comparison exhibit a similar pattern at the downstream locations
14 (Robinson Riffle and Gridley Bridge), with water temperature differences
15 between the No Action Alternative and the Second Basis of Comparison generally
16 decreasing in most water year types. However, water temperatures from July to
17 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)
18 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River
19 in wetter years (Appendix 6B, Table B-23-4).

20 Overall, the temperature differences in the Feather River between the No Action
21 Alternative and Second Basis of Comparison would be relatively minor (less than
22 0.5°F) and likely would have little effect on spring-run Chinook Salmon in the
23 Feather River. The slightly higher water temperatures in November and
24 December under the No Action Alternative would likely have little effect on
25 spring-run Chinook Salmon as water temperatures in the Feather River are
26 typically low during this time period. The somewhat lower water temperatures in
27 September of wetter years may reduce the likelihood of adverse effects on
28 spring-run Chinook Salmon spawning, although the increased temperatures in
29 September of critical dry years under the No Action Alternative may increase the
30 likelihood of adverse effects on spring-run Chinook Salmon spawning in this
31 water year type. There would be little difference in potential effects on spring-run
32 Chinook Salmon holding over the summer due to the similar water temperatures
33 during this time period under the No Action Alternative as compared and the
34 Second Basis of Comparison.

35 *Changes in Exceedances of Water Temperature Thresholds*

36 Changes in water temperature could result in the exceedance of established water
37 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,
38 Clear Creek, and Feather River. The following describes the extent of water
39 temperature threshold exceedances for each of those water bodies.

40 *Sacramento River*

41 Average monthly water temperatures under both the No Action Alternative and
42 Second Basis of Comparison indicate exceedances of the water temperature
43 threshold of 56°F established in the Sacramento River at Red Bluff for spring-run
44 Chinook Salmon (egg incubation) in October, November, and again in April. The

1 exceedances were predicted to occur at the greatest frequency in October
2 (82 percent of the time under the No action Alternative); the water temperature
3 threshold would be exceeded more frequently in November (8 percent under the
4 No Action Alternative) and not exceeded at all from December through March
5 under the No Action Alternative (Appendix 9N). As water temperatures warm in
6 the spring, the thresholds were predicted to be exceeded in April by 15 percent
7 under the No Action Alternative. In the months when the greatest frequency of
8 exceedances occur (October, November, and April), model results generally
9 indicate more frequent exceedances (by up to 4 percent in October) under the No
10 Action Alternative than under the Second Basis of Comparison. Temperature
11 conditions in the Sacramento River under the No Action Alternative could be
12 more likely to result in adverse effects on spring-run Chinook Salmon egg
13 incubation than under the Second Basis of Comparison because of the increased
14 frequency of exceedance of the 56°F threshold in October, November, and April.
15 However, this difference may be partially offset if the water temperature
16 management and fish passage measures associated with 2009 NMFS BO RPA
17 under the No Action Alternative are successful in improving water temperatures.

18 *Clear Creek*

19 Average monthly water temperatures under both the No Action Alternative and
20 Second Basis of Comparison would not exceed the water temperature threshold of
21 60°F established in Clear Creek at Igo for spring-run Chinook Salmon pre-
22 spawning and rearing in June through August. However, water temperatures
23 under the No Action Alternative and Second Basis of Comparison would exceed
24 the water temperature threshold of 56°F established for spawning in September
25 and October about 10 to 15 percent of the time. Water temperatures under the No
26 Action Alternative could exceed the threshold about 3 percent more frequently
27 than under the Second Basis of Comparison in September and about 2 percent
28 more frequently in October (Appendix 9N). Temperature conditions in Clear
29 Creek under the No Action Alternative could be more likely to result in adverse
30 effects on spring-run Chinook Salmon spawning than under the Second Basis of
31 Comparison because of the increased frequency of exceedance of the 56°F
32 threshold in September and October. However, this difference may be partially
33 offset if the thermal stress reduction measures associated with 2009 NMFS BO
34 RPA Action I.1.5 under the No Action Alternative are successful in improving
35 water temperatures in Clear Creek.

36 *Feather River*

37 Average monthly water temperatures under both the No Action Alternative and
38 the Second Basis of Comparison would exceed the water temperature threshold of
39 56°F established in the Feather River at Robinson Riffle for spring-run Chinook
40 Salmon egg incubation and rearing during some months, particularly in October
41 and November, and March and April, when temperature thresholds could be
42 exceeded frequently (Appendix 9N). The frequency of exceedance was highest in
43 October, a month in which average monthly water could get as high as about
44 68°F. Water temperatures under the No Action Alternative would exceed the
45 spawning temperature threshold about 1 percent more frequently than under the

1 Second Basis of Comparison in October, November, and December, and about
2 2 percent less frequently in March.

3 The established water temperature threshold of 63°F for rearing from May
4 through August would be exceeded often under both the No Action
5 Alternative and Second Basis of Comparison in May and June, but not at all in
6 July and August. Water temperatures under the No Action Alternative would
7 exceed the rearing temperature threshold about 9 percent more frequently than
8 under the Second Basis of Comparison in May. Temperature conditions in the
9 Feather River under the No Action Alternative could be more likely to result in
10 adverse effects on spring-run Chinook Salmon spawning and rearing than under
11 the Second Basis of Comparison because of the increased frequency of
12 exceedance of the 56°F threshold from October through December.

13 *Changes in Egg Mortality*

14 These temperature differences described above are reflected in the analysis of egg
15 mortality using the Reclamation salmon mortality model (Appendix 9C). For
16 spring-run Chinook Salmon in the Sacramento River, the long-term average egg
17 mortality rate is predicted to be relatively high (exceeding 20 percent), with high
18 mortality rates (exceeding 70 percent) occurring in critical dry years. In critical
19 dry years the average egg mortality rate under the No Action Alternative is
20 predicted to be 10.4 percent greater than under the Second Basis of Comparison
21 (Appendix 9C, Table B-3). Overall, egg mortality under the No Action
22 Alternative and the Second Basis of Comparison would be similar, except in
23 critical dry water years.

24 *Changes in Weighted Usable Area*

25 Weighted usable area curves are available for spring-run Chinook Salmon in
26 Clear Creek. As described above, flows in Clear Creek downstream of
27 Whiskeytown Dam are not anticipated to differ under the No Action
28 Alternative relative to the Second Basis of Comparison except in May due to the
29 release of spring attraction flows in accordance with the 2009 NMFS BO.
30 Therefore, there would be no change in the amount of potentially suitable
31 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by
32 WUA) available under the No Action Alternative as compared to the Second
33 Basis of Comparison. However, the results of the habitat suitability/IFIM studies
34 associated with the 2009 NMFS BO Action I.1.6 could result in changes in
35 releases from Whiskeytown Reservoir to Clear Creek. Any changes as a result of
36 these studies would be implemented to improve habitat for fish.

37 *Changes in SALMOD Output*

38 SALMOD results indicate that potential juvenile spring-run production would be
39 similar under the No Action Alternative and the Second Basis of Comparison,
40 except in critical dry water years when production under the No Action
41 Alternative could be 11 percent less than under the Second Basis of Comparison
42 (Appendix 9D, Table B-3-16).

1 *Changes in Delta Passage Model Output*

2 The Delta Passage Model predicted similar estimates of annual Delta survival
3 across the 81-year time period for spring-run between the No Action
4 Alternative and the Second Basis of Comparison (Appendix 9J). Median Delta
5 survival was 0.296 for the No Action Alternative and 0.286 for the Second Basis
6 of Comparison.

7 *Changes in Delta Hydrodynamics*

8 Spring-run Chinook Salmon are most abundant in the Delta from March through
9 May. Near the junction of Georgiana Slough, the median percent of time that
10 velocity was positive was similar in March, April, and May for both scenarios
11 (Appendix 9K). Near the confluence of the San Joaquin River and the
12 Mokelumne River, the median percent of times with positive velocities was
13 similar in March and slightly greater under the No Action Alternative relative to
14 the Second Basis of Comparison in April and May. A similar pattern was
15 observed in the San Joaquin River downstream of the Head of Old River; the
16 median percent of time that velocity was positive was similar in March, whereas
17 values for the No Action Alternative were slightly to moderately lower relative to
18 the Second Basis of Comparison in April and May. In Old River upstream of the
19 facilities median percent of time with positive velocities was similar in March,
20 slightly higher in April, and moderately higher in May under the No Action
21 Alternative relative to the Second Basis of Comparison. In Old River
22 downstream of the facilities, the median percent of time with positive velocity
23 was slightly greater in March and increasingly greater in April and May under the
24 No Action Alternative relative to the Second Basis of Comparison.

25 *Changes in Junction Entrainment*

26 Entrainment at Georgiana Slough was similar under both scenarios during March,
27 April, and May when spring-run are most abundant in the Delta (Appendix 9L).
28 At the Head of Old River, median entrainment probabilities were much greater
29 under the No Action Alternative during April and May, whereas probabilities
30 were similar in March. At the Turner Cut junction, median entrainment
31 probabilities under the No Action Alternative and the Second Basis of
32 Comparison were similar in March. During April and May, median entrainment
33 probabilities were more divergent with moderately lower values for the No Action
34 Alternative relative to the Second Basis of Comparison. Overall, entrainment was
35 slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of
36 median entrainment probabilities between the scenarios were similar. Patterns of
37 entrainment probability at the Middle River and Old River junctions were similar
38 to those observed at Columbia and Turner Cut junctions.

39 *Changes in Salvage*

40 Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower
41 under the No Action Alternative relative to the Second Basis of Comparison in
42 every month (Appendix 9M). Spring-run smolts migrating through the Delta
43 would be most susceptible in the months of March, April, and May. Predicted
44 values in April and May indicated a substantially reduced fraction of fish salvaged

1 under the No Action Alternative. Predicted salvage was more similar in March,
2 but still moderately lower under the No Action Alternative than under the Second
3 Basis of Comparison.

4 *Summary of Effects on Spring-Run Chinook Salmon*

5 The multiple model and analysis outputs described above characterize the
6 anticipated conditions for spring-run Chinook Salmon and their response to
7 change under the No Action Alternative as compared to the Second Basis of
8 Comparison. For the purpose of analyzing effects on spring-run Chinook Salmon
9 in the Sacramento River, greater reliance was placed on the outputs from the
10 SALMOD model because it integrates the available information on temperature
11 and flows to produce estimates of mortality for each life stage and an overall,
12 integrated estimate of potential spring-run Chinook Salmon juvenile production.
13 The output from SALMOD indicated that spring-run Chinook Salmon production
14 in the Sacramento River would be similar under the No Action Alternative and
15 the Second Basis of Comparison, although production under the No Action
16 Alternative could be over 10 percent less than under the Second Basis of
17 Comparison in critical dry years. The analyses attempting to assess the effects on
18 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that
19 salvage (as an indicator of potential losses of juvenile salmon at the export
20 facilities) of Sacramento River-origin Chinook Salmon is predicted to be lower
21 under the No Action Alternative relative to the Second Basis of Comparison in
22 every month.

23 In Clear Creek and the Feather River, the analysis of the effects of the No Action
24 Alternative and Second Basis of Comparison for spring-run Chinook Salmon
25 relied on output from the WUA analysis and water temperature output for Clear
26 Creek at Igo, and in the Feather River low flow channel and downstream of the
27 Thermalito complex. The WUA analysis suggests that there would be little
28 difference in the availability of spawning and rearing habitat in Clear Creek. The
29 temperature model outputs suggest that thermal conditions and effects on each of
30 the spring-run Chinook Salmon life stages generally would be similar under both
31 scenarios in Clear Creek and the Feather River, although water temperatures
32 could be somewhat less suitable for spring-run Chinook Salmon holding and
33 spawning/egg incubation in the Feather River under the No Action Alternative.
34 This conclusion is supported by the water temperature threshold exceedance
35 analysis that indicated that water temperature thresholds for spawning and egg
36 incubation would be exceeded slightly more frequently under the No Action
37 Alternative in Clear Creek and the Feather River. The water temperature
38 threshold for rearing spring-run Chinook Salmon would also be exceeded slightly
39 more frequently in the Feather River. Because of the inherent uncertainty
40 associated with the resolution of the temperature model (average monthly
41 outputs), the slightly greater likelihood of exceeding water temperature thresholds
42 under the No Action Alternative could increase the potential for adverse effects
43 on the spring-run Chinook Salmon populations in the Feather River. Given the
44 similarity of the results, the No Action Alternative and Second Basis of

1 Comparison are likely to have similar effects on the spring-run Chinook Salmon
2 population in Clear Creek.

3 The numerical model results suggest that, overall, effects on spring-run Chinook
4 Salmon could be slightly more adverse under the No Action Alternative than
5 under the Second Basis of Comparison, and with a small likelihood that spring-
6 run Chinook Salmon production would be lower under the No Action Alternative.
7 This potential distinction between the two scenarios, however, may be offset by
8 the benefits of implementation of fish passage under the No Action
9 Alternative intended to address the limited availability of suitable habitat for
10 spring-run Chinook Salmon in the Sacramento River reaches downstream of
11 Keswick Dam. This beneficial effect and its magnitude would depend on the
12 success of the fish passage program. In addition, spring-run Chinook Salmon
13 may benefit under the No Action Alternative by implementation of the 2009
14 NMFS BO RPA action suite (IV.4), which is intended to increase the efficiency
15 of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage
16 survival of listed salmonids, including spring-run Chinook Salmon.

17 Thus, it is concluded that the potential for adverse effects on spring-run Chinook
18 Salmon under the No Action Alternative suggested by the results of the numerical
19 models may be offset by the potential benefits of the RPA actions that are not
20 included in the numerical models, principally because the Second Basis of
21 Comparison does not include a fish passage strategy to address water
22 temperatures that NMFS (2009) indicates is critical to spring-run Chinook Salmon
23 sustainability over the long term with climate change by 2030. On balance and
24 over the long term, the adverse effects on spring-run Chinook Salmon under the
25 No Action Alternative would be less than those under the Second Basis of
26 Comparison.

27 *Fall-Run Chinook Salmon*

28 Changes in operations that influence temperature and flow conditions in the
29 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
30 Whiskeytown Dam, Feather River downstream of Oroville Dam and American
31 River below Nimbus could affect fall-run Chinook Salmon. The following
32 describes those changes and their potential effects.

33 *Changes in Water Temperature*

34 Changes in water temperature could affect fall-run Chinook Salmon in the
35 Sacramento, Feather, and American rivers, and Clear Creek. The following
36 describes temperature conditions in those water bodies.

37 *Sacramento River*

38 Average monthly water temperatures in the Sacramento River at Keswick Dam
39 under the No Action Alternative would generally be similar (less than 0.5°F
40 difference) to water temperatures under the Second Basis of Comparison. An
41 exception is during September and October of critical dry years when water
42 temperatures could be up to 1.1°F and 0.8°F higher, respectively, under the No
43 Action Alternative as compared to the Second Basis of Comparison and up to 1°F

1 cooler in September of wetter years under the No Action
2 Alternative (Appendix 6B). A similar pattern in temperature differences
3 generally would be exhibited at downstream locations along the Sacramento River
4 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and
5 Knights Landing), with average monthly temperatures increasing in a downstream
6 direction and temperature differences between scenarios at Knights Landing
7 progressively increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in
8 September during the wetter years under the No Action Alternative relative to the
9 Second Basis of Comparison.

10 Overall, the temperature differences between the No Action Alternative and
11 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
12 likely would have little effect on fall-run Chinook Salmon in the Sacramento
13 River. The somewhat lower water temperatures in September of wetter years may
14 reduce the likelihood of adverse effects on early spawning fall-run Chinook
15 Salmon, although the increased water temperatures in September of critical dry
16 years under the No Action Alternative may increase the likelihood of adverse
17 effects on fall-run Chinook Salmon spawning in this water year type.

18 *Clear Creek*

19 Long-term average monthly water temperatures in Clear Creek at Igo under the
20 No Action Alternative and the Second Basis of Comparison generally would be
21 similar (less than 0.5°F differences) in most months (Appendix 6B, Table B-3-4).
22 Modeled average monthly water temperatures during May under the No Action
23 Alternative would be up to 0.8°F lower than under the Second Basis of
24 Comparison. Fall-run Chinook Salmon spawn and rear in the lower portion of
25 Clear Creek, generally downstream of Igo. Average monthly temperatures at the
26 confluence with the Sacramento River would be similar under the No Action
27 Alternative and the Second Basis of Comparison, except during May. Modeled
28 average monthly water temperatures at the confluence during May could be 0.9°F
29 to 1.3°F lower under the No Action Alternative than under the Second Basis of
30 Comparison.

31 The lower water temperatures in May associated with the No Action
32 Alternative reflect the effects of the additional water discharged from
33 Whiskeytown Dam to meet the spring attraction flow requirements to promote
34 attraction of spring-run Chinook Salmon into Clear Creek. While the reduction in
35 water temperature indicated by the modeling could improve thermal conditions
36 for fall-run Chinook Salmon, the duration of the two pulse flows may not be of
37 sufficient duration (3 days each) to provide biologically meaningful temperature
38 benefits. Overall, thermal conditions for fall-run Chinook Salmon in Clear Creek
39 would be similar under the No Action Alternative and the Second Basis of
40 Comparison.

41 *Feather River*

42 Long-term average monthly water temperatures in the Feather River in the low
43 flow channel generally are predicted to be similar (less than 0.5°F differences)
44 under the No Action Alternative and the Second Basis of Comparison, except

1 during November and December when average monthly water temperatures could
2 be up to 1.4°F higher in some water year types. Average monthly water
3 temperatures in September under the No Action Alternative could be up to 1.3°F
4 lower than under the Second Basis of Comparison in wetter years. Although
5 temperatures in the river generally become progressively higher in the
6 downstream direction, the differences between the No Action Alternative and
7 Second Basis of Comparison exhibit a similar pattern at the downstream locations
8 (Robinson Riffle and Gridley Bridge), with water temperature differences
9 between the No Action Alternative and Second Basis of Comparison generally
10 decreasing in most water year types. However water temperatures from July to
11 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)
12 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River
13 in wetter years.

14 Overall, the temperature differences in the Feather River between the No Action
15 Alternative and Second Basis of Comparison would be relatively minor (less than
16 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the
17 Feather River. The slightly higher water temperatures in November and
18 December under the No Action Alternative would likely have little effect on
19 fall-run Chinook Salmon as water temperatures in the Feather River are typically
20 low during this time period. The somewhat lower water temperatures in
21 September of wetter years may reduce the likelihood of adverse effects on early
22 spawning fall-run Chinook Salmon, although the increased temperatures in
23 September of critical dry years under the No Action Alternative may increase the
24 likelihood of adverse effects on fall-run Chinook Salmon spawning in this water
25 year type.

26 *American River*

27 Average monthly water temperatures in the American River at Nimbus Dam
28 under the No Action Alternative generally would be similar (differences less than
29 0.5°F) to the Second Basis of Comparison, with the exception of June and
30 August, when temperatures under the No Action Alternative could be as much as
31 0.9°F higher in below normal years (Appendix 6B, Table B-12-4). This pattern
32 generally would persist downstream to Watt Avenue and the mouth, although
33 temperatures under the No Action Alternative would be up to 1.6°F and 2.0°F
34 greater, respectively, than under the Second Basis of Comparison in June. In
35 addition, average monthly water temperatures at the mouth generally would be
36 lower under the No Action Alternative than the Second Basis of Comparison in
37 September of wetter years when water temperatures under the No Action
38 Alternative could be up to 1.7°F cooler (Appendix 6B, Table B-14-4).

39 Overall, the temperature differences in the American River between the No
40 Action Alternative and Second Basis of Comparison would be relatively minor
41 (less than 0.5°F) and likely would have little effect on fall-run Chinook Salmon in
42 the American River. The slightly higher water temperatures in June and August
43 in some water year types under the No Action Alternative may increase the
44 likelihood of adverse effects on fall-run Chinook Salmon rearing in the American

1 River if they are present. The slightly lower water temperatures during
2 September under the No Action Alternative would have little effect on fall-run
3 Chinook Salmon spawning in the American River because most spawning occurs
4 later, in November, but conditions for holding would be improved.
5 Implementation of water temperature management structural improvements (2009
6 NMFS BO RPA Action II.3) could contribute to better water temperature
7 conditions for fish in the American River under the No Action Alternative than
8 under the Second Basis of Comparison.

9 *Changes in Exceedances of Water Temperature Thresholds*

10 Changes in water temperature could result in the exceedance of water
11 temperatures that are protective of fall-run Chinook Salmon in the Sacramento
12 River, Clear Creek, Feather River, and American River. The following describes
13 the extent of those exceedances for each of those water bodies.

14 *Sacramento River*

15 Average monthly water temperatures under both the No Action Alternative and
16 Second Basis of Comparison indicate exceedances of the water temperature
17 threshold of 56°F established in the Sacramento River at Red Bluff for Chinook
18 Salmon spawning and egg incubation in October, November, and again in April.
19 In the months when the greatest frequency of exceedances occur (October,
20 November, and April), model results generally indicate more frequent
21 exceedances (by up to 4 percent in October) under the No Action Alternative than
22 under the Second Basis of Comparison. Temperature conditions in the
23 Sacramento River under the No Action Alternative could be more likely to affect
24 fall-run Chinook Salmon spawning and egg incubation than under the Second
25 Basis of Comparison because of the increased frequency of exceedance of the
26 56°F threshold in October, November, and April. However, this difference may
27 be partially offset if water temperature management and fish passage measures
28 associated with 2009 NMFS BO RPA under the No Action Alternative are
29 successful.

30 *Clear Creek*

31 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during
32 October through December (USFWS 2015). Average monthly water
33 temperatures at Igo during this period are generally below 56°F, except in
34 October. Under the No Action Alternative, the 56°F threshold would be exceeded
35 in October about 12 percent of the time as compared to 10 percent under the
36 Second Basis of Comparison (Appendix 9N). At the confluence with the
37 Sacramento River, average monthly water temperatures in October would be
38 warmer, with 56°F exceeded nearly 20 percent of the time under the No Action
39 Alternative, about 6 percent more frequently than under the Second Basis of
40 Comparison (Appendix 6B, Figure B-4-1). During November and December,
41 average monthly water temperatures generally would remain below 56°F at both
42 locations (Appendix 6B, Figure B-4-2 and B-4-3). Temperature conditions in
43 Clear Creek under the No Action Alternative could be more likely to result in
44 adverse effects on fall-run Chinook Salmon spawning and egg incubation than

1 under the Second Basis of Comparison because of the increased frequency of
2 exceedance of the 56°F threshold in October.

3 For fall-run Chinook Salmon rearing (January through August), the average
4 monthly temperatures at Igo would likely remain below the 60°F threshold in all
5 months. Downstream at the mouth of Clear Creek, average monthly water
6 temperatures would exceed the 60°F threshold often during the summer, but the
7 frequency of exceedance would be similar under the No Action Alternative and
8 the Second Basis of Comparison (Appendix 6B). Temperature conditions for
9 fall-run Chinook Salmon rearing in Clear Creek would be similar under the No
10 Action Alternative and the Second Basis of Comparison.

11 *Feather River*

12 Average monthly water temperatures under both the No Action Alternative and
13 Second Basis of Comparison would exceed the water temperature threshold of
14 56°F established in the Feather River at Gridley Bridge for fall-run Chinook
15 Salmon spawning and egg incubation during some months, particularly in
16 October, November, March, and April, when water temperature thresholds would
17 be exceeded frequently (Appendix 9N). The frequency of exceedance would be
18 greatest in October, when average monthly temperatures under both the No
19 Action Alternative and Second Basis of Comparison would be above the
20 threshold in nearly every year. The magnitude of the exceedances would be high
21 as well, with average monthly temperatures in October reaching about 68°F. The
22 threshold would be exceeded under both the No Action Alternative and Second
23 Basis of Comparison about 75 percent of the time in April. The differences
24 between the No Action Alternative and Second Basis of Comparison, however,
25 would be relatively small, with the No Action Alternative generally exceeding
26 temperature thresholds about 1-2 percent more frequently than the Second Basis
27 of Comparison during the October through April period. Temperature conditions
28 in the Feather River under the No Action Alternative could be more likely to
29 result in adverse effects on fall-run Chinook Salmon spawning and egg incubation
30 than under the Second Basis of Comparison because of the increased frequency of
31 exceedance of the 56°F threshold from October through April.

32 *Changes in Egg Mortality*

33 Water temperatures influence the viability of incubating fall-run Chinook Salmon
34 eggs. The following describes the differences in egg mortality for the
35 Sacramento, Feather, and American rivers.

36 *Sacramento River*

37 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg
38 mortality rate is predicted to be around 17 percent, with higher mortality rates (in
39 excess of 35 percent) occurring in critical dry years under the No Action
40 Alternative. Predicted egg mortality would be similar under the No Action
41 Alternative and the Second Basis of Comparison in all water year types
42 (Appendix 9C, Table B-1).

1 *Feather River*

2 For fall-run Chinook Salmon in the Feather River, the long-term average egg
3 mortality rate is predicted to be relatively low (around 7 percent), with higher
4 mortality rates (around 14.5 percent) occurring in critical dry years under the No
5 Action Alternative. Predicted egg mortality would be similar under the No
6 Action Alternative and the Second Basis of Comparison in all water year types
7 (Appendix 9C, Table B-7).

8 *American River*

9 For fall-run Chinook Salmon in the American River, the long-term average egg
10 mortality rate is predicted to range from approximately 23 to 25 percent in all
11 water year types under the No Action Alternative. Overall, egg mortality would
12 be similar under the No Action Alternative and the Second Basis of Comparison
13 (Appendix 9C, Table B-6).

14 *Changes in Weighted Usable Area*

15 Weighted usable area, which is influenced by flow, is a measure of habitat
16 suitability. The following describes changes in WUA for fall-run Chinook
17 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

18 *Sacramento River*

19 As an indicator of the amount of suitable spawning habitat for fall-run Chinook
20 Salmon between Keswick Dam and Battle Creek, WUA modeling results indicate
21 that, in general, there would be lesser amounts of spawning habitat available in
22 September and November under the No Action Alternative as compared to the
23 Second Basis of Comparison. Fall-run spawning WUA would be similar in
24 October and December under the No Action Alternative and the Second Basis of
25 Comparison (Appendix 9E, Table C-11-4). The long-term average spawning
26 WUA during September (prior to the peak spawning period) under the No Action
27 Alternative would be more than 20 percent lower, and around 6 percent lower in
28 November compared to the Second Basis of Comparison. November is during the
29 peak spawning period for fall-run Chinook Salmon in the Sacramento River.
30 Results for the reach from Battle Creek to Deer Creek show the same pattern for
31 changes in WUA for spawning fall-run Chinook Salmon between the No Action
32 Alternative and the Second Basis of Comparison (Appendix 9E, Table C-10-4).
33 Overall, spawning habitat availability would be somewhat lower under the No
34 Action Alternative relative to the Second Basis of Comparison.

35 Modeling results indicate that, in general, the amount of suitable fry rearing
36 habitat available from December to March under the No Action Alternative would
37 be similar to the amount of fry rearing habitat available under the Second Basis of
38 Comparison (Appendix 9E, Table C-12-4).

39 Similar to the results for fry rearing WUA, modeling results indicate that there
40 would be similar amounts of suitable juvenile rearing habitat available during the
41 juvenile rearing period from February to June under the No Action
42 Alternative and the Second Basis of Comparison. (Appendix 9E, Table C-13-4).

1 *Clear Creek*

2 As described above, flows in Clear Creek downstream of Whiskeytown Dam are
3 not anticipated to differ under the No Action Alternative relative to the Second
4 Basis of Comparison except in May due to the release of spring attraction flows in
5 accordance with the 2009 NMFS BO. Therefore, there would be no change in the
6 amount of potentially suitable spawning and rearing habitat for fall-run Chinook
7 Salmon (as indexed by WUA) available under the No Action Alternative as
8 compared to the Second Basis of Comparison.

9 *Feather River*

10 As described above, flows in the low flow channel of the Feather River are not
11 anticipated to differ under the No Action Alternative relative to the Second Basis
12 of Comparison. Therefore, there would be no change in the amount of potentially
13 suitable spawning habitat for fall-run Chinook Salmon (as indexed by WUA)
14 available under the No Action Alternative as compared to the Second Basis of
15 Comparison. The majority of spawning activity by fall-run Chinook Salmon in
16 the Feather River occurs in this reach with a lesser amount of spawning occurring
17 downstream of the Thermalito Complex.

18 Modeling results indicate that, in general, there would be lesser amounts of
19 spawning habitat available in the Feather River downstream of the Thermalito
20 Complex during September under the No Action Alternative as compared to the
21 Second Basis of Comparison. Fall-run Chinook Salmon spawning WUA would
22 be similar under the No Action Alternative and Second Basis of Comparison in
23 October and November (the peak spawning months) and in December (after the
24 peak spawning period) in this reach (Appendix 9E, Table C-24-4). The decrease
25 in long-term average spawning WUA during September (prior to the peak
26 spawning period) under the No Action Alternative would be relatively large
27 (more than 15 percent). Overall, spawning habitat availability would be similar
28 under the No Action Alternative and the Second Basis of Comparison.

29 *American River*

30 Modeling results indicate that, in general, there would be similar amounts of
31 spawning habitat available for fall-run Chinook Salmon in the American River
32 from October through December under the No Action Alternative as compared to
33 the Second Basis of Comparison (Appendix 9E, Table C-25-4).

34 *Changes in SALMOD Output – Sacramento River*

35 SALMOD results indicate that potential juvenile production would similar under
36 the No Action Alternative and the Second Basis of Comparison, except in critical
37 dry water years when production could be 7 percent lower under the No Action
38 Alternative than under the Second Basis of Comparison (Appendix 9D,
39 Table B-1-16).

40 *Changes in Delta Passage Model Output*

41 The Delta Passage Model predicted similar estimates of annual Delta survival
42 across the 81-year time period for fall-run Chinook Salmon between the No Action
43 Alternative and the Second Basis of Comparison (Appendix 9J). Median Delta

1 survival was 0.248 for the No Action Alternative and 0.245 for the Second Basis
2 of Comparison.

3 *Changes in Delta Hydrodynamics*

4 Fall-run Chinook Salmon smolts are most abundant in the Delta during the
5 months of April, May, and June. At the junction of Georgiana Slough and the
6 Sacramento River, the median percent of time with positive velocity was similar
7 under both scenarios in the months of April, May and June (Appendix 9K). Near
8 the Confluence of the San Joaquin River and the Mokelumne River, the median
9 proportion of positive velocities was slightly greater under the No Action
10 Alternative relative to the Second Basis of Comparison in April and May and
11 similar in June. In Old River downstream of the facilities, the median proportion
12 of positive velocities was substantially greater in April and May, but became
13 more similar in June. In Old River upstream of the facilities, the median
14 proportion of positive velocities was slightly to moderately greater for the No
15 Action Alternative relative to the Second Basis of Comparison in April and May,
16 respectively, and slightly lower in June. On the San Joaquin River downstream of
17 the Head of Old River, the median proportion of positive velocities was slightly
18 moderately lower under the No Action Alternative relative to the Second Basis of
19 Comparison in April and May, respectively, whereas the values were similar
20 in June.

21 *Changes in Junction Entrainment*

22 Entrainment at Georgiana Slough was similar under both scenarios in most
23 months, but was slightly lower under the No Action Alternative relative to the
24 Second Basis of Comparison in the month of June (Appendix 9L). Median
25 entrainment probabilities at the Head of Old River were much greater under the
26 No Action Alternative relative to the Second Basis of Comparison during April
27 and May. The median entrainment probability was similar under both scenarios
28 in the month of June. At the Turner Cut junction, median entrainment
29 probabilities under the No Action Alternative were slightly lower than the Second
30 Basis of Comparison in June. During April and May, median entrainment
31 probabilities were more divergent with moderately lower values for the No Action
32 Alternative relative to the Second Basis of Comparison. Overall, entrainment was
33 slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of
34 entrainment between the two scenarios were similar. Patterns in entrainment
35 probabilities at the Middle River and Old River junctions were similar to those
36 observed at Columbia and Turner Cut junctions.

37 *Changes in Salvage*

38 Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower
39 under the No Action Alternative relative to the Second Basis of Comparison in
40 every month (Appendix 9M). Fall-run smolts migrating through the Delta would
41 be most susceptible in the months of April, May, and June. Predicted values in
42 April and May indicated a substantially reduced fraction of fish salvaged under
43 the No Action Alternative relative to the Second Basis of Comparison. Predicted
44 salvage was more similar in March but still lower under the No Action
45 Alternative.

1 *Summary of Effects on Fall-Run Chinook Salmon*

2 The multiple model and analysis outputs described above characterize the
3 anticipated conditions for fall-run Chinook Salmon and their response to change
4 under the No Action Alternative as compared to the Second Basis of Comparison.
5 For the purpose of analyzing effects on fall-run Chinook Salmon in the
6 Sacramento River, greater reliance was placed on the outputs from the SALMOD
7 model because it integrates the available information on temperature and flows to
8 produce estimates of mortality for each life stage and an overall, integrated
9 estimate of potential fall-run Chinook Salmon juvenile production. The output
10 from SALMOD indicated that fall-run Chinook Salmon production would be
11 similar in most water year types under the No Action Alternative than under the
12 Second Basis of Comparison, and up to 7 percent less than under the Second
13 Basis of Comparison in critical dry years. The analyses attempting to assess the
14 effects on routing, entrainment, and salvage of juvenile salmonids in the Delta
15 suggest that salvage (as an indicator of potential losses of juvenile salmon at the
16 export facilities) of Sacramento River-origin Chinook Salmon is predicted to be
17 lower under the No Action Alternative relative to the Second Basis of
18 Comparison in every month.

19 In Clear Creek and the Feather and American rivers, the analysis of the effects of
20 the No Action Alternative and Second Basis of Comparison for fall-run Chinook
21 Salmon relied on the WUA analysis for habitat and water temperature model
22 output for the rivers at various locations downstream of the CVP and SWP
23 facilities. The WUA analysis indicated that the availability of spawning and
24 rearing habitat in Clear Creek and spawning habitat in the Feather and American
25 rivers would be similar under the No Action Alternative and the Second Basis of
26 Comparison. The temperature model outputs for each of the fall-run Chinook
27 Salmon life stages suggest that thermal conditions and effects on fall-run Chinook
28 Salmon in all of these streams generally would be similar under both scenarios.
29 The water temperature threshold exceedance analysis that indicated that the water
30 temperature thresholds for fall-run Chinook Salmon spawning and egg incubation
31 would be exceeded slightly more frequently in the Feather River and Clear Creek
32 under the No Action Alternative and could increase the potential for adverse
33 effects on the fall-run Chinook Salmon populations in Clear Creek and the
34 Feather River. Results of the analysis using Reclamation's salmon mortality
35 model indicate that there would be little difference in fall-run Chinook Salmon
36 egg mortality under the No Action Alternative and the Second Basis of
37 Comparison.

38 These model results suggest that overall, effects on fall-run Chinook Salmon
39 could be slightly more adverse under the No Action Alternative than under the
40 Second Basis of Comparison, with a small likelihood that fall-run Chinook
41 Salmon production would be lower under the No Action Alternative.

42 Additional RPA actions in the 2009 NMFS BO could help improve conditions for
43 fall-run Chinook Salmon under the No Action Alternative relative to the Second
44 Basis of Comparison, such as structural improvements for water temperature
45 management in the American River (NMFS RPA Action II.3), development of a

1 hatchery management plan for the Nimbus Hatchery (NMFS RPA Action II.6.3)
2 and actions (NMFS RPA Action Suite IV.4) intended to increase the efficiency of
3 the Tracy and Skinner Fish Collection Facilities to improve the overall salvage
4 survival of salmonids.

5 The implementation of fish passage under the No Action Alternative intended to
6 address the limited availability of suitable habitat for winter-run and spring-run
7 Chinook Salmon in the Sacramento River reaches downstream of Shasta Dam is
8 unlikely to benefit fall-run Chinook Salmon unless passage is provided to fall-run
9 Chinook Salmon. It is unlikely that providing similar fish passage at Folsom Dam
10 for steelhead would benefit fall-run Chinook Salmon for the same reason.

11 Overall, the results of the numerical models suggest the potential for greater
12 adverse effects on fall-run Chinook Salmon under the No Action Alternative as
13 compared to the Second Basis of Comparison. However, discerning a meaningful
14 difference between these two scenarios based on the quantitative results is not
15 possible because of the similarity in results (generally differences less than
16 5 percent) and the inherent uncertainty of the models. In addition, any adverse
17 effect of the No Action Alternative could be offset by the potentially beneficial
18 effects resulting from the RPA actions evaluated qualitatively for the No Action
19 Alternative. Thus, it is concluded that the effects on fall-run Chinook Salmon
20 would be less adverse under the No Action Alternative than under the Second
21 Basis of Comparison.

22 *Late Fall-Run Chinook Salmon*

23 Changes in operations that influence temperature and flow conditions in the
24 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook
25 Salmon. The following describes those changes and their potential effects.

26 *Changes in Water Temperature*

27 As described above, long-term average monthly water temperatures in the
28 Sacramento River at Keswick Dam under the No Action Alternative would
29 generally be similar (less than 0.5°F difference) to water temperatures under the
30 Second Basis of Comparison. An exception is during September and October of
31 critical dry years when water temperatures could be up to 1.1°F and 0.8°F higher,
32 respectively, under the No Action Alternative as compared to the Second Basis of
33 Comparison and up to 1°F cooler in September of wetter years under the No
34 Action Alternative (Appendix 6B, Table 5-5-4). A similar pattern in temperature
35 differences generally would be exhibited at downstream locations along the
36 Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff,
37 Hamilton City, and Knights Landing), with average monthly temperatures
38 increasing and water temperature differences between scenarios progressively
39 increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in September
40 during the wetter years under the No Action Alternative relative to the Second
41 Basis of Comparison.

42 Overall, the temperature differences between the No Action Alternative and
43 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
44 likely would have little effect on late fall-run Chinook Salmon in the Sacramento

1 River. Spawning of late fall-run Chinook Salmon in the Sacramento River takes
2 place from December to mid-April with incubation occurring over the same time
3 period and extending into June. The likelihood of adverse effects on late fall-run
4 Chinook Salmon spawning and egg incubation would be similar under the No
5 Action Alternative and the Second Basis of Comparison due to similar water
6 temperatures during the January to May time period.

7 Because late fall-run Chinook Salmon have an extended rearing period, the
8 similar water temperatures during the summer under the No Action
9 Alternative and Second Basis of Comparison would have similar effects on
10 rearing fry and juvenile late fall-run Chinook Salmon in the Sacramento River.
11 The lower water temperatures under the No Action Alternative in September of
12 wetter years may reduce the likelihood of adverse effects on fry and juvenile late
13 fall-run Chinook Salmon in the Sacramento River during this limited time period.

14 *Changes in Exceedances of Water Temperature Thresholds*

15 Average monthly water temperatures under both the No Action Alternative and
16 Second Basis of Comparison indicate exceedances of the water temperature
17 threshold of 56°F established in the Sacramento River at Red Bluff for Chinook
18 Salmon spawning and egg incubation in October, November, and again in April.
19 There would be no exceedances of the threshold from December to March under
20 both the No Action Alternative and the Second Basis of Comparison. In April,
21 model results indicate that water temperatures under the No Action
22 Alternative could exceed the threshold about 2 percent more frequently than
23 under the Second Basis of Comparison. Temperature conditions in the
24 Sacramento River under the No Action Alternative could be slightly more likely
25 to affect late fall-run Chinook Salmon spawning and egg incubation than under
26 the Second Basis of Comparison because of the increased frequency of
27 exceedance of the 56°F threshold in April. However, this difference may be
28 partially offset if water temperature management and fish passage measures
29 associated with 2009 NMFS BO RPA under the No Action Alternative are
30 successful.

31 *Changes in Egg Mortality*

32 For late fall-run Chinook Salmon in the Sacramento River, the long-term average
33 egg mortality rate is predicted to range from approximately 2.5 to nearly 5 percent
34 in all water year types under the No Action Alternative. Overall, egg mortality
35 would be similar under the No Action Alternative and the Second Basis of
36 Comparison (Appendix 9C, Table B-2).

37 *Changes in Weighted Usable Area*

38 Modeling results indicate that there would be similar amounts of spawning habitat
39 available for late fall-run Chinook Salmon in the Sacramento River from January
40 through April under the No Action Alternative and the Second Basis of
41 Comparison (Appendix 9E, Table C-14-4). Modeling results also indicate that
42 there would be similar amounts of suitable late fall-run Chinook Salmon fry
43 rearing habitat available in the Sacramento River from April to June under the

1 No Action Alternative and Second Basis of Comparison (Appendix 9E,
2 Table C-15-4).

3 A substantial fraction of late fall run Chinook Salmon juveniles oversummer in
4 the Sacramento River before emigrating, which allows them to avoid predation
5 through both their larger size and greater swimming ability. One implication of
6 this life history strategy is that rearing habitat is most likely the limiting factor for
7 late-fall-run Chinook Salmon, especially if availability of cool water determines
8 the downstream extent of spawning habitat for late-fall-run Chinook Salmon.
9 Modeling results indicate that, there would generally be similar amounts of
10 suitable juvenile rearing habitat available from December through August under
11 the No Action Alternative and Second Basis of Comparison. There could be
12 decreases in the amount of late fall-run Chinook Salmon juvenile rearing WUA in
13 September and November of up to 15 percent (Appendix 9E, Table C-16-4).
14 Overall, late fall-run juvenile rearing habitat availability would be similar under
15 the No Action Alternative and the Second Basis of Comparison.

16 *Changes in SALMOD Output – Sacramento River*

17 SALMOD results indicate that potential juvenile production would be similar
18 under the No Action Alternative and the Second Basis of Comparison
19 (Appendix 9D, Table B-2-16).

20 *Changes in Delta Passage Model Output*

21 For late fall-run Chinook Salmon, through-Delta survival was predicted to be
22 slightly higher under the No Action Alternative relative to the Second Basis of
23 Comparison for all 81 years simulated by the Delta Passage Model (Appendix 9J).
24 Median Delta survival across all years was 0.244 for the No Action
25 Alternative and 0.199 for the Second Basis of Comparison.

26 *Changes in Hydrodynamics*

27 The late fall-run Chinook Salmon migration period overlaps with winter-run
28 Chinook Salmon. See the section on hydrodynamic analysis for winter-run
29 Chinook Salmon for potential effects on late fall-run Chinook Salmon.

30 *Changes in Junction Entrainment*

31 Entrainment probabilities for late fall-run are assumed to mimic that of winter-run
32 Chinook Salmon due to overlap in timing. See the section on winter-run Chinook
33 Salmon entrainment for potential effects on late fall-run Chinook Salmon.

34 *Changes in Salvage*

35 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run
36 Chinook Salmon due to overlap in timing. See the section on winter-run Chinook
37 Salmon entrainment for potential effects on late fall-run Chinook Salmon.

38 *Summary of Effects on Late Fall-Run Chinook Salmon*

39 The multiple model and analysis outputs described above characterize the
40 anticipated conditions for late fall-run Chinook Salmon and their response to
41 change under the No Action Alternative as compared to the Second Basis of
42 Comparison. For the purpose of analyzing effects on late fall-run Chinook

1 Salmon and developing conclusions, greater reliance was placed on the outputs
 2 from the SALMOD model because it integrates the available information on
 3 temperature and flows to produce estimates of mortality for each life stage and an
 4 overall, integrated estimate of potential fall-run Chinook Salmon juvenile
 5 production. The output from SALMOD indicated that late fall-run Chinook
 6 Salmon production would be similar under the No Action Alternative and the
 7 Second Basis of Comparison. The analyses attempting to assess the effects on
 8 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that
 9 salvage (as an indicator of potential losses of juvenile salmon at the export
 10 facilities) of Sacramento River-origin Chinook Salmon is predicted to be lower
 11 under the No Action Alternative relative to the Second Basis of Comparison in
 12 every month.

13 These model results suggest that overall, effects on late fall-run Chinook Salmon
 14 could be slightly less adverse under the No Action Alternative than under the
 15 Second Basis of Comparison. In addition, potential adverse effects may be
 16 lessened under the No Action Alternative by actions intended to increase the
 17 efficiency of the Tracy and Skinner Fish Collection Facilities (NMFS RPA Action
 18 Suite IV.4) and improve the overall salvage survival of salmonids, including late
 19 fall-run Chinook Salmon. Thus, it is concluded that the potential for adverse
 20 effects on late fall-run Chinook Salmon would be lower under the No Action
 21 Alternative compared to the Second Basis of Comparison.

22 *Steelhead*

23 Changes in operations that influence temperature and flow conditions could affect
 24 steelhead. The following describes those changes and their potential effects.

25 *Changes in Water Temperature*

26 Changes in water temperature could affect steelhead in the Sacramento, Feather,
 27 and American rivers, and Clear Creek. The following describes temperature
 28 conditions in those water bodies.

29 *Sacramento River*

30 As described above, long-term average monthly water temperatures in the
 31 Sacramento River at Keswick Dam under the No Action Alternative would
 32 generally be similar (less than 0.5°F difference) to water temperatures under the
 33 Second Basis of Comparison. An exception is during September and October of
 34 critical dry years when water temperatures could be up to 1.1°F and 0.8°F higher,
 35 respectively, under the No Action Alternative as compared to the Second Basis of
 36 Comparison and up to 1°F cooler in September of wetter years under the No
 37 Action Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern
 38 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend
 39 Bridge and Red Bluff, with average monthly temperatures increasing in a
 40 downstream direction and temperature differences between scenarios
 41 progressively decreasing except in September (up to a 3.2°F difference at Red
 42 Bluff) during wetter years (Appendix 6B, Table B-9-4).

1 Overall, the temperature differences between the No Action Alternative and
2 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
3 likely would have little effect on steelhead in the Sacramento River. Based on the
4 life history timing for steelhead, the slightly higher water temperatures in
5 September of drier years under the No Action Alternative may increase the
6 likelihood of adverse effects on steelhead adults migrating upstream in the
7 Sacramento River. The lower water temperatures in September of wetter years
8 under the No Action Alternative may decrease the likelihood of adverse effects on
9 steelhead migration compared to the Second Basis of Comparison.

10 *Clear Creek*

11 Long-term average monthly water temperatures in Clear Creek at Igo under the
12 No Action Alternative and the Second Basis of Comparison generally would be
13 similar (less than 0.5°F differences) in most months (Appendix 6B, Table B-3-4).
14 Modeled average monthly water temperatures during May under the No Action
15 Alternative would be up to 0.8°F lower than under the Second Basis of
16 Comparison.

17 The lower water temperatures in May associated with the No Action
18 Alternative reflect the effects of the additional water discharged from
19 Whiskeytown Dam to meet the spring attraction flow requirements to promote
20 attraction of spring-run Chinook Salmon into Clear Creek. While the reduction in
21 water temperature indicated by the modeling could improve thermal conditions
22 for steelhead, the duration of the two pulse flows may not be of sufficient duration
23 (3 days each) to provide temperature benefits. Overall, thermal conditions for
24 steelhead in Clear Creek would be similar under the No Action Alternative and
25 the Second Basis of Comparison.

26 *Feather River*

27 Long-term average monthly water temperature in the Feather River in the low
28 flow channel generally are predicted to be similar (less than 0.5°F differences)
29 under the No Action Alternative and the Second Basis of Comparison, except
30 during November and December when average monthly water temperatures could
31 be up to 1.4°F higher in some water year types. Average monthly water
32 temperatures in September under the No Action Alternative could be up to 1.3°F
33 lower than the Second Basis of Comparison in wetter years. Although
34 temperatures in the river generally become progressively higher in the
35 downstream direction, the differences between the No Action Alternative and
36 Second Basis of Comparison exhibit a similar pattern at the downstream locations
37 (Robinson Riffle and Gridley Bridge), with water temperature differences
38 between the No Action Alternative and Second Basis of Comparison generally
39 decreasing in most water year types. However, water temperatures from July to
40 September under the No Action Alternative could be somewhat (0.7°F to 1.6°F)
41 cooler on average and up to 4.0°F cooler at the confluence with Sacramento River
42 in wetter years.

43 Overall, the temperature differences in the Feather River between the No Action
44 Alternative and Second Basis of Comparison would be relatively minor (less than

1 0.5°F) and likely would have little effect on steelhead in the Feather River. The
2 slightly higher water temperatures in November and December under the No
3 Action Alternative would likely have little effect on adult steelhead migration as
4 water temperatures in the Feather River are typically low during this time period.
5 The somewhat lower water temperatures in September of wetter years may reduce
6 the likelihood of adverse effects on adult steelhead migrating upstream and
7 juveniles rearing in the Feather River, although the increased temperatures in
8 September of critical dry years under the No Action Alternative may increase the
9 likelihood of adverse effects on migrating and rearing steelhead in this water
10 year type.

11 *American River*

12 Average monthly water temperatures in the American River at Nimbus Dam
13 under the No Action Alternative generally would be similar (differences less than
14 0.5°F) to the Second Basis of Comparison, with the exception of June and
15 August, when differences under the No Action Alternative could be as much as
16 0.9°F higher in below normal years. This pattern generally would persist
17 downstream to Watt Avenue and the mouth, although temperatures under the No
18 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than
19 under the Second Basis of Comparison in June. In addition, average monthly
20 water temperatures at the mouth generally would be lower under the No Action
21 Alternative than the Second Basis of Comparison in September of wetter years
22 when water temperatures under the No Action Alternative could be up to 1.7°F
23 cooler.

24 Overall, the temperature differences between the No Action Alternative and
25 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
26 likely would have little effect on steelhead in the American River. The slightly
27 warmer water temperatures in June and August under the No Action
28 Alternative may increase the likelihood of adverse effects on steelhead rearing in
29 the American River compared to the Second Basis of Comparison.

30 *Changes in Exceedances of Water Temperature Thresholds*

31 Changes in water temperature could result in the exceedance of established water
32 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and
33 Feather River. The following describes the extent of exceedance for each of
34 those streams.

35 *Sacramento River*

36 As described in the life history accounts (Appendix), steelhead spawning in the
37 mainstem Sacramento River generally occurs in the upper reaches from Keswick
38 Dam downstream to near Balls Ferry, with most spawning concentrated near
39 Redding. Most steelhead, however, spawn in tributaries to the Sacramento River.
40 Spawning generally takes place in the January through March period when water
41 temperatures in the river generally do not exceed 52°F under either the No Action
42 Alternative or Second Basis of Comparison. While there are no established
43 temperature thresholds for steelhead rearing in the mainstem Sacramento River,
44 average monthly temperatures when fry and juvenile steelhead are in the river

1 would generally remain below 56°F at Balls Ferry except in August and
2 September when this temperature would be exceeded 30 to 40 percent of the time
3 under both the No Action Alternative and Second Basis of Comparison.
4 However, water temperatures in the Sacramento River at Balls Ferry would
5 exceed 56°F about 10 percent more often in September under the Second Basis of
6 Comparison. Overall, thermal conditions for steelhead in the Sacramento River
7 would be similar under the No Action Alternative and the Second Basis of
8 Comparison.

9 *Clear Creek*

10 While there are no established temperature thresholds for steelhead spawning in
11 Clear Creek, average monthly water temperatures in the river generally would not
12 exceed 48°F during the spawning period (December to April) under either the No
13 Action Alternative or Second Basis of Comparison. Similarly, while there are no
14 established temperature thresholds for steelhead rearing in Clear Creek, average
15 monthly temperatures throughout the year would not exceed 56°F at Igo. Overall,
16 thermal conditions for steelhead in Clear Creek would be similar under the No
17 Action Alternative and the Second Basis of Comparison.

18 *Feather River*

19 Average monthly water temperatures under both the No Action Alternative and
20 the Second Basis of Comparison would on occasion exceed the water temperature
21 threshold of 56°F established in the Feather River at Robinson Riffle for steelhead
22 spawning and incubation during some months, particularly in October and
23 November, and March and April, when temperature thresholds could be exceeded
24 frequently (Appendix 9N). There would be a 1 percent exceedance of the 56°F
25 threshold in December under the No Action Alternative and no exceedances of
26 the 56°F threshold in January and February under both the No Action
27 Alternative and the Second Basis of Comparison. However, the differences in the
28 frequency of exceedance between the No Action Alternative and Second Basis of
29 Comparison during March and April would be relatively small with water
30 temperatures under the No Action Alternative exceeding the threshold about
31 2 percent less frequently in March (18 percent) and the same exceedance
32 frequency (75 percent) as the Second Basis of Comparison in April.

33 The established water temperature threshold of 63°F for rearing from May
34 through August would be exceeded often under both the No Action
35 Alternative and Second Basis of Comparison in May and June, but not at all in
36 July and August. Water temperatures under the No Action Alternative would
37 exceed the rearing temperature threshold about 9 percent more frequently than
38 under the Second Basis of Comparison in May, but no more frequently in June.
39 Temperature conditions in the Feather River under the No Action
40 Alternative could be more likely to affect steelhead spawning and rearing than
41 under the Second Basis of Comparison because of the increased frequency of
42 exceedance of the 56°F spawning threshold in March and the increased frequency
43 of exceedance of the 63°F rearing threshold in May.

1 *American River*

2 In the American River, the water temperature threshold for steelhead rearing
3 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly
4 water temperatures would exceed this threshold often under both the No Action
5 Alternative and Second Basis of Comparison, especially in the July through
6 September period when the threshold is exceeded nearly all of the time. In
7 addition, the magnitude of the exceedance would be high, with average monthly
8 water temperatures sometimes higher than 76°F. The differences between the No
9 Action Alternative and Second Basis of Comparison, however, would be
10 relatively small and occur only in June (1 percent less frequent exceedance under
11 the No Action Alternative), and in September, when average monthly water
12 temperatures under the No Action Alternative would exceed 65°F about 7 percent
13 less frequently than under the Second Basis of Comparison. Temperature
14 conditions in the American River under the No Action Alternative could be less
15 likely to result in adverse effects on steelhead rearing than under the Second Basis
16 of Comparison because of the reduced frequency of exceedance of the 65°F
17 rearing threshold.

18 *Changes in Weighted Usable Area*

19 The following describes changes in WUA for steelhead in the Sacramento,
20 Feather, and American rivers and Clear Creek.

21 *Sacramento River*

22 Modeling results indicate that, in general, there would be similar amounts of
23 suitable steelhead spawning habitat available from December through March
24 under the No Action Alternative and the Second Basis of Comparison
25 (Appendix 9E, Table C-20-4).

26 *Clear Creek*

27 As described above, flows in Clear Creek downstream of Whiskeytown Dam are
28 not anticipated to differ under the No Action Alternative relative to the Second
29 Basis of Comparison except in May due to the release of spring attraction flows in
30 accordance with the 2009 NMFS BO. Therefore, there would be no change in the
31 amount of potentially suitable spawning and rearing habitat for steelhead (as
32 indexed by WUA) available under the No Action Alternative as compared to the
33 Second Basis of Comparison.

34 *Feather River*

35 As described above, flows in the low flow channel of the Feather River are not
36 anticipated to differ under the No Action Alternative relative to the Second Basis
37 of Comparison. Therefore, there would be no change in the amount of potentially
38 suitable spawning habitat for steelhead (as indexed by WUA) available under the
39 No Action Alternative as compared to the Second Basis of Comparison. The
40 majority of spawning activity by steelhead in the Feather River occurs in this
41 reach with a lesser amount of spawning occurring downstream of the
42 Thermalito Complex.

1 Modeling results indicate that, in general, there would be similar amounts of
2 spawning habitat for steelhead in the Feather River downstream of Thermalito
3 available from December through April under the No Action Alternative and the
4 Second Basis of Comparison (Appendix 9E, Table C-22-4).

5 *American River*

6 Modeling results indicate that, in general, there would be similar amounts of
7 spawning habitat for steelhead in the American River downstream of Nimbus
8 Dam available from December through April under the No Action Alternative and
9 the Second Basis of Comparison (Appendix 9E, Table C-26-4).

10 *Changes in Delta Hydrodynamics*

11 Sacramento River-origin steelhead generally move through the Delta during
12 spring; however, there is less information on their timing than there is for
13 Chinook Salmon. Thus, hydrodynamics in the entire January through June period
14 have the potential to affect juvenile steelhead. For a description of potential
15 hydrodynamic effects on steelhead, see the descriptions for winter-run and
16 fall-run Chinook Salmon above.

17 *Summary of Effects on Steelhead*

18 The multiple model and analysis outputs described above characterize the
19 anticipated conditions for steelhead and their response to change under the No
20 Action Alternative as compared to the Second Basis of Comparison. The analysis
21 of the effects of the No Action Alternative and Second Basis of Comparison for
22 steelhead relied on the WUA analysis for habitat and water temperature model
23 output for the rivers at various locations downstream of the CVP and SWP
24 facilities. The WUA analysis indicated that the availability of steelhead spawning
25 and rearing habitat in Clear Creek and steelhead spawning habitat in the
26 Sacramento, Feather and American rivers would be similar under the No Action
27 Alternative and the Second Basis of Comparison. The temperature model outputs
28 for each of the steelhead life stages suggest that thermal conditions and effects on
29 steelhead in all of these streams generally would be similar under both scenarios.
30 This conclusion is supported by the water temperature threshold exceedance
31 analysis that indicated that the water temperature thresholds for steelhead
32 spawning and egg incubation would be exceeded slightly less frequently in the
33 Feather River under the No Action Alternative, although water temperature
34 thresholds for steelhead rearing would be exceeded more frequently during some
35 months in the Feather River and American River under the No Action Alternative.
36 The increased frequency of exceedance of rearing temperature thresholds under
37 the No Action Alternative could increase the potential for adverse effects on the
38 steelhead population in the Feather and American rivers.

39 These numerical model results suggest that overall, effects on steelhead could be
40 slightly more adverse under the No Action Alternative than under the Second
41 Basis of Comparison, particularly in the Feather and American rivers. However,
42 implementation of a fish passage program under the No Action
43 Alternative intended to address the limited availability of suitable habitat for
44 steelhead in the Sacramento River reaches downstream of Keswick Dam and in

1 the American River could provide a benefit to Central Valley steelhead in the
2 Sacramento and American rivers. This is particularly important in light of
3 anticipated increases in water temperature associated with climate change in
4 2030. In addition to fish passage, preparation and implementation of an HGMP
5 for steelhead at the Nimbus Fish Hatchery (NMFS RPA Action Suite II.6) and
6 actions under the No Action Alternative intended to increase the efficiency of the
7 Tracy and Skinner Fish Collection Facilities (NMFS RPA Action Suite IV.4)
8 could benefit steelhead under the No Action Alternative in comparison to the
9 Second Basis of Comparison. Thus, it is concluded that the effects on steelhead
10 would be less adverse under the No Action Alternative than under the Second
11 Basis of Comparison.

12 *Green Sturgeon*

13 Potential effects on Green Sturgeon were evaluated based on anticipated water
14 temperature conditions and exceedances of established temperature thresholds in
15 the Sacramento and Feather rivers. In addition, potential effects on Green
16 Sturgeon during the Delta portion of their life cycle were evaluated based on
17 changes in Delta outflow. The effects are described and summarized below.

18 *Changes in Water Temperature*

19 The effects of the No Action Alternative compared to the Second Basis of
20 Comparison on Green Sturgeon were analyzed based on water temperature model
21 outputs and comparisons of the frequency of water temperature threshold
22 exceedances in the Sacramento and Feather rivers.

23 *Sacramento River*

24 Long-term average monthly water temperatures in the Sacramento River at
25 Keswick Dam under the No Action Alternative would generally be similar (less
26 than 0.5°F difference) to water temperatures under the Second Basis of
27 Comparison. An exception is during September and October of critical years
28 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,
29 under the No Action Alternative as compared to the Second Basis of Comparison
30 and up to 1°F cooler in September of wetter years under the No Action
31 Alternative (Appendix 6B). A similar pattern in temperature differences
32 generally would be exhibited at downstream locations along the Sacramento River
33 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and
34 Knights Landing), with average monthly temperatures increasing in a downstream
35 direction and temperature differences between scenarios at Knights Landing
36 progressively increasing (up to 0.9°F warmer) in June and up to 4.6°F cooler in
37 September during the wetter years under the No Action Alternative relative to the
38 Second Basis of Comparison. Overall, the temperature differences between the
39 No Action Alternative and Second Basis of Comparison would be relatively
40 minor (less than 0.5°F) and likely would have little effect on Green Sturgeon in
41 the Sacramento River.

1 *Feather River*

2 Long-term average monthly water temperatures in the Feather River in the low
3 flow channel generally are predicted to be similar (less than 0.5°F differences)
4 under the No Action Alternative and the Second Basis of Comparison, except
5 during November and December when average monthly water temperatures could
6 be up to 1.4°F higher in some water year types. Average monthly water
7 temperatures in September under the No Action Alternative could be up to 1.3°F
8 lower than the Second Basis of Comparison in wetter years. Although
9 temperatures in the river would become progressively higher in the downstream
10 directions, the water temperature differences between the No Action
11 Alternative and Second Basis of Comparison exhibit a similar pattern at the
12 downstream locations (Robinson Riffle and Gridley Bridge), with water
13 temperature differences between the No Action Alternative and Second Basis of
14 Comparison generally decreasing in most water year types at the confluence with
15 Sacramento River (Appendix 6B, Table B-23-1). However, water temperatures
16 from July to September under the No Action Alternative could be somewhat
17 (0.7°F to 1.6°F) cooler on average and up to 4.0°F cooler at the confluence with
18 Sacramento River in wetter years. Overall, the temperature differences between
19 the No Action Alternative and Second Basis of Comparison would be relatively
20 minor (less than 0.5°F) and likely would have little effect on Green Sturgeon in
21 the Feather River.

22 *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water
24 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.
25 The following describes the exceedances for each of those rivers.

26 *Sacramento River*

27 Average monthly water temperatures in the Sacramento River at Bend Bridge
28 under both the No Action Alternative and Second Basis of Comparison would
29 exceed the water temperature threshold of 63°F established for Green Sturgeon
30 larval rearing in August and September, with exceedances under the No Action
31 Alternative occurring about 7 percent of the time in August and about 12 percent
32 of the time in September. This is 1 to 2 percent more frequently than under the
33 Second Basis of Comparison. Average monthly water temperatures at Bend
34 Bridge could exceed the threshold by up to 10 degrees (reaching 73°F) during this
35 period. Temperature conditions in the Sacramento River under the No Action
36 Alternative could be more likely to result in adverse effects on Green Sturgeon
37 rearing than under the Second Basis of Comparison because of the increased
38 frequency of exceedance of the 63°F threshold in August and September.

39 *Feather River*

40 Average monthly water temperatures in the Feather River at Gridley Bridge under
41 both the No Action Alternative and Second Basis of Comparison would exceed
42 the water temperature threshold of 64°F established for Green Sturgeon spawning,
43 incubation, and rearing in May, June, and September; no exceedances under either
44 scenario would occur in July and August. The frequency of exceedances would

1 be high, with both the No Action Alternative and Second Basis of Comparison
2 exceeding the threshold in June nearly 100 percent of the time. The magnitude of
3 the exceedance also would be substantial, with average monthly temperatures
4 higher than 72°F in June, and higher than 75°F in July and August. Average
5 monthly water temperatures under the No Action Alternative would exceed the
6 threshold about 9 percent more frequently than under the Second Basis of
7 Comparison during May and about 35 percent less frequently in September.
8 Temperature conditions in the Feather River under the No Action
9 Alternative could be more likely result in adverse effects on Green Sturgeon
10 spawning and egg incubation than under the Second Basis of Comparison because
11 of the increased frequency of exceedance of the 64°F threshold in May. The
12 reduction in exceedance frequency in September may have little effect on rearing
13 Green Sturgeon as many juvenile sturgeon may have migrated downstream to the
14 lower Sacramento River and Delta by this time.

15 *Changes in Delta Outflow*

16 As described in Appendix 9P, mean (March to July) Delta outflow was used an
17 indicator of potential year class strength and the likelihood of producing a strong
18 year class of sturgeon. The median value over the 82-year CalSim II modeling
19 period of mean (March to July) Delta outflow was predicted to be 13 percent
20 higher under the No Action Alternative than under the Second Basis of
21 Comparison. In addition, the likelihood of mean (March to July) Delta outflow
22 exceeding the threshold of 50,000 cfs was the same under both alternatives.

23 *Summary of Effects on Green Sturgeon*

24 The analysis of the effects of the No Action Alternative and Second Basis of
25 Comparison for Green Sturgeon relied on water temperature model output for the
26 Sacramento and Feather rivers at various locations downstream of Shasta Dam
27 and the Thermalito complex. The temperature model outputs for each of these
28 rivers suggest that thermal conditions and effects on Green Sturgeon in the
29 Sacramento and Feather rivers generally would be slightly more adverse under the
30 No Action Alternative. This conclusion is supported by the water temperature
31 threshold exceedance analysis that indicated that the water temperature thresholds
32 for Green Sturgeon spawning, incubation, and rearing would be exceeded more
33 frequently under the No Action Alternative in the Sacramento River. The water
34 temperature threshold for Green Sturgeon spawning, incubation, and rearing
35 would also be exceeded more frequently during some months in the Feather River
36 but would be exceeded substantially less frequently in September under the No
37 Action Alternative.

38 The increased frequency of exceedance of temperature thresholds under the No
39 Action Alternative could increase the potential for adverse effects on Green
40 Sturgeon in the Sacramento and Feather rivers relative to the Second Basis of
41 Comparison. The analysis based on Delta outflows suggests that the No Action
42 Alternative provides higher mean (March to July) outflows which could result in
43 stronger year classes of juvenile Green Sturgeon relative to the Second Basis of
44 Comparison. In addition, actions under the No Action Alternative intended to
45 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could

1 improve the overall salvage survival of Green Sturgeon. However, early life stage
2 survival in the natal rivers is crucial in development of a strong year class.
3 Therefore, based primarily on the analysis of water temperatures, the No Action
4 Alternative could be more likely to result in adverse effects on Green Sturgeon
5 than the Second Basis of Comparison.

6 *White Sturgeon*

7 Changes in water temperature conditions in the Sacramento River would be the
8 same as those described above for Green Sturgeon in the Sacramento River.
9 Overall, the temperature differences between the No Action Alternative and
10 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
11 likely would have little effect on White Sturgeon in the Sacramento River.

12 The water temperature threshold established for White Sturgeon spawning and
13 egg incubation in the Sacramento River at Hamilton City is 61°F from March
14 through June. Although there would be no exceedances of the threshold in March
15 and April, water temperatures under both the No Action Alternative and Second
16 Basis of Comparison would exceed this threshold in May and June. The average
17 monthly water temperatures in May under the No Action Alternative would
18 exceed this threshold about 55 percent of the time (about 6 percent more
19 frequently than under the Second Basis of Comparison). In June, average
20 monthly water temperatures under the No Action Alternative would exceed the
21 threshold about 86 percent of the time (about 13 percent more frequently than
22 under the Second Basis of Comparison). Average monthly water temperatures
23 during May and June under the No Action Alternative would as high as about
24 65°F which is below the 68°F threshold considered lethal for White Sturgeon
25 eggs and may cause higher growth rates in juvenile white sturgeon. Temperature
26 conditions in the Sacramento River under the No Action Alternative could be
27 more likely to result in adverse effects on White Sturgeon rearing than under the
28 Second Basis of Comparison because of the increased frequency of exceedance of
29 the 61°F threshold in May and June.

30 The analysis of the effects of the No Action Alternative and Second Basis of
31 Comparison for White Sturgeon relied on water temperature model output for the
32 Sacramento River at various locations downstream of Shasta Dam. The
33 temperature model outputs suggest that thermal conditions and effects on White
34 Sturgeon in the Sacramento River generally would be slightly more adverse under
35 the No Action Alternative. This conclusion is supported by the water temperature
36 threshold exceedance analysis that indicated that the water temperature thresholds
37 for White Sturgeon spawning, incubation, and rearing would be exceeded more
38 frequently under the No Action Alternative in the Sacramento River.

39 Changes in Delta outflows would be the same as those described above for Green
40 Sturgeon. Mean (March to July) Delta outflow was predicted to be 13 percent
41 higher under the No Action Alternative than under the Second Basis of
42 Comparison. In addition, the likelihood of mean (March to July) Delta outflow
43 exceeding the threshold of 50,000 cfs was the same under both alternatives. In
44 addition, actions under the No Action Alternative intended to increase the

1 efficiency of the Tracy and Skinner Fish Collection Facilities could improve the
2 overall salvage survival of White Sturgeon.

3 Overall, the increased frequency of exceedance of temperature thresholds in June
4 under the No Action Alternative could increase the potential for effects on White
5 Sturgeon in the Sacramento River relative to the Second Basis of Comparison,
6 however these effects are uncertain and may include reduced spawning and/or
7 increased growth. The analysis based on Delta outflows suggests that the No
8 Action Alternative provides higher mean (March to July) outflows which could
9 result in stronger year classes of juvenile White Sturgeon relative to the Second
10 Basis of Comparison. However, early life stage survival in the natal rivers is
11 crucial in development of a strong year class. Therefore, based primarily on the
12 analysis of water temperatures, the No Action Alternative could be more likely to
13 result in adverse effects on White Sturgeon than the Second Basis of Comparison.

14 *Delta Smelt*

15 The potential effects of the No Action Alternative as compared to the Second
16 Basis of Comparison were analyzed based on differences in proportional
17 entrainment and the fall abiotic index as described below.

18 As described in Appendix 9G, a proportional entrainment regression model
19 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt
20 entrainment, as influenced by OMR flow in December through March. Results
21 indicate that the percentage of entrainment of migrating and spawning adult Delta
22 Smelt under the No Action Alternative would be 7 to 8.3 percent, depending on
23 the water year type, with a long-term average percent entrainment of 7.6 percent.
24 Percent entrainment of adult Delta Smelt under the No Action Alternative would
25 be similar to results under the Second Basis of Comparison.

26 A proportional entrainment regression model (based on Kimmerer 2008) was also
27 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced
28 by OMR flow and location of X2 in March through June (Appendix 9G). Results
29 indicate that the percentage of entrainment of larval and early juvenile Delta
30 Smelt under the No Action Alternative would be 1.3 to 19.3 percent, depending
31 on the water year type, with a long term average percent entrainment of
32 8.6 percent, and highest entrainment under critical water year conditions. Percent
33 entrainment of larval and early juvenile Delta Smelt under the No Action
34 Alternative would be lower than projected entrainment under the Second Basis of
35 Comparison by up to 9.4 percent. Under the Second Basis of Comparison, the
36 long-term average percent entrainment would be 15.5 percent, and highest
37 entrainment would occur under critical water year conditions, at 23.6 percent.

38 The predicted position of Fall X2 (in September through December) is used as an
39 indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al. (2010) used
40 X2 location as an indicator of the extent of habitat available with suitable salinity
41 for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010) concluded that
42 when X2 is located downstream (west) of the confluence of the Sacramento and
43 San Joaquin Rivers, at a distance of 70 to 80 km from the Golden Gate Bridge,
44 there is a larger area of suitable habitat. The overlap of the low salinity zone (or

1 X2) with the Suisun Bay/Marsh results in a two-fold increase in the habitat index
2 (Feyrer et al. 2010).

3 The average September through December X2 position in km was used to
4 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.
5 X2 values simulated in the CalSim II model for each Alternative were averaged
6 over September through December, and compared. Results indicate that under
7 the No Action Alternative, the X2 position would range from 75.9 km to 92.4 km,
8 depending on the water year type, with a long term average X2 position of 84 km.
9 The most eastward location of X2 is predicted under Critical water year
10 conditions. The X2 positions predicted under the No Action Alternative would be
11 similar to results under the Second Basis of Comparison in drier water year types.
12 In wetter years, the X2 location would be further west under the No Action
13 Alternative than under the Second Basis of Comparison, by 6.1 to 9.8 km. This
14 difference is largely due to implementation of 2008 USFWS BO RPA
15 Component 3 (Action 4), under the No Action Alternative, which requires
16 Reclamation and DWR to provide sufficient Delta outflow to maintain a monthly
17 average X2 no more eastward than 74 km in above normal and wet year types.
18 Under the Second Basis of Comparison, the long-term average X2 position would
19 be 88.1 km, a location that does not provide for the advantageous overlap of the
20 low salinity zone with Suisun Bay/Marsh.

21 Overall, the No Action Alternative likely would result in better conditions for
22 Delta Smelt than would the Second Basis of Comparison, primarily due to
23 lower percentage entrainment for larval and juvenile life stages, and more
24 favorable location of Fall X2 in wetter years, and on average. Given the current
25 condition of the Delta Smelt population, even small differences between
26 alternatives may be important.

27 *Longfin Smelt*

28 The effects of the No Action Alternative as compared to the Second Basis of
29 Comparison were analyzed based on the direction and magnitude of OMR flows
30 during the period (December through June) when adult, larvae, and young
31 juvenile Longfin Smelt are present in the Delta in the vicinity of the export
32 facilities (Appendix 5A). The analysis was augmented with calculated Longfin
33 Smelt abundance index values (Appendix 9G) per Kimmerer et al. (2009), which
34 is based on the assumptions that lower X2 values reflect higher flows and that
35 transporting Longfin Smelt farther downstream leads to greater Longfin Smelt
36 survival. The index value indicates the relative abundance of Longfin Smelt and
37 not the calculated population.

38 As described in Appendix 5A, OMR flows would generally be negative in all
39 months under the Second Basis of Comparison, with the long-term average
40 ranging from -3,700 to -7,400 cfs from December through June; whereas the
41 OMR flows would generally be less negative during this time period under the No
42 Action Alternative. The greatest differences between alternatives would be in
43 April and May, where long-term average OMR flows would be positive under the
44 No Action Alternative (Appendix 5A, Table C-17-4). The decrease in the
45 magnitude of negative flows, with positive flows in April and May, under the No

1 Action Alternative as compared to the Second Basis of Comparison suggests that
2 it could reduce the potential for entrainment of Delta Smelt at the export facilities.

3 Under the No Action Alternative, Longfin Smelt abundance index values range
4 from 1,147, under critical water year conditions, to a high of 16,635 under wet
5 water year conditions, with a long-term average value of 7,951. Under the
6 Second Basis of Comparison, Longfin Smelt abundance index values range from
7 947 during critical water year conditions to a high of 15,822 under wet water year
8 conditions, with a long-term average value of 7,257. These results suggest that
9 the Longfin Smelt abundance index values would be higher in every water year
10 type under the No Action Alternative as compared to the Second Basis of
11 Comparison, with a long-term average index for the No Action Alternative that is
12 almost 10 percent higher than the long-term average index for the Second Basis of
13 Comparison. For below normal, dry, and critical water years, the Longfin Smelt
14 abundance index values would be over 20 percent higher under the No Action
15 Alternative than under the Second Basis of Comparison, with the greatest
16 difference (26.2 percent) predicted under dry conditions.

17 Overall, based on the decrease in frequency and magnitude of negative OMR
18 flows and the higher Longfin Smelt abundance index values, especially in dry and
19 critical years, potential adverse effects on the Longfin Smelt population under the
20 No Action Alternative likely would be less than under the Second Basis of
21 Comparison.

22 *Sacramento Splittail*

23 Sacramento Splittail could benefit from the increase in inundated floodplain
24 resulting from implementation of 2009 NMFS BO RPA Action I.6.1, Restoration
25 of Floodplain Rearing Habitat, which would restore 17,000 to 20,000 acres for the
26 primary purpose of enhancing rearing habitat for juvenile salmonids. The efforts
27 currently underway in the Yolo Bypass to comply with this action apply to all
28 alternatives under consideration and it is assumed that a notch in the Fremont
29 Weir (6,000 cfs capacity) will be constructed and that the inundation objectives
30 will be met by 2030. It is not currently known if and how the notch would be
31 operated and how flows entering the bypass would be managed to accommodate
32 floodplain rearing.

33 While this action is common to all alternatives, changes in operations that
34 influence the hydrology in the Sacramento River could affect the frequency and
35 duration of flows available to provide inundation on the bypass. To generally
36 evaluate the potential influence of these changes in hydrology, the flows entering
37 the Yolo Bypass during December through April were examined to determine the
38 differences among alternatives. It was assumed that the magnitude of flow (and
39 flow change) roughly corresponds to the amount of inundated floodplain.

40 Under the No Action Alternative, flows entering the Yolo Bypass generally would
41 be lower than under the Second Basis of Comparison from December through
42 March, especially during wetter years (Appendix 5A, Table C-26-4). These
43 decreases would occur during periods of relatively high flow in the bypass, and
44 may only slightly decrease the potential area of inundation.

1 Overall, the slight flow decreases under the No Action Alternative could result in
2 less spawning habitat for Sacramento Splittail than under the Second Basis of
3 Comparison because of the decreased area of potential habitat (inundation).
4 Given the relatively minor changes in flows into the Yolo Bypass, and the
5 inherent uncertainty associated with the resolution of the CalSim II model
6 (average monthly outputs), it is concluded that there would be no definitive
7 difference in effects on Sacramento Splittail between the No Action
8 Alternative and Second Basis of Comparison.

9 *Reservoir Fishes*

10 The analysis of effects associated with changes in operation on reservoir fishes
11 relied on evaluation of changes in available habitat (reservoir storage) and
12 anticipated changes in black bass nesting success.

13 *Changes in Available Habitat (Storage)*

14 As described in Chapter 5, Surface Water Resources and Water Supplies, changes
15 in CVP and SWP water supplies and operations under the No Action
16 Alternative as compared to the Second Basis of Comparison generally would
17 result in lower reservoir storage in CVP and SWP reservoirs in the Central Valley
18 Region. Storage levels in Shasta Lake, Lake Oroville, and Folsom Lake would be
19 lower under the No Action Alternative as compared to the Second Basis of
20 Comparison, as summarized in Tables 5.12 through 5.14, in the fall and winter
21 months due to the inclusion of Fall X2 criteria under the No Action Alternative.

22 The highest reductions in Shasta Lake and Lake Oroville storage could be in
23 excess of 20 percent. Storage in Folsom Lake could be reduced up to around
24 10 percent in some months of some water year types. Additional information
25 related to monthly reservoir elevations is provided in Appendix 5A, CalSim II and
26 DSM2 Modeling. It is anticipated that aquatic habitat within the CVP and SWP
27 water supply reservoirs is not limiting; however, storage volume is an indicator of
28 how much habitat is available to fish species inhabiting these reservoirs.
29 Therefore, the amount of habitat for reservoir fishes could be reduced under the
30 No Action Alternative as compared to the Second Basis of Comparison.

31 *Changes in Black Bass Nesting Success*

32 Black bass nest survival in CVP and SWP reservoirs is anticipated to be near
33 100 percent in March and April due to increasing reservoir elevations
34 (Appendix 9F). For May and June, the likelihood of nest survival for Largemouth
35 Bass in Shasta Lake being in the 40 to 100 percent range is similar under the No
36 Action Alternative and the Second Basis of Comparison; however, nest survival
37 of greater than 40 percent in June is likely only in about 20 percent of the years
38 evaluated. The likelihood of nest survival for Smallmouth Bass in Shasta Lake
39 exhibits nearly the same pattern. For Spotted Bass, the likelihood of nest survival
40 being greater than 40 percent is generally high (near 100 percent) from March to
41 May under both the No Action Alternative and the Second Basis of Comparison.
42 For June, Spotted Bass nest survival would be less than for May due to greater
43 daily reductions in water surface elevation as Shasta Lake is drawn down. The

1 likelihood of survival being greater than 40 percent is about 10 percent higher
2 under the No Action Alternative as compared to the Second Basis of Comparison.

3 For May and June, the likelihood of nest survival for Largemouth Bass in Lake
4 Oroville being in the 40 to 100 percent range is higher under the No Action
5 Alternative as compared to the Second Basis of Comparison; about 10 percent
6 higher in May and 3 percent higher in June. However, June nest survival of
7 greater than 40 percent is likely only in about 40 percent of the years evaluated.
8 The likelihood of nest survival for Smallmouth Bass in Lake Oroville exhibits
9 nearly the same pattern. For Spotted Bass, the likelihood of nest survival being
10 greater than 40 percent is high (>90 percent) in May under both the No Action
11 Alternative and the Second Basis of Comparison with the likelihood of greater
12 than 40 percent survival similar under the No Action Alternative and the Second
13 Basis of Comparison. For June, Spotted Bass survival would be less than for May
14 due to greater daily reductions in water surface elevation as Lake Oroville is
15 drawn down. The likelihood of survival being greater than 40 percent is
16 substantially (about 20 percent) higher under the No Action Alternative as
17 compared to the Second Basis of Comparison.

18 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and
19 May due to increasing reservoir elevations. For June, the likelihood of nest
20 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the
21 40 to 100 percent range is around 5 percent higher under the No Action
22 Alternative than under the Second Basis of Comparison. For Spotted Bass, nest
23 survival for June would be less than for May due to greater daily reductions in
24 water surface elevation. However, the likelihood of survival being greater than
25 40 percent is about 5 percent higher under the No Action Alternative as compared
26 to the Second Basis of Comparison.

27 *Summary of Effects on Reservoir Fishes*

28 Reservoir storage is anticipated to be reduced under the No Action
29 Alternative relative to the Second Basis of Comparison and this reduction could
30 affect the amount of warm and cold water habitat available within the reservoirs.
31 However, it is unlikely that aquatic habitat within the CVP and SWP water supply
32 reservoirs is limiting.

33 The analysis of black bass nest survival based on changes in water surface
34 elevation during the spawning period indicated that the likelihood of high
35 (>40 percent) nest survival in most of the reservoirs under the No Action
36 Alternative would be similar under the Second Basis of Comparison from March
37 through May and somewhat higher in June. Most black bass spawning likely
38 occurs prior to June, such that drawdowns during June would likely affect only a
39 small proportion of the spawning population. Thus, it is concluded that effects on
40 black bass nesting success would be similar under the No Action Alternative and
41 the Second Basis of Comparison.

1 *Pacific Lamprey*

2 Little information is available on factors that influence populations of Pacific
3 Lamprey in the Sacramento River, but they are likely affected by many of the
4 same factors as salmon and steelhead because of the parallels in their life cycles.

5 *Changes in Water Temperature*

6 The following describes anticipated changes in average monthly water
7 temperature in the Sacramento, Feather, and American rivers and the potential for
8 those changes to affect Pacific Lamprey.

9 *Sacramento River*

10 Long-term average monthly water temperatures in the Sacramento River at
11 Keswick Dam under the No Action Alternative would generally be similar (less
12 than 0.5°F difference) to water temperatures under the Second Basis of
13 Comparison. An exception is during September and October of critical dry years
14 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,
15 under the No Action Alternative as compared to the Second Basis of Comparison
16 and up to 1°F cooler in September of wetter years under the No Action
17 Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern generally
18 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,
19 with average monthly temperatures increasing in a downstream direction and
20 temperature differences between scenarios progressively decreasing except in
21 September (up to 2.8°F cooler) at Bend Bridge) during wetter years under the No
22 Action Alternative. Due to the similarity of water temperatures under the No
23 Action Alternative and Second Basis of Comparison from January through the
24 summer, there would be little difference in potential effects on Pacific Lamprey
25 adults during their migration, holding, and spawning periods.

26 *Feather River*

27 Long-term average monthly water temperature in the Feather River in the low
28 flow channel (downstream of the Thermalito Complex) generally are predicted to
29 be similar (less than 0.5°F differences) under the No Action Alternative and the
30 Second Basis of Comparison, except during November and December when
31 average monthly water temperatures could be up to 1.4°F higher in some water
32 year types. Average monthly water temperatures in September under the No
33 Action Alternative could be up to 1.3°F lower than under the Second Basis of
34 Comparison in wetter years (Appendix 6B, Table B-20-4). Although
35 temperatures in the river would become progressively higher in the downstream
36 directions, the differences in water temperatures between the No Action
37 Alternative and Second Basis of Comparison would exhibit a similar pattern at the
38 downstream locations (Robinson Riffle and Gridley Bridge), with water
39 temperature differences between the No Action Alternative and Second Basis of
40 Comparison generally decreasing in most water year types. However, water
41 temperatures from July to September under the No Action Alternative could be
42 somewhat (0.7°F to 1.6°F) cooler on average and up to 4.0°F cooler at the
43 confluence with Sacramento River in wetter years (Appendix 6B, Table B-23-4).

1 Due to the similarity of water temperatures under the No Action Alternative and
2 Second Basis of Comparison from January through the summer, there would be
3 little difference in potential effects on Pacific Lamprey adults during their
4 migration, holding, and spawning periods.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam
7 under the No Action Alternative generally would be similar (differences less than
8 0.5°F) to the Second Basis of Comparison, with the exception of during June and
9 August, when differences under the No Action Alternative could be as much as
10 0.9°F higher in below normal years. This pattern generally would persist
11 downstream to Watt Avenue and the mouth, although temperatures under the No
12 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than
13 under the Second Basis of Comparison in June. In addition, average monthly
14 water temperatures at the mouth generally would be lower under the No Action
15 Alternative than the Second Basis of Comparison in September of wetter years
16 when water temperatures under the No Action Alternative could be up to 1.7°F
17 cooler. Due to the similarity of water temperatures under the No Action
18 Alternative and Second Basis of Comparison from January through the summer,
19 there would be little difference in potential effects on Pacific Lamprey adults
20 during their migration, holding, and spawning periods.

21 *Summary of Effects on Pacific Lamprey*

22 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up
23 to around 72°F during their entire life history. Given the relatively minor changes
24 in water temperature and water temperature threshold exceedance, and the
25 inherent uncertainty associated with the resolution of the temperature model
26 (average monthly outputs), it is likely that effects on Pacific Lamprey in the
27 Sacramento, Feather, and American rivers would be similar under the No Action
28 Alternative and the Second Basis of Comparison. This conclusion likely applies
29 to other species of lamprey that inhabit these rivers (e.g., River Lamprey).

30 *Striped Bass, American Shad, and Hardhead*

31 Changes in operations influence temperature and flow conditions that could affect
32 Striped Bass, American Shad, and Hardhead. The following describes those
33 changes and their potential effects.

34 *Changes in Water Temperature*

35 The following describes temperature conditions in the Sacramento, Feather, and
36 American rivers.

37 *Sacramento River*

38 Long-term average monthly water temperatures in the Sacramento River at
39 Keswick Dam under the No Action Alternative would generally be similar (less
40 than 0.5°F difference) to water temperatures under the Second Basis of
41 Comparison. An exception is during September and October of critical dry years
42 when water temperatures could be up to 1.1°F and 0.8°F higher, respectively,
43 under the No Action Alternative as compared to the Second Basis of Comparison

1 and up to 1°F cooler in September of wetter years under the No Action
2 Alternative (Appendix 6B, Table 5-5-4). A similar temperature pattern generally
3 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,
4 with average monthly temperatures increasing in a downstream direction and
5 temperature differences between scenarios progressively increasing (up to 0.9°F
6 warmer) in June and up to 4.6°F cooler in September during the wetter years
7 under the No Action Alternative relative to the Second Basis of Comparison. In
8 general, Striped Bass, American Shad, and Hardhead can tolerate higher
9 temperatures than salmonids. Therefore, it is unlikely that the slightly increased
10 temperatures during some months under the No Action Alternative would have
11 substantial adverse effects on these species.

12 *Feather River*

13 Average monthly water temperature in the Feather River in the low flow channel
14 (below the Thermalito Complex) generally were predicted to be similar (less than
15 0.5°F differences) under the No Action Alternative and the Second Basis of
16 Comparison, except during November and December when average monthly
17 water temperatures would be up to 1.4°F higher in some water year types
18 (Appendix 6B, Table B-20-4). Average monthly water temperatures in
19 September under the No Action Alternative could be up to 1.3°F lower than under
20 the Second Basis of Comparison in wetter years. Although temperatures in the
21 river would become progressively higher in the downstream directions, the
22 differences between the No Action Alternative and Second Basis of Comparison
23 exhibit a similar pattern at the downstream locations (Appendix 6B,
24 Table B-23-4). As described above for the Sacramento River, Striped Bass,
25 American Shad, and Hardhead can tolerate higher temperatures than salmonids.
26 Therefore, it is unlikely that the slightly increased temperatures during some
27 months under the No Action Alternative would have substantial adverse effects
28 on these species in the Feather River.

29 *American River*

30 Average monthly water temperatures in the American River at Nimbus Dam
31 under the No Action Alternative generally would be similar (differences less than
32 0.5°F) to the Second Basis of Comparison, with the exception of during June and
33 August, when differences under the No Action Alternative could be as much as
34 0.9°F higher in below normal years. This pattern generally would persist
35 downstream to Watt Avenue and the mouth, although temperatures under the No
36 Action Alternative would be up to 1.6°F and 2.0°F greater, respectively, than
37 under the Second Basis of Comparison in June. As described above for the
38 Sacramento River, Striped Bass, American Shad, and Hardhead can tolerate
39 higher temperatures than salmonids. Therefore, it is unlikely that the slightly
40 increased temperatures during some months under the No Action
41 Alternative would have substantial adverse effects on these species in the
42 American River.

1 *Changes in Position of X2*

2 The No Action Alternative would result in a more westward X2 position as
3 compared to the Second Basis of Comparison during April and May, with similar
4 values in June (Appendix 5A, Section C Table C-16-4). Based on Kimmerer
5 (2002) and Kimmerer et al. (2009), this change in X2 would likely increase the
6 survival index and the habitat index as measured by salinity for Striped Bass and
7 abundance and habitat index for American Shad.

8 *Summary of Effects on Striped Bass, American Shad, and Hardhead*

9 In general, Striped Bass, American Shad, and Hardhead can tolerate higher
10 temperatures than salmonids. Given the relatively minor changes in temperature
11 and temperature threshold exceedance, and the inherent uncertainty associated
12 with the resolution of the temperature model (average monthly outputs), it is
13 likely that thermal conditions for and effects on Striped Bass, American Shad, and
14 Hardhead in the Sacramento, Feather, and American rivers would be similar
15 under the No Action Alternative and the Second Basis of Comparison. Overall,
16 the No Action Alternative likely would be similar for Hardhead and have a
17 slightly lower potential for adverse effects on Striped Bass and American Shad as
18 compared to the Second Basis of Comparison, primarily due to the potential for
19 increased survival during larval and juvenile life stages, and more favorable
20 location of Spring X2 on average.

21 **9.4.3.1.3 Stanislaus River/Lower San Joaquin River**

22 *Fall-Run Chinook Salmon*

23 Changes in operations influence temperature and flow conditions that could affect
24 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam
25 and in the San Joaquin River downstream of the Stanislaus River confluence, as
26 measured at Vernalis. The following describes those changes and their
27 potential effects.

28 *Changes in Water Temperature (Stanislaus River)*

29 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
30 under the No Action Alternative and Second Basis of Comparison generally
31 would be similar (differences less than 0.5°F), with small differences in critical
32 dry years when the No Action Alternative would 0.8°F and 1.3°F warmer on
33 average than under the Second Basis of Comparison during June and September,
34 respectively, and 0.7°F cooler in November (Appendix 6B, Table B-17-4).

35 Downstream at Orange Blossom Bridge, average monthly water temperatures in
36 October under the No Action Alternative would be lower in all water year types
37 than the Second Basis of Comparison by as much as 1.9°F. In most other months,
38 water temperatures under the No Action Alternative and Second Basis of
39 Comparison generally would be similar. An exception to this pattern occurs in
40 April when average monthly water temperatures in all but wet water year types
41 would be lower under the No Action Alternative by as much as about 1.2°F
42 (Appendix 6B, Table B-18-4).

1 This temperature pattern would continue downstream to the confluence with the
2 San Joaquin River, although temperatures would progressively increase, as would
3 the magnitude of difference between the No Action Alternative and Second Basis
4 of Comparison. Decreases in average monthly water temperatures in October and
5 April would be more pronounced under the No Action Alternative, with average
6 differences as much as 2.7°F in October and 2.0°F in April (Appendix 6B,
7 Table B-19-4) relative to the Second Basis of Comparison. The magnitude of
8 differences in average monthly water temperatures between the No Action
9 Alternative and the Second Basis of Comparison in May and June also would
10 increase relative to the upstream locations with average June water temperatures
11 reaching 2.4°F warmer under the No Action Alternative in wet years.

12 Based on the life history timing for fall-run Chinook Salmon, the lower
13 temperatures in October under the No Action Alternative may reduce the
14 likelihood of adverse to fall-run Chinook Salmon spawning and egg incubation as
15 compared to the Second Basis of Comparison.

16 *Changes in Exceedance of Water Temperature Thresholds (Stanislaus River)*

17 While specific water temperature thresholds for fall-run Chinook Salmon in the
18 Stanislaus River are not established, temperatures generally considered suitable
19 for fall-run Chinook Salmon spawning (56°F) would be exceeded in October and
20 November approximately 30 percent of the time in the Stanislaus River at
21 Goodwin Dam under the No Action Alternative (Appendix 6B, Figures B-17-1
22 and B-17-2). Similar exceedances would occur under the Second Basis of
23 Comparison, although slightly less frequently in November. Water temperatures
24 for rearing from January to May generally would be below 56°F, except in May
25 when average monthly water temperatures would reach about 60°F under both the
26 No Action Alternative and the Second Basis of Comparison (Appendix 6B,
27 Figure B-17-8).

28 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run
29 Chinook Salmon spawning (56°F) would be exceeded frequently under both the
30 No Action Alternative and Second Basis of Comparison during October and
31 November. Under the No Action Alternative, average monthly water
32 temperatures would exceed 56°F about 57 percent of the time in October
33 (Appendix 6B, Figure B-18-1). This, however, would be about 28 percent less
34 frequently than under the Second Basis of Comparison. In November, average
35 monthly water temperatures would exceed 56°F about 33 percent of the time
36 under the No Action Alternative, which would be about 5 percent more frequently
37 than under the Second Basis of Comparison (Appendix 6B, Figure B-18-2).

38 From January through May, rearing fall-run Chinook Salmon would be subjected
39 to average monthly water temperatures that exceed 56°F in March (less than
40 10 percent of the time) and May (about 30 percent of the time) under the No
41 Action Alternative which is about 10 percent more frequently in May than under
42 the Second Basis of Comparison (Appendix 6B, Figure B-18-8).

1 *Changes in Egg Mortality (Stanislaus River)*

2 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg
3 mortality rate is predicted to be around 7 percent, with higher mortality rates (in
4 excess of 14 percent) occurring in critical dry years under the No Action
5 Alternative. Overall, egg mortality in the Stanislaus River would be similar under
6 the No Action Alternative and the Second Basis of Comparison (Appendix 9C,
7 Table B-8).

8 *Changes in Delta Hydrodynamics*

9 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in
10 the Delta during the months of April, May and June. Near the Confluence of the
11 San Joaquin River and the Mokelumne River, the median proportion of positive
12 velocities was slightly greater under the No Action Alternative relative to the
13 Second Basis of Comparison in April and May and similar in June
14 (Appendix 9K). In Old River downstream of the facilities, the median proportion
15 of positive velocities was substantially greater in April and May, but became
16 more similar in June. In Old River upstream of the facilities, the median
17 proportion of positive velocities was slightly to moderately greater for the No
18 Action Alternative relative to the Second Basis of Comparison in April and May,
19 respectively, and slightly lower in June. On the San Joaquin River downstream of
20 the Head of Old River, the proportion of positive velocities was slightly to
21 moderately lower under the No Action Alternative relative to the Second Basis
22 of Comparison in April and May, respectively, whereas the values were similar
23 in June.

24 *Changes in Junction Entrainment*

25 Median entrainment probabilities at the Head of Old River were much greater
26 under the No Action Alternative relative to the Second Basis of Comparison
27 during April and May. The median entrainment probability was similar under
28 both scenarios in the month of June (Appendix 9L). At the Turner Cut junction,
29 median entrainment probabilities under the No Action Alternative were slightly
30 lower than the Second Basis of Comparison in June. During April and May,
31 median entrainment probabilities were more divergent with moderately lower
32 values for the No Action Alternative relative to the Second Basis of Comparison.
33 Overall, entrainment was slightly lower at the Columbia Cut junction relative to
34 Turner Cut, but patterns of entrainment between these two scenarios were similar.
35 Patterns at the Middle River and Old River junctions were similar to those
36 observed at Columbia and Turner Cut junctions.

37 *Changes in Fish Passage on the Stanislaus River*

38 The No Action Alternative includes the provision of passage at New Melones
39 Dam for steelhead. The challenges and difficulties associated with providing fish
40 passage upstream of Shasta and Folsom dams were briefly summarized
41 previously, and the same considerations apply to passage upstream of New
42 Melones Dam.

1 If a fish passage program could establish self-sustaining populations of spring-run
2 Chinook Salmon and steelhead upstream of New Melones, it would contribute
3 substantially to satisfaction of the spatial diversity viability standard. The passage
4 program could also contribute to abundance and productivity, if average returns
5 consistently exceeded 500 individuals. However, the passage program could also
6 function as a population sink if fish transported above the reservoir achieved a
7 cohort replacement rate of less than 1.

8 Insufficient information is available currently on the quantity, suitability, and
9 accessibility of habitat upstream of New Melones. Given poor habitat data and
10 the considerable technical uncertainties discussed previously, it is not possible to
11 determine if (or how much) fish passage at New Melones Dam are likely to affect
12 the status of Central Valley spring-run Chinook Salmon and steelhead
13 populations.

14 While the purpose of the fish passage action is not intended to benefit fall-run
15 Chinook Salmon, it could provide benefit if passage is provided for fall-run
16 Chinook Salmon.

17 *Summary of Effects on Fall-Run Chinook Salmon*

18 The multiple model and analysis outputs described above characterize the
19 anticipated conditions for fall-run Chinook Salmon and their response to change
20 under the No Action Alternative as compared to the Second Basis of Comparison.
21 In the Stanislaus River, the analysis of the effects of the No Action
22 Alternative and Second Basis of Comparison for fall-run Chinook Salmon relied
23 on the water temperature model output for the rivers at various locations
24 downstream of Goodwin Dam. The temperature model outputs for each of the
25 fall-run Chinook Salmon life stages suggest that thermal conditions and effects on
26 fall-run Chinook Salmon in the Stanislaus River generally would be similar under
27 both scenarios, although water temperatures could be somewhat more suitable for
28 fall-run Chinook Salmon spawning/egg incubation under the No Action
29 Alternative. This conclusion is supported by the water temperature threshold
30 exceedance analysis that indicated that suitable water temperatures for fall-run
31 Chinook Salmon spawning and egg incubation would be exceeded slightly more
32 frequently in November, but substantially less frequently in October under the No
33 Action Alternative. Suitable water temperatures for fall-run Chinook Salmon
34 rearing would be exceeded somewhat more frequently under the No Action
35 Alternative. Results of the analysis using Reclamation's salmon mortality model
36 indicate that there would be little difference in fall-run Chinook Salmon egg
37 mortality under the No Action Alternative and the Second Basis of Comparison.

38 Implementation of a fish passage project under the No Action Alternative,
39 although intended to address the limited availability of suitable habitat for spring-
40 run Chinook Salmon and steelhead in the Stanislaus River reaches downstream of
41 Goodwin Dam, likely would provide some benefit to fall-run Chinook Salmon if
42 passage for adult fall-run Chinook Salmon was provided and additional habitat
43 could be accessed. Any potential benefit to fall-run Chinook Salmon is uncertain.
44 Moreover, RPA actions intended to increase the efficiency of the Tracy and

1 Skinner Fish Collection Facilities could improve the overall salvage survival of
2 fall-run Chinook Salmon.

3 The numerical model results for effects on fall-run Chinook Salmon under the No
4 Action Alternative and Second Basis of Comparison do not definitively show
5 distinct differences. Because the No Action Alternative has the potential for
6 beneficial effects resulting from the RPA actions, it is concluded that the effects
7 on fall-run Chinook Salmon would be less adverse under the No Action
8 Alternative relative to the Second Basis of Comparison.

9 *Steelhead*

10 Changes in operations that influence temperature and flow conditions in the
11 Stanislaus River downstream of Goodwin Dam and the San Joaquin River
12 downstream of the Stanislaus River confluence, as measured at Vernalis could
13 affect steelhead. The following describes those changes and their potential
14 effects.

15 *Changes in Water Temperature (Stanislaus River)*

16 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
17 under the No Action Alternative and Second Basis of Comparison generally
18 would be similar (differences less than 0.5°F), with small differences in critical
19 dry years when water temperatures under the No Action Alternative would 0.8°F
20 and 1.3°F warmer on average than under the Second Basis of Comparison during
21 June and September, respectively, and 0.7°F cooler in November (Appendix 6B,
22 Table B-17-4).

23 Downstream at Orange Blossom Bridge, average monthly water temperatures in
24 October under the No Action Alternative would be lower than the Second Basis
25 of Comparison in all water year types by as much as 1.9°F. In most other months,
26 water temperatures under the No Action Alternative and Second Basis of
27 Comparison generally would be similar, except in April when average monthly
28 water temperatures would be lower under the No Action Alternative by as much
29 as about 1.2°F in the drier years (Appendix 6B, Table B-18-4).

30 This temperature pattern would continue downstream to the confluence with the
31 San Joaquin River, although temperatures would progressively increase, as would
32 the magnitude of difference between the No Action Alternative and Second Basis
33 of Comparison. Decreases in average monthly water temperatures in October and
34 April would be more pronounced under the No Action Alternative, with average
35 differences as much as 2.7°F (Appendix 6B, Table B-19-4) relative to the Second
36 Basis of Comparison. The magnitude of differences in average monthly water
37 temperatures between the No Action Alternative and the Second Basis of
38 Comparison in May and June also would increase relative to the upstream
39 locations with average June water temperatures reaching 2.4°F warmer under the
40 No Action Alternative in wet years.

41 Overall, the temperature differences between the No Action Alternative and
42 Second Basis of Comparison would be relatively minor (less than 0.5°F) and
43 likely would have little effect on steelhead in the Stanislaus River. Based on the

1 life history timing for steelhead, the slightly higher temperatures in June and
2 September of drier years under the No Action Alternative may increase the
3 likelihood of adverse effects to steelhead rearing in the Stanislaus River; the lower
4 temperatures in October under the No Action Alternative may reduce the
5 likelihood of adverse effects on adult steelhead during their upstream migration.

6 *Changes in Exceedance of Water Temperature Thresholds (Stanislaus River)*

7 Average monthly water temperatures in the Stanislaus River at Orange Blossom
8 Bridge would frequently exceed the temperature threshold (56°F) established for
9 adult steelhead migration under both the No Action Alternative and Second Basis
10 of Comparison during October and November. Under the No Action Alternative,
11 average monthly water temperatures would exceed 56°F about 57 percent of the
12 time in October which is about 28 percent less frequently than under the Second
13 Basis of Comparison (Appendix 6B, Figure B-18-1). In November, average
14 monthly water temperatures would exceed 56°F about 33 percent of the time
15 under the No Action Alternative, which would be about 5 percent more frequently
16 than under the Second Basis of Comparison (Appendix 6B, Figure B-18-2).

17 From January through May, the temperature threshold at Orange Blossom Bridge
18 is 55°F, which is intended to support steelhead spawning. This threshold would
19 not be exceeded under either the No Action Alternative or Second Basis of
20 Comparison during January or February. From March through May, however,
21 exceedances would occur under both the No action Alternative and Second Basis
22 of Comparison, with the threshold most frequently exceeded (nearly half the time)
23 under the No Action Alternative in May (Appendix 9N). Average monthly water
24 temperatures under the No Action Alternative would exceed the threshold
25 5 percent more frequently in March, 6 percent more frequently in May, and
26 17 percent less frequently in April than under the Second Basis of Comparison.

27 From June through November, the temperature threshold of 65°F established to
28 support steelhead rearing would be exceeded under both the No Action
29 Alternative and Second Basis of Comparison in all months but November, and
30 would exceed the threshold about 16 percent of the time in July under both the No
31 Action Alternative and Second Basis of Comparison. The differences between
32 the No Action Alternative and Second Basis of Comparison range from 1 percent
33 less frequent exceedance in October to 4 percent more frequent exceedance in
34 June under the No Action Alternative.

35 Average monthly water temperatures also would exceed the threshold (52°F)
36 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles
37 upstream of Knights Ferry, average monthly water temperatures under the No
38 Action Alternative would exceed 52°F in March, April, and May about 8 percent,
39 33 percent, and 63 percent of the time, respectively. Water temperatures under
40 the No Action Alternative would result in exceedances occurring about 1 to
41 2 percent less frequently during the January through May period. Farther
42 downstream at Orange Blossom Bridge, the temperature threshold for
43 smoltification is higher (57°F) and would be exceeded less frequently. The
44 magnitude of the exceedance also would be less. Average monthly water

1 temperatures under the No Action Alternative and the Second Basis of
2 Comparison would not exceed the threshold during January through March. In
3 April and May, exceedances of 2 percent and 18 percent would occur under the
4 No Action Alternative, which represent a frequency of about 6 percent less than
5 the Second Basis of Comparison in April and about an 8 percent higher frequency
6 in May.

7 Overall, the differences in exceedance frequency between the No Action
8 Alternative and Second Basis of Comparison would be relatively small, with the
9 exception of substantial differences in the frequency of exceedances in October
10 when the average monthly water temperatures under the No Action
11 Alternative would exceed the threshold for adult steelhead migration about
12 28 percent less frequently and in April during the spawning period when the
13 exceedance frequency would be about 17 percent less. Given the frequency of
14 exceedance under both the No Action Alternative and Second Basis of
15 Comparison and the generally stressful temperature conditions in the river, the
16 substantial differences (improvements) in October and April under the No Action
17 Alternative suggest that there would be less potential to for adverse effects on
18 steelhead under the No Action Alternative than under the Second Basis of
19 Comparison. Even during months when the differences would be relatively small,
20 the lower frequency of exceedances under the No Action Alternative suggest that
21 there would be less potential to result in adverse effects on steelhead under the No
22 Action Alternative than under the Second Basis of Comparison.

23 *Changes in Delta Hydrodynamics*

24 San Joaquin River-origin steelhead generally move through the Delta during
25 spring; however, there is less information on their timing than there is for
26 Chinook salmon. Thus, hydrodynamics in the entire January through June period
27 have the potential to affect juvenile steelhead. For a description of potential
28 hydrodynamic effects on steelhead, see the descriptions for fall-run Chinook
29 Salmon in the San Joaquin River basin above.

30 *Summary of Effects on Steelhead*

31 The analysis of the effects of the No Action Alternative and Second Basis of
32 Comparison for steelhead relied on the water temperature model output for the
33 rivers at various locations downstream of Goodwin Dam. The temperature model
34 outputs for each of the steelhead life stages suggest that thermal conditions and
35 effects on steelhead generally would be similar under both scenarios, although
36 water temperatures could be somewhat more suitable for steelhead rearing under
37 the No Action Alternative. Water temperatures could be somewhat less suitable
38 during the adult upstream migration period under the No Action relative to the
39 Second Basis of Comparison. This conclusion is supported by the water
40 temperature threshold exceedance analysis that indicated that the water
41 temperature threshold for steelhead migration would be exceeded less frequently
42 in October, but more frequently in November under the No Action Alternative.
43 The water temperature threshold for steelhead spawning would also be exceeded
44 less frequently under the No Action Alternative. The water temperature threshold
45 for steelhead rearing generally would be exceeded more frequently under the No

1 Action Alternative, while the temperature thresholds for smoltification would be
2 exceeded less frequently in most months.

3 Implementation of the fish passage program under the No Action
4 Alternative intended to address the limited availability of suitable habitat for
5 steelhead in the Stanislaus River reaches downstream of Goodwin Dam could
6 provide a benefit to steelhead, however, the extent of benefit is uncertain. In
7 addition, the potential effects of the No Action Alternative could be offset by the
8 RPA actions intended to reduce predation risk on steelhead in the Stanislaus
9 River, provide passage to upstream habitat, and to increase the efficiency of the
10 Tracy and Skinner Fish Collection Facilities. The actions to augment spawning
11 gravel in the Stanislaus River under the No Action Alternative also could benefit
12 steelhead.

13 The numerical model results for effects on steelhead under the No Action
14 Alternative and Second Basis of Comparison do not definitively show distinct
15 differences. However, in consideration of the potentially beneficial effects
16 resulting from the RPA actions under the No Action Alternative that are not
17 included in the numerical models (see Appendix 5A, Section B), the No Action
18 Alternative has a much greater potential to address the long-term sustainability of
19 steelhead than does the Second Basis of Comparison. The No Action
20 Alternative includes provisions for fish passage upstream of New Melones Dam
21 to address long-term temperature increases associated with climate change. Even
22 though the success of fish passage is uncertain, it is concluded that the potential
23 for adverse effects on steelhead under the No Action Alternative would be clearly
24 less than those under the Second Basis of Comparison, principally because the
25 Second Basis of Comparison does not include a strategy to address water
26 temperatures critical to steelhead sustainability over the long term with climate
27 change by 2030.

28 *Reservoir Fishes*

29 The analysis of effects associated with changes in operation on reservoir fishes
30 relied on evaluation of changes in available habitat (reservoir storage) and
31 anticipated changes in black bass nesting success.

32 As described in Chapter 5, Surface Water Resources and Water Supplies, changes
33 in CVP and SWP water supplies and operations under the No Action
34 Alternative as compared to the Second Basis of Comparison would result in lower
35 Storage levels in New Melones Reservoir under the No Action Alternative as
36 compared to the Second Basis of Comparison, as summarized in Table 5.16, due
37 to increased instream releases to support fish flows under the 2009 NMFS BO.

38 Storage in New Melones could be reduced up to around 10 percent in some
39 months of some water year types. Additional information related to monthly
40 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.
41 It is anticipated that aquatic habitat within New Melones is not limiting; however,
42 storage volume is an indicator of how much habitat is available to fish species
43 inhabiting these reservoirs. Therefore, the amount of habitat for reservoir fishes

1 could be reduced under the No Action Alternative as compared to the Second
2 Basis of Comparison.

3 As shown in Appendix 9F, predicted survival in New Melones is higher than in
4 the other reservoirs during May and June. For March, Largemouth Bass and
5 Smallmouth Bass nest survival is predicted to be above 40 percent in all of the
6 years simulated. For April, the likelihood that nest survival of Largemouth Bass
7 and Smallmouth Bass is between 40 and 100 percent would be about 13 percent
8 lower under the No Action Alternative than under the Second Basis of
9 Comparison, but still would be relatively high (around 80 percent). For May, this
10 pattern is reversed with the likelihood of high nest survival being similar under
11 the No Action Alternative and the Second Basis of Comparison. For June, the
12 likelihood of survival being greater than 40 percent for Largemouth Bass and
13 Smallmouth Bass in New Melones is also higher (by about 8 percent) under the
14 No Action Alternative as compared to the Second Basis of Comparison. For
15 Spotted Bass, nest survival from March through June is anticipated to be near
16 100 percent in every year under both the No Action Alternative and Second Basis
17 of Comparison.

18 The somewhat lower likelihood of high nesting survival for Largemouth and
19 Smallmouth Bass during April is not expected to adversely affect nesting success
20 because the likelihood of successful nesting would be relatively high. Thus, it is
21 concluded that effects on black bass nesting success would be similar under the
22 No Action Alternative and the Second Basis of Comparison.

23 *Other species*

24 Changes in operations that influence temperature and flow conditions in the
25 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at
26 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

27 As described above, average monthly water temperatures in the Stanislaus River
28 at Goodwin Dam under the No Action Alternative and Second Basis of
29 Comparison generally would be similar. Downstream at Orange Blossom Bridge,
30 average monthly water temperatures in the November to March period under the
31 No Action Alternative generally would be similar to, although somewhat higher
32 than, under the Second Basis of Comparison, except in April when average
33 monthly water temperatures in all water year types would be lower under the No
34 Action Alternative. This temperature pattern would continue downstream to the
35 confluence with the San Joaquin River, although temperatures would
36 progressively increase, as would the magnitude of difference between the No
37 Action Alternative and Second Basis of Comparison (Appendix 6B,
38 Table B-19-1).

39 In general, lamprey species can tolerate higher temperatures than salmonids, up to
40 around 72°F during their entire life history. Because lamprey ammocoetes remain
41 in the river for several years, any substantial flow reductions or water temperature
42 increases could result in adverse effects on larval lamprey. Given the relatively
43 minor changes in water temperature and water temperature threshold exceedance,
44 and the inherent uncertainty associated with the resolution of the temperature

1 model (average monthly outputs), it is likely that the potential to affect lamprey
2 species in the Stanislaus and San Joaquin rivers would be similar under the No
3 Action Alternative and the Second Basis of Comparison.

4 In general, Striped Bass and Hardhead also can tolerate higher temperatures than
5 salmonids. Given the relatively minor changes in water temperature and water
6 temperature threshold exceedance, the inherent uncertainty associated with the
7 resolution of the temperature model (average monthly outputs), it is likely that the
8 potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin
9 rivers would be similar under the No Action Alternative and the Second Basis of
10 Comparison.

11 **9.4.3.2 Alternative 1**

12 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical
13 to the Second Basis of Comparison. As described in Chapter 4, Approach to
14 Environmental Analysis, Alternative 1 is compared to the No Action
15 Alternative and the Second Basis of Comparison. However, because aquatic
16 resource conditions under Alternative 1 are identical to aquatic resource
17 conditions under the Second Basis of Comparison; Alternative 1 is only compared
18 to the No Action Alternative.

19 **9.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

20 *Trinity River Region*

21 *Coho Salmon*

22 The analysis of effects associated with changes in operation on Coho Salmon was
23 conducted using temperature model outputs for Lewiston Dam to anticipate the
24 likely effects on conditions in the Trinity River downstream of Lewiston Dam for
25 Coho Salmon.

26 Long-term average monthly water temperatures in the Trinity River at Lewiston
27 Dam under Alternative 1 generally would be similar to the water temperatures
28 that would occur under the No Action Alternative (Appendix 6B, Table B-1-1).
29 Average monthly temperatures under Alternative 1 generally would be similar to
30 those predicted under the No Action Alternative in most water year types, except
31 from November through January in above- and below-normal water years when
32 water temperatures under Alternative 1 could be up to 1.5°F cooler than under the
33 No Action Alternative. In November of critical years water temperatures under
34 Alternative 1 could be as much as 2.4°F warmer than under the No action
35 Alternative (Appendix 6B, Table B-1-1). Average monthly water temperatures
36 generally would be similar (less than 0.5°F differences) under Alternative 1 and
37 the No Action Alternative from July through September, except in September of
38 wet years when temperatures would be slightly (0.7°F) lower under Alternative 1.

39 The USFWS established a water temperature threshold of 56°F for Coho Salmon
40 spawning in the reach of the Trinity River from Lewiston to the confluence with
41 the North Fork Trinity River from October through December. Although not
42 entirely reflective of water temperatures throughout the reach, the temperature

1 model provides average monthly water temperature outputs for releases from the
2 Lewiston Dam, which may provide perspective on temperature conditions in the
3 reach below. In October and November, average monthly water temperatures
4 under both Alternative 1 and the No Action Alternative would exceed 56°F at
5 Lewiston Dam in some years (Appendix 9N). Under Alternative 1, the threshold
6 would be exceeded about 6 percent of the time in October, about 1 percent less
7 frequently than under the No Action Alternative. In November, both scenarios
8 would result in an exceedance frequency of about 2 percent. There would be no
9 exceedance of the threshold in December under both the Alternative 1 and the No
10 Action Alternative.

11 Overall, the temperature model outputs for each of the Coho Salmon life stages
12 suggest that the temperature of water released at Lewiston Dam generally would
13 be similar under both scenarios, although the exceedance of water temperature
14 thresholds would be slightly less frequent (1 percent) under Alternative 1. The
15 higher water temperatures in November of critical years (and lower temperatures
16 in December) under Alternative 1 would likely have little effect on Coho Salmon
17 as water temperatures in the Trinity River are typically low during this time
18 period. Given the similarity of the results and the inherent uncertainty associated
19 with the resolution of the temperature model (average monthly outputs),
20 Alternative 1 and the No Action Alternative are likely to have similar effects on
21 the Coho Salmon population in the Trinity River.

22 *Spring-run Chinook Salmon*

23 The analysis of effects associated with changes in operation on spring-run
24 Chinook Salmon was conducted using temperature model outputs for Lewiston
25 Dam to anticipate the likely effects on conditions in the Trinity River downstream
26 of Lewiston Dam.

27 As described above for Coho Salmon, the temperature differences between
28 Alternative 1 and the No Action Alternative would be relatively minor (less than
29 0.5°F) and likely would have little effect on spring-run Chinook Salmon in the
30 Trinity River. The higher average monthly water temperatures (up to 2.4°F) in
31 November of critical years (and lower temperatures in December) under
32 Alternative 1 would likely have little effect on spring-run Chinook Salmon as
33 water temperatures in the Trinity River are typically low during this time period.

34 Under both Alternative 1 and the No Action Alternative, average monthly water
35 temperatures in the Trinity River at Lewiston Dam would infrequently (1 percent
36 to 2 percent of the time) exceed 60°F, the threshold for spring-run Chinook
37 Salmon holding. There would be no difference in the frequency of exceedance of
38 the 60°F threshold under Alternative 1 as compared to the No Action Alternative.
39 In September, however, the threshold for spawning (56°F) would be exceeded
40 11 percent of the time under Alternative 1 which is about 2 percent more
41 frequently than under the No Action Alternative.

42 Overall, the differences in the frequency of threshold exceedance between
43 Alternative 1 and the No Action Alternative would be relatively minor, although
44 temperature conditions under Alternative 1 could be slightly more likely to result

1 in adverse effects on spring-run Chinook Salmon spawning than under the No
2 Action Alternative because of the increased frequency of exceedance of the 56°F
3 threshold at Lewiston Dam in September.

4 The majority of spring-run Chinook Salmon in the Trinity River are produced in
5 the South Fork Trinity watershed. Although the water temperatures under
6 Alternative 1 could result in adverse effects on spring-run Chinook Salmon in the
7 Trinity River, these effects would not occur in every year and are not anticipated
8 to be substantial based on the relatively small differences water temperatures
9 under Alternative 1 as compared to the No Action Alternative.

10 Overall, Alternative 1 is likely to have similar effects on the spring-run Chinook
11 Salmon population in the Trinity River as compared to the No Action Alternative.
12 However, implementation of the Hatchery Management Plan (RPA Action II.6.3)
13 under the No Action Alternative could reduce the impacts of hatchery Chinook
14 Salmon on natural spring-run Chinook Salmon in the Trinity River, and increase
15 the genetic diversity and diversity of run-timing for these stocks relative to
16 Alternative 1. Thus, given the relatively minor changes in water temperature and
17 water temperature threshold exceedance, the inherent uncertainty associated with
18 the resolution of the temperature model (average monthly outputs), and the
19 uncertainty of the hatchery benefits, it is concluded that Alternative 1 and the No
20 Action Alternative are likely to have similar effects on the spring-run Chinook
21 Salmon in the Trinity River.

22 *Fall-Run Chinook Salmon*

23 The analysis of effects associated with changes in operation on fall-run Chinook
24 Salmon was conducted using temperature model outputs for Lewiston Dam to
25 anticipate the likely effects on conditions in the Trinity River downstream of
26 Lewiston Dam. In addition, the Reclamation Salmon Mortality Model was used
27 to assess egg mortality.

28 As described above for Coho Salmon, the temperature differences between
29 Alternative 1 and No Action Alternative would be relatively minor (less than
30 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the
31 Trinity River. The higher water temperatures (as much as 2.4°F) in November of
32 critical years (and lower temperatures in December) under Alternative 1 would
33 likely have little effect on fall-run Chinook Salmon as water temperatures in the
34 Trinity River are typically low during this time period.

35 The temperature threshold and months during which it applies for fall-run
36 Chinook Salmon are the same as those for Coho Salmon. Under Alternative 1,
37 the threshold would be exceeded about 6 percent of the time in October, about
38 1 percent less frequently than under the No Action Alternative. In November,
39 both conditions would result in an exceedance frequency of about 2 percent.
40 There would be no exceedance of the threshold in December under both
41 Alternative 1 and the No Action Alternative. Overall, the differences in the
42 frequency of threshold exceedance between Alternative 1 and the No Action
43 Alternative would be relatively minor. Temperature conditions under the
44 Alternative 1 could be slightly less likely to result in adverse effects on fall-run

1 Chinook Salmon spawning than under the No Action Alternative because of the
2 reduced frequency of exceedance of the 56°F threshold at Lewiston Dam in
3 October. However, this would occur prior to the peak spawning period for
4 fall-run Chinook Salmon.

5 The temperatures described above for the Trinity River downstream of Lewiston
6 Dam are reflected in the analysis of egg mortality using the Reclamation salmon
7 mortality model (Appendix 9C). For fall-run Chinook Salmon in the Trinity
8 River, the long-term average egg mortality rate is predicted to be relatively low
9 (around 4 percent), with higher mortality rates (nearly 15 percent) occurring in
10 critical dry years under the No Action Alternative (Appendix 9C, Table B-1-5).
11 Overall, egg mortality under Alternative 1 and the No Action Alternative would
12 be similar in all water year types.

13 Although the combined analysis based on water temperature suggests that
14 operations under Alternative 1 could be slightly less adverse than under the No
15 Action Alternative, these effects would not occur in every year and are not
16 anticipated to be substantial based on the relatively small differences in water
17 temperatures (and similar egg mortality) between Alternative 1 and the No Action
18 Alternative. In addition, implementation of the Hatchery Management Plan (RPA
19 Action II.6.3) under the No Action Alternative could reduce the impacts of
20 hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity
21 River, and increase the genetic diversity and diversity of run-timing for these
22 stocks relative to Alternative 1.

23 Overall, given the small differences in the numerical model results and the
24 inherent uncertainty in the temperature model, as well as the potential for
25 offsetting benefits associated with the Hatchery Management Plan, it is concluded
26 that there would be no definitive difference in effects on fall-run Chinook Salmon
27 between Alternative 1 and the No Action Alternative.

28 *Steelhead*

29 The analysis of effects associated with changes in operation on steelhead relied on
30 temperature model outputs for Lewiston Dam to anticipate the likely effects on
31 conditions in the Trinity River downstream of Lewiston Dam.

32 Temperature differences between Alternative 1 and No Action Alternative would
33 be relatively minor (less than 0.5°F) and likely would have little effect on
34 steelhead in the Trinity River. The higher water temperatures (up to 2.4°F) in
35 November of critical years (and lower temperatures in December) under
36 Alternative 1 would likely have little effect on steelhead as water temperatures in
37 the Trinity River are typically low during this time period.

38 The temperature threshold and months during which it applies for steelhead are
39 the same as those described for Coho Salmon. Thus, the frequency of average
40 monthly water temperatures in the Trinity River at Lewiston Dam exceeding the
41 threshold of 56°F for steelhead would be the same as those described above for
42 Coho Salmon. Water temperature conditions under Alternative 1 could be less
43 likely to affect steelhead spawning than under the No Action Alternative because

1 of the slightly (1 percent) reduced frequency of exceedance of the 56°F threshold
2 at Lewiston Dam in October. The biological significance of this difference,
3 however, is uncertain.

4 Although the combined analysis based on water temperature suggests that
5 operations under Alternative 1 could be slightly less adverse than under the No
6 Action Alternative, these effects would not occur in every year and are not
7 anticipated to be substantial based on the relatively small differences in water
8 temperatures between Alternative 1 and the No Action Alternative. Overall,
9 given these small differences in water temperatures and the inherent uncertainty
10 in the temperature model, Alternative 1 and the No Action Alternative are likely
11 to have similar effects on steelhead in the Trinity River.

12 *Green Sturgeon*

13 The analysis of effects associated with changes in operation on Green Sturgeon
14 relied on temperature model outputs for Lewiston Dam to anticipate the likely
15 effects on conditions in the Trinity River downstream of Lewiston Dam.

16 Green Sturgeon spawn in the lower reaches of the Trinity River during April
17 through June, and water temperatures above about 63°F are believed stressful to
18 embryos (Van Eenennaam et al. 2005). Average monthly water temperature
19 conditions during April through June in the Trinity River at Lewiston Dam under
20 Alternative 1 would be similar to the temperatures under the No Action
21 Alternative and would not exceed 58°F during this period. In addition, water
22 temperatures in the reach of the river where Green Sturgeon spawn are likely
23 controlled by other factors (e.g., ambient air temperatures and tributary inflows)
24 more than water operations at Trinity and Lewiston dams.

25 Overall, given the similarities between average monthly water temperatures at
26 Lewiston Dam under Alternative 1 and the No Action Alternative, it is likely that
27 water temperature conditions for Green Sturgeon in the Trinity River or lower
28 Klamath River and estuary would be similar under both scenarios.

29 *Reservoir Fishes*

30 The analysis of effects associated with changes in operation on reservoir fishes
31 relied on evaluation of changes in available habitat (reservoir storage) and
32 anticipated changes in black bass nesting success.

33 Changes in CVP water supplies and operations under Alternative 1 as compared
34 to the No Action Alternative would result in higher reservoir storage in Trinity
35 Lake. Storage in Trinity Lake could increase by up to about 10 percent in some
36 months of some water year types. Additional information related to monthly
37 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.

38 Using Trinity Lake storage as an indicator of habitat available to fish species
39 inhabiting the reservoir, the amount of habitat for reservoir fishes would not be
40 reduced under Alternative 1 as compared to the No Action Alternative.

1 As shown in Appendix 9F, nest survival in Trinity Lake is near 100 percent in
2 March and April due to increasing reservoir elevations. For May, the likelihood
3 of survival for Largemouth Bass in Trinity Lake being in the 40 to 100 percent
4 range is slightly (about 2 percent) higher under Alternative 1 as compared to the
5 No Action Alternative. For June, the likelihood of survival being greater than
6 40 percent for Largemouth Bass is somewhat lower than in May and is slightly
7 lower (about 2 percent) under Alternative 1 as compared to the No Action
8 Alternative. For Spotted Bass, the likelihood of survival being greater than
9 40 percent would be 100 percent in May under both Alternative 1 and the No
10 Action Alternative. For June, Spotted Bass survival in Trinity Lake would be less
11 than for May due to greater daily reductions in water surface elevation. The
12 likelihood of survival being greater than 40 percent would be similar (near
13 100 percent) under Alternative 1 and the No Action Alternative.

14 Overall, the comparison of storage and the analysis of nesting suggest that effects
15 of Alternative 1 on reservoir fishes would be similar to those under the No Action
16 Alternative.

17 *Pacific Lamprey*

18 Little information is available on factors that influence populations of Pacific
19 Lamprey in the Trinity River, but they are likely affected by many of the same
20 factors as salmon and steelhead because of the parallels in their life cycles. On
21 average, the temperature of water released at Lewiston Dam under Alternative 1
22 generally would be similar to (less than 0.5°F differences) to those under the No
23 Action Alternative. Given the similarities in water temperatures, it is likely that
24 the effects on Pacific Lamprey would be similar under Alternative 1 and the No
25 Action Alternative. This conclusion likely applies to other species of lamprey
26 that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).

27 *Eulachon*

28 It is unclear whether this species has been extirpated from the Klamath River.
29 Given that the highest increases in flow under Alternative 1 would be less than
30 10 percent in the Trinity River (Appendix 5A), with a smaller relative change in
31 the lower Klamath River and Klamath River estuary, and that water temperatures
32 in the Klamath River are unlikely to be affected by changes upstream at Lewiston
33 Dam, it is likely that Alternative 1 would have a similar potential to influence
34 Eulachon in the Klamath River as the No Action Alternative.

35 *Sacramento River System*

36 *Winter-run Chinook Salmon*

37 Changes in operations that influence temperature and flow conditions in the
38 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
39 Salmon. The following describes those changes and their potential effects.

40 *Changes in Water Temperature*

41 Long-term average monthly water temperature in the Sacramento River at
42 Keswick Dam under Alternative 1 would generally be similar to (less than 0.5°F
43 difference) to water temperatures under the No Action Alternative. An exception

1 is during September and October of critical dry years when water temperatures
2 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
3 compared to the No Action Alternative and up to 1°F warmer in September of
4 wetter years in some water year types(up to 0.3°F) (Appendix 6B, Table B-5-1).
5 A similar pattern of changes in temperature generally would be exhibited
6 downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with average monthly
7 temperatures differences between the scenarios progressively decreasing, except
8 in September (up to 2.8°F warmer at Bend Bridge) during wetter years under
9 Alternative 1 (Appendix 6B, Table B-8-1).

10 Overall, the temperature differences between Alternative 1 and the No Action
11 Alternative would be relatively minor (less than 0.5°F) and likely would have
12 similar effects on winter-run Chinook Salmon in the Sacramento River.
13 Spawning for winter-run Chinook Salmon in the Sacramento River takes place
14 from mid-April to mid-August with incubation occurring over the same time
15 period and extending into October. The somewhat lower water temperatures in
16 September and October of critical dry years under the No Action
17 Alternative could reduce the likelihood of adverse effects on winter-run Chinook
18 Salmon egg incubation and fry rearing during this water year type. However, the
19 increased water temperatures during this time period under Alternative 1 in wetter
20 years could increase the likelihood of adverse effects on egg incubation relative to
21 the No Action Alternative.

22 *Changes in Exceedances of Water Temperature Thresholds*

23 With the exception of April, average monthly water temperatures from April to
24 September under both Alternative 1 and the No Action Alternative would show
25 exceedances of the water temperature threshold of 56°F established in the
26 Sacramento River at Ball's Ferry for winter-run Chinook Salmon spawning and
27 egg incubation (Appendix 9N). Under Alternative 1, the temperature threshold
28 generally would be exceeded less frequently than under the No Action
29 Alternative (by about 1 percent to 3 percent) in the April through August period,
30 with the temperature threshold in September exceeded in 52 percent of the
31 simulated years about 10 percent more frequently under Alternative 1 than the No
32 Action Alternative (42 percent). Farther downstream at Bend Bridge, the
33 frequency of exceedances would increase, with exceedances under both
34 Alternative 1 and the No Action as Alternative as high as about 90 percent in
35 some months. Under Alternative 1, temperature exceedances generally would be
36 less frequent (by up to 8 percent) than under the No Action Alternative, with the
37 exception of September, when threshold exceedances under Alternative 1 would
38 be about 29 percent more frequent.

39 Overall, there would be substantial differences in the frequency of threshold
40 exceedance between Alternative 1 and the No Action Alternative, particularly in
41 September. Temperature conditions under Alternative 1 would reduce the
42 likelihood of adverse effects on winter-run Chinook Salmon egg incubation than
43 under the No Action Alternative because of the reduced frequency of exceedance
44 of the 56°F threshold from April through August. However, the substantial

1 increase in the frequency of exceedance in September under Alternative 1 may
2 increase the likelihood of adverse effects on winter-run Chinook Salmon egg
3 incubation during this limited portion of the spawning and egg incubation period.

4 *Changes in Egg Mortality*

5 The temperatures described above for the Sacramento River downstream of
6 Keswick Dam are reflected in the analysis of egg mortality using the Reclamation
7 salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the
8 Sacramento River, the long-term average egg mortality rate is predicted to be
9 relatively low (around 4 percent), with higher mortality rates (exceeding
10 20 percent) occurring in critical dry years under Alternative 1. In critical dry
11 years the average egg mortality rate would be 5.4 percent lower under
12 Alternative 1 than under the No Action Alternative (Appendix 9C, Table B-4).
13 Overall, winter-run Chinook Salmon egg mortality in the Sacramento River under
14 Alternative 1 and the No Action Alternative would be similar, except in critical
15 dry water years.

16 *Changes in Weighted Usable Area*

17 As described above for the assessment methodology, Weighted Usable Area
18 (WUA) is a function of flow, but the relationship is not linear due to differences
19 in depths and velocities present in the wetted channel at different flows. Because
20 the combination of depths, velocities, and substrates preferred by species and life
21 stages varies, WUA values at a given flow can differ substantially for the life
22 stages evaluated.

23 As an indicator of the amount of suitable spawning habitat for winter-run Chinook
24 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
25 in general, there would be similar amounts of spawning habitat available from
26 May through September under Alternative 1 and the No Action
27 Alternative (Appendix 9E).

28 Modeling results indicate that, in general, there would be similar amounts of
29 suitable fry rearing habitat available from June through October under
30 Alternative 1 and the No Action Alternative (Appendix 9E).

31 Similar to the results for fry rearing WUA, modeling results indicate that there
32 would be similar amounts of suitable juvenile rearing habitat available during the
33 juvenile rearing period from September through August under Alternative 1 and
34 the No Action Alternative (Appendix 9E).

35 *Changes in SALMOD Output*

36 SALMOD results indicate that potential juvenile production under Alternative 1
37 would be the similar to the No Action Alternative (Appendix 9D, Table B-4-1).

38 *Changes in Delta Passage Model Output*

39 The Delta Passage Model predicted similar estimates of annual Delta survival
40 across the 81 water year time period for winter-run Chinook Salmon between
41 Alternative 1 and the No Action Alternative (Appendix 9J). Median Delta
42 survival would be 0.352 for Alternative 1 and 0.349 for the No Action
43 Alternative.

1 *Changes in Oncorhynchus Bayesian Analysis Output*

2 Escapement of winter-run Chinook Salmon and Delta survival was modeled by
3 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook
4 salmon. Escapement was generally lower under Alternative 1 as compared to the
5 No Action Alternative (Appendix 9I). The median abundance under Alternative 1
6 was lower in 19 of the 22 years of simulation (1971 to 2002), and there was
7 typically greater than a 25 percent chance that Alternative 1 values would be
8 lower than under the No Action Alternative. Median delta survival was
9 approximately 12 percent lower under Alternative 1 as compared to the No Action
10 Alternative. However, the probability intervals indicated that no difference
11 between scenarios was a likely outcome.

12 *Changes in Interactive Object-Oriented Simulation Output*

13 The IOS model predicted similar adult escapement trajectories for winter-run
14 Chinook Salmon between Alternative 1 and the No Action Alternative across the
15 81 water years (Appendix 9H). Under Alternative 1 median adult escapement
16 was 4,042 and under the No Action Alternative, median escapement was 3,935.

17 Similar to adult escapement, the IOS model predicted similar egg survival time
18 histories for winter-run Chinook Salmon between Alternative 1 and the No Action
19 Alternative across the 81 water years (Appendix 9H). Under Alternative 1
20 median egg survival was 0.987 and under the No Action Alternative median egg
21 survival was 0.990.

22 *Changes in Delta Hydrodynamics*

23 Winter-run Chinook Salmon smolts are most abundant in the Delta during
24 January, February and March. On the Sacramento River near the confluence of
25 Georgiana Slough, the median proportion of positive velocities under
26 Alternative 1 was indistinguishable from the No Action
27 Alternative (Appendix 9K).

28 *Changes in Junction Entrainment*

29 Entrainment at Georgiana Slough was similar under both Alternative 1 and No
30 Action Alternative during January, February and March when winter-run Chinook
31 Salmon smolts are most abundant in the Delta (Appendix 9L).

32 *Changes in Salvage*

33 Salvage of Sacramento River-origin Chinook Salmon is predicted to be greater
34 under Alternative 1 relative to No Action Alternative in every month
35 (Appendix 9M). Winter-run Chinook Salmon smolts migrating through the Delta
36 would be most susceptible in the months of January, February and March.
37 Predicted values in January and February indicated a moderate increase in the
38 proportion of fish salvaged under Alternative 1 relative to the No Action
39 Alternative.

40 *Summary of Effects on Winter-Run Chinook Salmon*

41 The multiple model and analysis outputs described above characterize the
42 anticipated conditions for winter-run Chinook Salmon and their response to
43 change under Alternative 1 as compared to the No Action Alternative. For the

1 purpose of analyzing effects on winter-run Chinook Salmon and developing
2 conclusions, greater reliance was placed on the outputs from the two life cycle
3 models, IOS and OBAN because they each integrate the available information to
4 produce single estimates of winter-run Chinook Salmon escapement. The output
5 from IOS indicated that winter-run Chinook Salmon escapement would be similar
6 under both scenarios, whereas the OBAN results indicated that escapement under
7 Alternative 1 would be lower than under the No Action Alternative, although
8 there would be some chance (less than a 25 percent) that escapement under the
9 Alternative 1 could be greater than the No Action Alternative.

10 These model results suggest that effects on winter-run Chinook Salmon would be
11 similar under both scenarios, with a small likelihood that winter-run Chinook
12 Salmon escapement would be lower under Alternative 1 than under the No Action
13 Alternative. This potential distinction between the two scenarios, however, may
14 be offset or reversed by the benefits of implementation of fish passage under the
15 No Action Alternative intended to address the limited availability of suitable
16 habitat for winter-run Chinook Salmon in the Sacramento River reaches
17 downstream of Keswick Dam. This potential beneficial effect and its magnitude
18 would depend on the success of the fish passage program. In addition, RPA
19 actions intended to increase the efficiency of the Tracy and Skinner Fish
20 Collection Facilities could improve the overall salvage survival of winter-run
21 Chinook Salmon.

22 Overall, the quantitative results from the numerical models suggest that operation
23 under the Alternative 1 would be more likely to result in adverse effects on
24 winter-run Chinook Salmon than would the No Action Alternative. In addition,
25 the potentially beneficial effects resulting from the RPA actions under the No
26 Action Alternative that are not included in the numerical models (see
27 Appendix 5A, Section B) suggest that the No Action Alternative has a much
28 greater potential to address the long-term sustainability of winter-run Chinook
29 Salmon than does the Alternative 1. It is concluded that the potential for adverse
30 effects on winter-run Chinook Salmon under Alternative 1 would be greater than
31 those under the No Action Alternative, principally because Alternative 1 does not
32 include fish passage to address water temperatures critical to winter-run Chinook
33 Salmon sustainability over the long term with climate change by 2030.

34 *Spring-run Chinook Salmon*

35 Changes in operations that influence temperature and flow conditions in the
36 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
37 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect
38 spring-run Chinook Salmon. The following describes those changes and their
39 potential effects.

40 *Changes in Water Temperature*

41 Changes in water temperature that could affect spring-run Chinook Salmon could
42 occur in the Sacramento River, Clear Creek, and Feather River. The following
43 describes temperature conditions in those water bodies.

1 *Sacramento River*

2 Long-term average monthly water temperature in the Sacramento River at
3 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
4 difference) to water temperatures under the No Action Alternative. An exception
5 is during September and October of critical dry years when water temperatures
6 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
7 compared to the No Action Alternative and up to 1°F warmer in September of
8 wetter years (Appendix 6B, Table B-5-1). A similar pattern of changes in
9 temperature generally would be exhibited downstream at Ball's Ferry, Jelly's
10 Ferry, Bend Bridge and Red Bluff, with average monthly temperature differences
11 between scenarios progressively decreasing, except in September (up to 3.2°F
12 warmer at Red Bluff) during wetter years (Appendix 6B, Table B-9-1).

13 Overall, the temperature differences between Alternative 1 and the No Action
14 Alternative would be relatively minor (less than 0.5°F) and likely would have
15 little effect on spring-run Chinook Salmon in the Sacramento River. The slightly
16 lower water temperatures from October to December under Alternative 1 would
17 likely have little effect on spring-run Chinook Salmon as water temperatures in
18 the Sacramento River below Keswick Dam are typically low during this time
19 period. The somewhat higher water temperatures in September of wetter years
20 may increase the likelihood of adverse effects on spring-run Chinook Salmon
21 spawning, although the decreased temperatures in September of critical dry years
22 under Alternative 1 may reduce the likelihood of adverse effects on spring-run
23 Chinook Salmon spawning in this water year type. There would be little
24 difference in potential effects on spring-run Chinook Salmon holding over the
25 summer due to the similar water temperatures during this time period under
26 Alternative 1 and the No Action Alternative.

27 *Clear Creek*

28 Average monthly water temperatures in Clear Creek at Igo under Alternative 1
29 relative to the No Action Alternative are generally predicted to be similar (less
30 than 0.5°F differences) from September through April and June through August
31 from September through April and June through August (Appendix 6B,
32 Table B-3-1). Average monthly water temperatures during May under
33 Alternative 1 could be higher by up to 0.8°F than under the No Action
34 Alternative. Overall, thermal conditions for spring-run Chinook Salmon in Clear
35 Creek would be similar under Alternative 1 and the No Action Alternative.

36 *Feather River*

37 Average monthly water temperature in the Feather River in the low flow channel
38 generally were predicted to be similar (less than 0.5°F differences) under
39 Alternative 1 and the No Action Alternative, except during November and
40 December when average monthly water temperatures could be up to 1.4°F lower
41 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
42 temperatures in September under Alternative 1 could be up to 1.3°F warmer than
43 under the No Action Alternative in wetter years. Although temperatures in the
44 river would become progressively higher in the downstream directions, the
45 differences between Alternative 1 and No Action Alternative would exhibit a

1 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
 2 with water temperature differences between Alternative 1 and the No Action
 3 Alternative generally decreasing in most water year types. However, water
 4 temperatures from July to September under Alternative 1 were predicted to be
 5 somewhat (0.7°F to 1.6°F) warmer on average and up to 4.0°F warmer at the
 6 confluence with the Sacramento River in wetter years (Appendix 6B,
 7 Table B-23-1).

8 Overall, the temperature differences in the Feather River between Alternative 1
 9 and the No Action Alternative would be relatively minor (less than 0.5°F) and
 10 likely would have little effect on spring-run Chinook Salmon in the Feather River.
 11 The slightly lower water temperatures in November and December under
 12 Alternative 1 would likely have little effect on spring-run Chinook Salmon as
 13 water temperatures in the Feather River are typically low during this time period.
 14 The somewhat higher water temperatures in September of wetter years may
 15 increase the likelihood of adverse effects on spring-run Chinook Salmon
 16 spawning, although the decreased temperatures in September of critical dry years
 17 under Alternative 1 may reduce the likelihood of adverse effects on spring-run
 18 Chinook Salmon spawning in this water year type. There would be little
 19 difference in potential effects on spring-run Chinook Salmon holding over the
 20 summer due to the similar water temperatures during this time period under
 21 Alternative 1 and the No Action Alternative.

22 *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water
 24 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,
 25 Clear Creek, and Feather River. The following describes the extent of water
 26 temperature threshold exceedances for each of those water bodies.

27 *Sacramento River*

28 Average monthly water temperatures under both Alternative 1 and No Action
 29 Alternative would show exceedances of the water temperature threshold of 56°F
 30 established in the Sacramento River at Red Bluff for spring-run Chinook Salmon
 31 (egg incubation) in October, November, and again in April. The exceedances
 32 would occur at the greatest frequency in October (79 percent of the time under
 33 Alternative 1); under Alternative 1 the water temperature threshold would be
 34 exceeded less frequently in November (7 percent of the time under Alternative 1)
 35 and not exceeded at all from December through March (Appendix 9N). As water
 36 temperatures warm in the spring, the thresholds would be exceeded in April by
 37 15 percent under Alternative 1. In the months when the greatest frequency of
 38 exceedances occur (October, November, and April), model results generally
 39 indicate less frequent exceedances (by up to 4 percent in October) under
 40 Alternative 1 than under the No Action Alternative. Temperature conditions in
 41 the Sacramento River under Alternative 1 could be less likely to affect spring-run
 42 Chinook Salmon egg incubation than under the No Action Alternative because of
 43 the decreased frequency of exceedance of the 56°F threshold in October,
 44 November, and April. However, this difference may be partially offset if water

1 temperature management and fish passage measures associated with 2009 NMFS
2 BO RPA under the No Action Alternative are successful.

3 *Clear Creek*

4 Average monthly water temperatures under both Alternative 1 and No Action
5 Alternative would not exceed the water temperature threshold of 60°F established
6 in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning and rearing in
7 June through August. However, water temperatures under Alternative 1 and the
8 No Action Alternative would exceed the water temperature threshold of 56°F
9 established for spawning in September and October about 10 percent to
10 15 percent of the time (Appendix 9N). Water temperatures under Alternative 1
11 could exceed the threshold about 3 percent less frequently than under the No
12 Action Alternative in September and about 2 percent less frequently in October
13 (Appendix 9N). Temperature conditions in Clear Creek under Alternative 1 could
14 be less likely to affect spring-run Chinook Salmon spawning than under the No
15 Action Alternative because of the decreased frequency of exceedance of the 56°F
16 threshold in September and October. However, this difference may be partially
17 offset if the thermal stress reduction measures associated with 2009 NMFS BO
18 RPA Action I.1.5 under the No Action Alternative are successful in improving
19 water temperatures in Clear Creek.

20 *Feather River*

21 Average monthly water temperatures under both Alternative 1 and the No Action
22 Alternative would exceed the water temperature threshold of 56°F established in
23 the Feather River at Robinson Riffle for spring-run Chinook Salmon egg
24 incubation and rearing during some months, particularly in October and
25 November, and March and April, when temperature thresholds could be exceeded
26 frequently (Appendix 9N). The frequency of exceedance was highest in October,
27 a month in which average monthly water could get as high as about 68°F.
28 However, water temperatures under Alternative 1 would exceed the spawning
29 temperature threshold about 1 percent less frequently than under the No Action
30 Alternative in October, November, and December, and about 2 percent more
31 frequently in March.

32 The established water temperature threshold of 63°F for rearing during May
33 through August would be exceeded often under both Alternative 1 and the No
34 Action Alternative in May and June, but not at all in July and August. Water
35 temperatures under Alternative 1 would exceed the rearing temperature threshold
36 about 9 percent less frequently than under the No Action Alternative in May.
37 Temperature conditions in the Feather River under Alternative 1 could be less
38 likely to affect spring-run Chinook Salmon spawning and rearing than under the
39 No Action Alternative because of the decreased frequency of exceedance of the
40 water temperature thresholds.

41 *Changes in Egg Mortality*

42 These temperature differences described above are reflected in the analysis of egg
43 mortality using the Reclamation salmon mortality model (Appendix 9C). For
44 spring-run Chinook Salmon in the Sacramento River, the long-term average egg

1 mortality rate is predicted to be relatively high (exceeding 20 percent), with high
2 mortality rates (exceeding 70 percent) occurring in critical dry years. In critical
3 dry years the average egg mortality rate under Alternative 1 is predicted to be
4 10.4 percent lower than under the No Action Alternative (Appendix 9C,
5 Table B-3). Overall, spring-run Chinook Salmon egg mortality in the Sacramento
6 River under Alternative 1 and the No Action Alternative would be similar, except
7 in critical dry water years.

8 *Changes in Weighted Usable Area*

9 Weighted usable area curves are available for spring-run Chinook Salmon in
10 Clear Creek. As described above, flows in Clear Creek downstream of
11 Whiskeytown Dam are not anticipated to differ under Alternative 1 relative to the
12 No Action Alternative except in May due to the release of spring attraction flows
13 in accordance with the 2009 NMFS BO under the No Action Alternative.
14 Therefore, there would be no change in the amount of potentially suitable
15 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by
16 WUA) available under Alternative 1 as compared to the No Action Alternative.

17 *Changes in SALMOD Output*

18 SALMOD results indicate that potential spring-run juvenile production would be
19 similar under Alternative 1 and the No Action Alternative except that production
20 under Alternative 1 could be 12 percent higher than under the No Action
21 Alternative in critical dry years (Appendix 9D, Table B-3-1).

22 *Changes in Delta Passage Model Output*

23 The Delta Passage Model predicted similar estimates of annual Delta survival
24 across the 81 water year time period for spring-run Chinook Salmon between
25 Alternative 1 and the No Action Alternative (Appendix 9J). Median Delta
26 survival was 0.286 for Alternative 1 and 0.296 for the No Action Alternative.

27 *Changes in Delta Hydrodynamics*

28 Spring-run Chinook Salmon are most abundant in the Delta from March through
29 May. Near the junction of Georgiana Slough, the median percent of time that
30 velocity was positive was similar in March, April, and May for both scenarios. In
31 Old River upstream of the facilities, the median percent of time with positive
32 velocity was similar in March, slightly lower in April, and moderately lower in
33 May under Alternative 1 relative to the No Action Alternative (Appendix 9K). In
34 Old River downstream of the facilities the median percent of time with positive
35 velocity was slightly lower in March and increasingly lower in April and May
36 under Alternative 1 relative to No Action Alternative.

37 *Changes in Junction Entrainment*

38 Entrainment at Georgiana Slough was similar under both Alternative 1 and No
39 Action Alternative during March, April and May when spring run are most
40 abundant in the Delta (Appendix 9L).

1 *Changes in Salvage*

2 Salvage of Sacramento River-origin Chinook Salmon is predicted to be higher
3 under Alternative 1 relative to No Action Alternative in every month
4 (Appendix 9M). Spring-run smolts migrating through the Delta would be most
5 susceptible in the months of March April and May. Predicted values in April and
6 May indicated a substantially larger fraction of fish salvaged under Alternative 1.
7 Predicted salvage was more similar in March but still higher under Alternative 1
8 than under the No Action Alternative.

9 *Summary of Effects on Spring-Run Chinook Salmon*

10 The multiple model and analysis outputs described above characterize the
11 anticipated conditions for spring-run Chinook Salmon and their response to
12 change under Alternative 1 and the No Action Alternative. For the purpose of
13 analyzing effects on spring-run Chinook Salmon in the Sacramento River, greater
14 reliance was placed on the outputs from the SALMOD model because it integrates
15 the available information on temperature and flows to produce estimates of
16 mortality for each life stage and an overall, integrated estimate of potential spring-
17 run Chinook Salmon juvenile production. The output from SALMOD indicated
18 that spring-run Chinook Salmon production in the Sacramento River would be
19 similar under Alternative 1 and the No Action Alternative, although production
20 under Alternative 1 could be over 10 percent greater than under the No Action
21 Alternative in critical dry years. The analyses attempting to assess the effects on
22 routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that
23 salvage (as an indicator of potential losses of juvenile salmon at the export
24 facilities) of Sacramento River-origin Chinook Salmon is predicted to be higher
25 under Alternative 1 relative to No Action Alternative in every month.

26 In Clear Creek and the Feather River, the analysis of the effects of Alternative 1
27 and the No Action Alternative for spring-run Chinook Salmon relied on output
28 from the WUA analysis and water temperature output for Clear Creek at Igo, and
29 in the Feather River low flow channel and downstream of the Thermalito
30 complex. The WUA analysis suggests that there would be little difference in the
31 availability of spawning and rearing habitat in Clear Creek. The temperature
32 model outputs suggest that thermal conditions and effects on each of the spring-
33 run Chinook Salmon life stages generally would be similar under both scenarios
34 in Clear Creek and the Feather River, although water temperatures could be
35 somewhat more suitable for spring-run Chinook Salmon holding and
36 spawning/egg incubation in the Feather River under Alternative 1. This
37 conclusion is supported by the water temperature threshold exceedance analysis
38 that indicated that water temperature thresholds for spawning and egg incubation
39 would be exceeded slightly less frequently under Alternative 1 than under the No
40 Action Alternative in Clear Creek and the Feather River. The water temperature
41 threshold for rearing spring-run Chinook Salmon would also be exceeded slightly
42 less frequently in the Feather River under Alternative 1. Because of the inherent
43 uncertainty associated with the resolution of the temperature model (average
44 monthly outputs), the slightly greater likelihood of exceeding water temperature
45 thresholds under Alternative 1 could increase the potential for adverse effects on

1 the spring-run Chinook Salmon populations in the Feather River. Given the
2 similarity of the results, Alternative 1 and the No Action Alternative are likely to
3 have similar effects on the spring-run Chinook Salmon population in Clear Creek.

4 These model results suggest that overall, effects on spring-run Chinook Salmon
5 could be slightly less adverse under Alternative 1 than the No Action Alternative.
6 This potential distinction between the two scenarios, however, may be partially
7 offset by the benefits of implementation of fish passage under the No Action
8 Alternative intended to address the limited availability of suitable habitat for
9 spring-run Chinook Salmon in the Sacramento River reaches downstream of
10 Keswick Dam. This potential beneficial effect and its magnitude would depend
11 on the success of the fish passage program. In addition, RPA actions intended to
12 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could
13 improve the overall salvage survival of spring-run Chinook Salmon under the No
14 Action Alternative.

15 Thus, it is concluded that the potential for adverse effects on spring-run Chinook
16 Salmon under Alternative 1 would be greater than under the No Action
17 Alternative, principally because Alternative 1 does not include a strategy to
18 address water temperatures critical to spring-run Chinook Salmon sustainability
19 over the long term with climate change by 2030.

20 *Fall-Run Chinook Salmon*

21 Changes in operations that influence temperature and flow conditions in the
22 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
23 Whiskeytown Dam, Feather River downstream of Oroville Dam and American
24 River downstream of Nimbus could affect fall-run Chinook Salmon. The
25 following describes those changes and their potential effects.

26 *Changes in Water Temperature*

27 Changes in water temperature could affect fall-run Chinook Salmon in the
28 Sacramento, Feather, and American rivers, and Clear Creek. The following
29 describes temperature conditions in those water bodies.

30 *Sacramento River*

31 Long-term average monthly water temperature in the Sacramento River at
32 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
33 difference) to water temperatures under the No Action Alternative. An exception
34 is during September and October of critical dry years when water temperatures
35 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
36 compared to the No Action Alternative and up to 1°F warmer in September of
37 wetter years (Appendix 6B). A similar pattern in temperature differences
38 generally would be exhibited at downstream locations along the Sacramento River
39 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and
40 Knights Landing), with temperature differences between scenarios at Knights
41 Landing progressively increasing (up to 0.9°F cooler) in June and up to 4.6°F
42 warmer in September during wetter years under Alternative 1 relative to the No
43 Action Alternative.

1 Overall, the temperature differences between Alternative 1 and the No Action
2 Alternative would be relatively minor (less than 0.5°F) and likely would have
3 little effect on fall-run Chinook Salmon in the Sacramento River. The somewhat
4 higher water temperatures in September of wetter years may increase the
5 likelihood of adverse effects on early spawning fall-run Chinook Salmon under
6 Alternative 1, although the reduced water temperatures in September of critical
7 dry years under Alternative 1 may decrease the likelihood of adverse effects on
8 fall-run Chinook Salmon spawning in this water year type.

9 *Clear Creek*

10 Average monthly water temperatures in Clear Creek at Igo under Alternative 1
11 relative to the No Action Alternative are generally predicted to be similar (less
12 than 0.5°F) from September through April and June through August
13 (Appendix 6B, Table B-3-1). Average monthly water temperatures during May
14 under Alternative 1 would be higher by up to 0.8°F than under the No Action
15 Alternative. Average monthly temperatures at the confluence with the
16 Sacramento River would exhibit a similar pattern, although temperatures in the
17 creek would be slightly higher in general.

18 Under Alternative 1, temperature conditions at Igo would be similar to
19 temperature conditions under the No Action Alternative. However, these
20 temperature outputs represent conditions at Igo, a location upstream of most
21 fall-run Chinook Salmon spawning and rearing. Water temperatures where most
22 fall-run Chinook Salmon inhabit the creek would be somewhat higher as indicated
23 by average monthly temperatures at the confluence with the Sacramento River,
24 although these temperatures would be similar under Alternative 1 and the No
25 Action Alternative. Overall, thermal conditions for fall-run Chinook Salmon in
26 Clear Creek would be similar under Alternative 1 and the No Action Alternative.

27 *Feather River*

28 Average monthly water temperature in the Feather River in the low flow channel
29 generally were predicted to be similar (less than 0.5°F differences) under
30 Alternative 1 and the No Action Alternative, except during November and
31 December when average monthly water temperatures could be up to 1.4°F lower
32 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
33 temperatures in September under Alternative 1 could be up to 1.3°F warmer than
34 under the No Action Alternative in wetter years. Although temperatures in the
35 river would become progressively higher in the downstream directions, the
36 differences between Alternative 1 and No Action Alternative would exhibit a
37 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
38 with water temperatures differences between Alternative 1 and the No Action
39 Alternative generally decreasing in most water year types. However, water
40 temperatures under Alternative 1 were predicted to be somewhat (0.7°F to 1.6°F)
41 warmer on average and up to 4.0°F warmer at the confluence with the Sacramento
42 River from July to September in wetter years (Appendix 6B, Table B-23-1).

1 Overall, the temperature differences in the Feather River between Alternative 1
 2 and the No Action Alternative would be relatively minor (less than 0.5°F) and
 3 likely would have little effect on fall-run Chinook Salmon in the Feather River.
 4 The slightly lower water temperatures in November and December under
 5 Alternative 1 would likely have little effect on fall-run Chinook Salmon as water
 6 temperatures in the Feather River are typically low during this time period. The
 7 somewhat higher water temperatures in September of wetter years may increase
 8 the likelihood of adverse effects on early spawning fall-run Chinook Salmon,
 9 although the decreased temperatures in September of critical dry years under
 10 Alternative 1 may reduce the likelihood of adverse effects on fall-run Chinook
 11 Salmon spawning in this water year type.

12 *American River*

13 Long-term average monthly water temperatures in the American River at Nimbus
 14 Dam under Alternative 1 generally would be similar (differences less than 0.5°F)
 15 to the No Action Alternative, with the exception of during June and August, when
 16 temperatures under Alternative 1 could be as much as 0.9°F lower in below
 17 normal years (Appendix 6B, Table B-12-1). This pattern generally would persist
 18 downstream to Watt Avenue and the mouth, although temperatures under
 19 Alternative 1 would be up to 1.6°F and 2.0°F lower, respectively, than under the
 20 No Action Alternative in June. In addition, average monthly water temperatures
 21 at the mouth generally would be higher under Alternative 1 than the No Action
 22 Alternative in September of wetter years when water temperatures under
 23 Alternative 1 could be up to 1.7°F warmer (Appendix 6B, Table B-14-1).

24 Overall, the temperature differences in the American River between Alternative 1
 25 and the No Action Alternative would be relatively minor (less than 0.5°F) and
 26 likely would have little effect on fall-run Chinook Salmon in the American River.
 27 The slightly lower water temperatures in June and August in some water year
 28 types under Alternative 1 may decrease the likelihood of adverse effects on
 29 fall-run Chinook Salmon rearing in the American River if they are present. The
 30 slightly higher water temperatures during September under Alternative 1 would
 31 have little effect on fall-run Chinook Salmon spawning in the American River
 32 because most spawning occurs later in November.

33 *Changes in Exceedances of Water Temperature Thresholds*

34 Changes in water temperature could result in the exceedance of water
 35 temperatures that are protective of fall-run Chinook Salmon in the Sacramento
 36 River, Clear Creek, Feather River, and American River. The following describes
 37 the extent of those exceedances for each of those water bodies.

38 *Sacramento River*

39 Average monthly water temperatures under both Alternative 1 and the No Action
 40 Alternative indicate exceedances of the water temperature threshold of 56°F
 41 established in the Sacramento River at Red Bluff for Chinook Salmon spawning
 42 and egg incubation in October, November, and again in April. There would be no
 43 exceedances of the threshold from December to March under both Alternative 1
 44 and the No Action Alternative. In the months when the greatest frequency of

1 exceedances occur (October, November, and April), model results generally
2 indicate less frequent exceedances (by up to 4 percent in October) under
3 Alternative 1 than under the No Action Alternative. Temperature conditions in
4 the Sacramento River under Alternative 1 could be less likely to affect fall-run
5 Chinook Salmon spawning and egg incubation than under the No Action
6 Alternative because of the reduced frequency of exceedance of the 56°F threshold
7 in October, November, and April. However, this difference may be partially
8 offset if water temperature management and fish passage measures associated
9 with 2009 NMFS BO RPA under the No Action Alternative are successful.

10 *Clear Creek*

11 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during
12 October through December (USFWS 2015). Average monthly water
13 temperatures at Igo during this period generally fall below 56°F, except in
14 October. Under Alternative 1, the 56°F threshold would be exceeded in October
15 about 10 percent of the time as compared to 12 percent under the No Action
16 Alternative (Appendix 9N). At the confluence with the Sacramento River,
17 average monthly water temperatures in October would be warmer, with the 56°F
18 threshold exceeded slightly less frequently under Alternative 1 compared to the
19 No Action Alternative (Appendix 6B, Figure B-4-1). During November and
20 December, average monthly water temperatures generally would remain below
21 56°F at both locations (Appendix 6B, Figure B-4-2 and B-4-3). Temperature
22 conditions in Clear Creek under Alternative 1 could be less likely to affect
23 fall-run Chinook Salmon spawning and egg incubation than under the No Action
24 Alternative because of the reduced frequency of exceedance of the 56°F threshold
25 in October.

26 For fall-run Chinook Salmon rearing (January through August), the average
27 monthly temperatures at Igo would likely remain below the 60°F rearing
28 threshold in all months. Downstream at the mouth of Clear Creek, average
29 monthly water temperatures would exceed the 60°F threshold often during the
30 summer, but the frequency of exceedance would be similar under Alternative 1
31 and the No Action Alternative (Appendix 6B). Temperature conditions for fall-
32 run Chinook Salmon rearing in Clear Creek would be similar under Alternative 1
33 and the No Action Alternative.

34 *Feather River*

35 Average monthly water temperatures under both Alternative 1 and No Action
36 Alternative would exceed the water temperature threshold of 56°F established in
37 the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and
38 egg incubation during some months, particularly in October, November, March,
39 and April, when this temperature threshold would be exceeded frequently
40 (Appendix 6B, Table B-22-4). The frequency of exceedance would be greatest in
41 October, when average monthly temperatures under both Alternative 1 and the No
42 Action Alternative would be above the threshold in nearly every year. The
43 magnitude of the exceedances would be high as well, with average monthly
44 temperatures in October reaching about 68°F. Similarly, the threshold would be
45 exceeded under both Alternative 1 and the No Action Alternative about

1 85 percent of the time in April. The differences between Alternative 1 and the No
 2 Action Alternative, however, would be relatively small, with water temperatures
 3 under Alternative 1 generally exceeding the spawning temperature threshold
 4 about 1-2 percent less frequently than under the No Action Alternative during the
 5 October through April period. Temperature conditions in the Feather River under
 6 Alternative 1 could be less likely to affect fall-run Chinook Salmon spawning and
 7 egg incubation than under the No Action Alternative because of the reduced
 8 frequency of exceedance of the 56°F threshold from October through April.

9 *Changes in Egg Mortality*

10 Water temperatures influence the viability of incubating fall-run Chinook Salmon
 11 eggs. The following describes the differences in egg mortality for the
 12 Sacramento, Feather, and American rivers.

13 *Sacramento River*

14 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg
 15 mortality rate is predicted to be around 17 percent, with higher mortality rates (in
 16 excess of 35 percent) occurring in critical dry years under Alternative 1.
 17 Predicted egg mortality would similar under Alternative 1 and the No Action
 18 Alternative in all water year types (Appendix 9C, Table B-1).

19 *Feather River*

20 For fall-run Chinook Salmon in the Feather River, the long-term average egg
 21 mortality rate is predicted to be relatively low (around 7 percent), with higher
 22 mortality rates (around 17 percent) occurring in critical dry years under
 23 Alternative 1. Predicted egg mortality would similar under Alternative 1 and the
 24 No Action Alternative in all water year types (Appendix 9C, Table B-7).

25 *American River*

26 For fall-run Chinook Salmon in the American River, the predicted long-term
 27 average egg mortality rate is predicted to range from approximately 22 to
 28 25 percent in all water year types under Alternative 1. The predicted egg
 29 mortality rate would similar under Alternative 1 and the No Action
 30 Alternative (Appendix 9C, Table B-6).

31 *Changes in Weighted Usable Area*

32 Weighted usable area, which is influenced by flow, is a measure of habitat
 33 suitability. The following describes changes in WUA for fall-run Chinook
 34 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

35 *Sacramento River*

36 As an indicator of the amount of suitable spawning habitat for fall-run Chinook
 37 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
 38 in general, there would be greater amounts of spawning habitat available in
 39 September and November under Alternative 1 as compared to the No Action
 40 Alternative. Fall-run spawning WUA would be similar in October and December,
 41 under Alternative 1 and the No Action Alternative (Appendix 9E, Table C-11-4).
 42 The increase in long-term average spawning WUA during September (prior to the
 43 peak spawning period) under Alternative 1 would be relatively large (more than

1 20 percent) and around 6 percent higher in November. November is during the
2 peak spawning period for fall-run Chinook Salmon in the Sacramento River.
3 Results for the reach from Battle Creek to Deer Creek show the same pattern for
4 changes in WUA for spawning fall-run Chinook Salmon between Alternative 1
5 and the No Action Alternative (Appendix 9E, Table C-10-4). Overall, spawning
6 habitat availability would be somewhat higher under Alternative 1 relative to the
7 No Action Alternative.

8 Modeling results indicate that, in general, the amount of suitable fry rearing
9 habitat available from December to March under Alternative 1 would be similar
10 to the amount of fry rearing habitat available under the No Action
11 Alternative (Appendix 9E, Table C-12-4).

12 Similar to the results for fry rearing WUA, modeling results indicate that, there
13 would be similar amounts of suitable juvenile rearing habitat available during the
14 juvenile rearing period from February to June under Alternative 1 and the No
15 Action Alternative (Appendix 9E, Table C-13-4).

16 *Clear Creek*

17 As described above, flows in Clear Creek downstream of Whiskeytown Dam are
18 not anticipated to differ under Alternative 1 relative to the No Action
19 Alternative except in May due to the release of spring attraction flows in
20 accordance with the 2009 NMFS BO under the No Action Alternative. Therefore,
21 there would be no change in the amount of potentially suitable spawning and
22 rearing habitat for fall-run Chinook Salmon (as indexed by WUA) available under
23 Alternative 1 as compared to the No Action Alternative.

24 *Feather River*

25 As described above, Flows in the low flow channel of the Feather River are not
26 anticipated to differ under Alternative 1 relative to the No Action Alternative.
27 Therefore, there would be no change in the amount of potentially suitable
28 spawning habitat for fall-run Chinook Salmon (as indexed by WUA) available
29 under Alternative 1 as compared to the No Action Alternative. The majority of
30 spawning activity by fall-run Chinook Salmon in the Feather River occurs in this
31 reach with a lesser amount of spawning occurring downstream of the
32 Thermalito Complex.

33 Modeling results indicate that, in general, there would be greater amounts of
34 spawning habitat available in September under Alternative 1 as compared to the
35 No Action Alternative; fall-run Chinook Salmon spawning WUA would be
36 similar in October and November (the peak spawning months) and in December
37 (after the peak spawning period) for fall-run Chinook Salmon in this reach
38 (Appendix 9E, Table C-24-4). The increase in long-term average spawning WUA
39 during September (prior to the peak spawning period) under Alternative 1 would
40 be relatively large (more than 15 percent). Overall, spawning habitat availability
41 would be similar under Alternative 1 and the No Action Alternative.

1 *American River*

2 Modeling results indicate that, in general, there would be similar amounts of
3 spawning habitat available for fall-run Chinook Salmon in the American River
4 from October through December under Alternative 1 as compared to the No
5 Action Alternative (Appendix 9E, Table C-25-4).

6 *Changes in SALMOD Output*

7 SALMOD results indicate that pre-spawning mortality of fall-run Chinook
8 Salmon eggs would be approximately 16 percent lower under Alternative 1,
9 primarily due to reduced summer temperatures. Flow-related fall-run Chinook
10 Salmon egg mortality would be increased by 8 percent under Alternative 1
11 compared to the No Action Alternative. Conversely, temperature-related egg
12 mortality would be 11 percent lower under Alternative 1 (Appendix 9D,
13 Table B-1-4). Flow (habitat)-related fry mortality would be similar under
14 Alternative 1 and the No Action Alternative. Temperature-related juvenile
15 mortality would be approximately 21 percent lower under Alternative 1, while
16 flow (habitat)-related mortality would be similar under Alternative 1 and the No
17 Action Alternative. Overall, potential fall-run juvenile production would be
18 similar under Alternative 1 and the No Action Alternative, but up to 12 percent
19 greater than under the No Action Alternative in critical dry years (Appendix 9D,
20 Table B-1-1).

21 *Changes in Delta Passage Model Output*

22 The Delta Passage Model predicted similar estimates of annual Delta survival
23 across the 81 water year time period for fall-run between Alternative 1 and the No
24 Action Alternative (Appendix 9J). Median Delta survival was 0.245 for
25 Alternative 1 and 0.248 for the No Action Alternative.

26 *Changes in Delta Hydrodynamics*

27 Fall-run Chinook Salmon smolts are most abundant in the Delta during the
28 months of April, May and June. At the junction of Georgiana Slough and the
29 Sacramento River, median percent of time with positive velocity was similar
30 under both Alternative 1 and No Action Alternative in the months of April, May
31 and June (Appendix 9K). Near the confluence of the San Joaquin River and the
32 Mokelumne River, the median proportion of positive velocities was slightly lower
33 under Alternative 1 relative to No Action Alternative in April and May and
34 similar in June. In Old River downstream of the facilities, the median proportion
35 of positive velocities was substantially lower in April and May under
36 Alternative 1 relative to No Action Alternative but became more similar in June
37 (Appendix 9K). In Old River upstream of the facilities, the median proportion of
38 positive velocities was slightly to moderately lower for Alternative 1 relative to
39 No Action Alternative in April and May, respectively and slightly higher in June
40 (Appendix 9K). On the San Joaquin River downstream of the Head of Old River,
41 the median proportion of positive velocities was slightly to moderately higher
42 under Alternative 1 relative to No Action Alternative in April and May,
43 respectively, whereas the values were similar in June (Appendix 9K).

1 *Changes in Junction Entrainment*

2 Entrainment at Georgiana Slough was similar under both Alternative 1 and the No
3 Action Alternative in most months but was slightly higher under Alternative 1 in
4 the month of June (Appendix 9L). Median entrainment probabilities at the Head
5 of Old River were much lower under Alternative 1 relative to the No Action
6 Alternative during April and May. The median entrainment probability was
7 similar under both alternatives in the month of June. At the Turner Cut junction,
8 median entrainment probabilities under Alternative 1 were slightly higher than
9 under the No Action Alternative in June. During April and May, median
10 entrainment probabilities were more divergent with moderately higher values for
11 Alternative 1 relative to No Action Alternative. Overall, entrainment was slightly
12 lower at the Columbia Cut junction relative to Turner Cut but patterns of
13 entrainment between the two alternatives were similar. Patterns in entrainment
14 probabilities at the Middle River and Old River junctions were similar to those
15 observed at Columbia and Turner Cut junctions.

16 *Changes in Salvage*

17 Salvage of Sacramento River-origin Chinook Salmon is predicted to be greater
18 under Alternative 1 relative to No Action Alternative in every month
19 (Appendix 9M). Fall-run smolts migrating through the Delta would be most
20 susceptible in the months of April, May and June. Predicted values in April and
21 May indicated a substantially increased fraction of fish salvaged under
22 Alternative 1 relative to No Action Alternative. Predicted salvage was more
23 similar in March but still higher under Alternative 1.

24 *Summary of Effects on Fall-Run Chinook Salmon*

25 The multiple model and analysis outputs described above characterize the
26 anticipated conditions for fall-run Chinook Salmon and their response to change
27 under Alternative 1 and the No Action Alternative. For the purpose of analyzing
28 effects on fall-run Chinook Salmon in the Sacramento River, greater reliance was
29 placed on the outputs from the SALMOD model because it integrates the
30 available information on temperature and flows to produce estimates of mortality
31 for each life stage and an overall, integrated estimate of potential fall-run Chinook
32 Salmon juvenile production. The output from SALMOD indicated that fall-run
33 Chinook Salmon production would be similar in most water year types under
34 Alternative 1 than under the No Action Alternative, and up to 12 percent greater
35 than under the No Action Alternative in critical dry years.

36 The analyses attempting to assess the effects on routing, entrainment, and salvage
37 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
38 potential losses of juvenile salmon at the export facilities) of Sacramento River-
39 origin Chinook Salmon is predicted to be higher under Alternative 1 relative to
40 No Action Alternative in every month.

41 In Clear Creek and the Feather and American rivers, the analysis of the effects of
42 Alternative 1 and the No Action Alternative for fall-run Chinook Salmon relied
43 on the WUA analysis for habitat and water temperature model output for the
44 rivers at various locations downstream of the CVP and SWP facilities. The WUA

1 analysis indicated that the availability of spawning and rearing habitat in Clear
2 Creek and spawning habitat in the Feather and American rivers would be similar
3 under Alternative 1 and the No Action Alternative. The temperature model
4 outputs for each of the fall-run Chinook Salmon life stages suggest that thermal
5 conditions and effects on fall-run Chinook Salmon in all of these streams
6 generally would be similar under both scenarios. The water temperature threshold
7 exceedance analysis that indicated that the water temperature thresholds for
8 fall-run Chinook Salmon spawning and egg incubation would be exceeded
9 slightly less frequently in the Feather River and Clear Creek under Alternative 1
10 and could reduce the potential for adverse effects on the fall-run Chinook Salmon
11 populations in Clear Creek and the Feather River. Results of the analysis using
12 Reclamation's salmon mortality model indicate that there would be little
13 difference in fall-run Chinook Salmon egg mortality under Alternative 1 and the
14 No Action Alternative.

15 These model results suggest that overall, effects on fall-run Chinook Salmon
16 could be slightly less adverse under Alternative 1 than the No Action Alternative,
17 with a small likelihood that fall-run Chinook Salmon production would be higher
18 under Alternative 1 due to increased production potential in critical dry years.
19 This potential distinction between the two scenarios, however, may be partially
20 balanced by the benefits of implementation of fish passage under the No Action
21 Alternative intended to address the limited availability of suitable habitat for
22 winter-run and spring-run Chinook Salmon in the Sacramento River reaches
23 downstream of Keswick Dam. This potential benefit, however, would only apply
24 if passage is provided for adult fall-run Chinook Salmon that allows access to
25 additional habitat. In addition, RPA actions under the No Action
26 Alternative intended to increase the efficiency of the Tracy and Skinner Fish
27 Collection Facilities could improve the overall salvage survival of fall-run
28 Chinook Salmon.

29 The results of the numerical models suggest that Alternative 1 is less likely to
30 result in adverse effects on fall-run Chinook Salmon than the No Action
31 Alternative. However, discerning a meaningful difference between these two
32 scenarios based on the quantitative results is not possible because of the similarity
33 in results (generally differences less than 5 percent) and the inherent uncertainty
34 of the models. In addition, adverse effects of the No Action Alternative could be
35 balanced by the potentially beneficial effects resulting from the RPA actions
36 evaluated qualitatively for the No Action Alternative. Overall, given the small
37 differences in the numerical model results and the inherent uncertainty in the
38 temperature model, as well as the potential for benefits associated with the RPA
39 actions under the No Action Alternative, it is concluded that there would be no
40 definitive difference in effects on fall-run Chinook Salmon between Alternative 1
41 and the No Action Alternative.

42 *Late Fall-Run Chinook Salmon*

43 Changes in operations that influence temperature and flow conditions in the
44 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook
45 Salmon. The following describes those changes and their potential effects.

1 *Changes in Water Temperature*

2 Long-term average monthly water temperature in the Sacramento River at
3 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
4 difference) to water temperatures under the No Action Alternative. An exception
5 is during September and October of critical dry years when water temperatures
6 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
7 compared to the No Action Alternative and up to 1°F warmer in September of
8 wetter years (Appendix 6B, Table 5-5-1). A similar pattern in temperature
9 differences generally would be exhibited at downstream locations along the
10 Sacramento River (i.e., Ball's Ferry, Jelly's Ferry, Bend Bridge, Red Bluff,
11 Hamilton City, and Knights Landing), with temperature differences between
12 scenarios in June at Knights Landing progressively increasing (up to 0.9°F cooler)
13 in June and up to 4.6°F warmer in September during wetter years under
14 Alternative 1 relative to the No Action Alternative.

15 Overall, the temperature differences between Alternative 1 and the No Action
16 Alternative would be relatively minor (less than 0.5°F) and likely would have
17 little effect on late fall-run Chinook Salmon in the Sacramento River. The
18 likelihood of adverse effects on late fall-run Chinook Salmon spawning and egg
19 incubation would be similar under Alternative 1 and the No Action
20 Alternative due to similar water temperatures during the January to May time
21 period. Because late fall-run Chinook Salmon have an extended rearing period,
22 the similar water temperatures during the summer under Alternative 1 and the No
23 Action Alternative would have similar effects on rearing fry and juvenile late
24 fall-run Chinook Salmon in the Sacramento River. The higher water temperatures
25 under Alternative 1 in September of wetter years may increase the likelihood of
26 adverse effects on fry and juvenile late fall-run Chinook Salmon in the
27 Sacramento River during this limited time period.

28 *Changes in Exceedances of Water Temperature Thresholds*

29 Average monthly water temperatures under both Alternative 1 and the No Action
30 Alternative indicate exceedances of the water temperature threshold of 56°F
31 established in the Sacramento River at Red Bluff for Chinook Salmon spawning
32 and egg incubation in October, November, and again in April. There would be no
33 exceedances of the threshold from December to March under both Alternative 1
34 and the No Action Alternative. In April, model results indicate that water
35 temperatures under Alternative 1 would exceed the threshold about 2 percent less
36 frequently than under the No Action Alternative. Temperature conditions in the
37 Sacramento River under Alternative 1 could be slightly less likely to result in
38 adverse effects on late fall-run Chinook Salmon spawning and egg incubation
39 than under the No Action Alternative because of the reduced frequency of
40 exceedance of the 56°F threshold in April.

41 *Changes in Egg Mortality*

42 For late fall-run Chinook Salmon in the Sacramento River, the long-term average
43 egg mortality rate is predicted to range from approximately 2 to nearly 5 percent
44 in all water year types under Alternative 1. Overall, egg mortality would be

1 similar under Alternative 1 and the No Action Alternative (Appendix 9C,
2 Table B-2).

3 *Changes in Weighted Usable Area*

4 Modeling results indicate that there would be similar amounts of spawning habitat
5 available for late fall-run Chinook Salmon in the Sacramento River from January
6 through April under Alternative 1 and the No Action Alternative (Appendix 9E,
7 Table C-14-4). Modeling results also indicate that there would be similar
8 amounts of suitable late fall-run Chinook Salmon fry rearing habitat available
9 from April to June under Alternative 1 and the No Action
10 Alternative (Appendix 9E, Table C-15-4).

11 A substantial fraction of late fall run Chinook Salmon juveniles oversummer in
12 the Sacramento River before emigrating, which allows them to avoid predation
13 through both their larger size and greater swimming ability. One implication of
14 this life history strategy is that rearing habitat is most likely the limiting factor for
15 late-fall-run Chinook Salmon, especially if availability of cool water determines
16 the downstream extent of spawning habitat for late-fall-run salmon. Modeling
17 results indicate that, there would generally be similar amounts of suitable juvenile
18 rearing habitat available from December through August under Alternative 1 and
19 the No Action Alternative. There could be an increase in the amount of late fall-
20 run Chinook Salmon juvenile rearing WUA in September and November of up to
21 15 percent (Appendix 9E, Table C-16-4). Overall, late fall-run juvenile rearing
22 habitat availability would be similar under Alternative 1 and the No Action
23 Alternative.

24 *Changes in SALMOD Output*

25 SALMOD results indicate that potential juvenile production would be similar
26 under Alternative 1 and the No Action Alternative (Appendix 9D, Table B-2-1).

27 *Changes in Delta Passage Model Output*

28 For late fall-run Chinook Salmon, through-Delta survival was predicted to be
29 slightly lower under Alternative 1 relative to the No Action Alternative for all
30 81 years simulated by the Delta Passage Model (Appendix 9J). Median Delta
31 survival across all years was 0.199 for Alternative 1 and 0.244 for the No Action
32 Alternative.

33 *Changes in Delta Hydrodynamics*

34 The late fall run Chinook migration period overlaps with winter-run. See the
35 section on hydrodynamic analysis for winter run Chinook Salmon for potential
36 effects on late fall-run Chinook Salmon.

37 *Changes in Junction Entrainment*

38 Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic
39 that of winter-run Chinook Salmon due to the overlap in timing. See the section
40 on winter-run Chinook Salmon entrainment for potential effects on late fall-run
41 Chinook Salmon.

1 *Changes in Salvage*

2 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run
3 Chinook Salmon due to the overlap in timing. See the section on winter-run
4 Chinook Salmon entrainment for potential effects on late fall-run Chinook
5 Salmon.

6 *Summary of Effects on Late Fall-Run Chinook Salmon*

7 The multiple model and analysis outputs described above characterize the
8 anticipated conditions for late fall-run Chinook Salmon and their response to
9 change under Alternative 1 and the No Action Alternative. For the purpose of
10 analyzing effects on late fall-run Chinook Salmon and developing conclusions,
11 greater reliance was placed on the outputs from the SALMOD model because it
12 integrates the available information on temperature and flows to produce
13 estimates of mortality for each life stage and an overall, integrated estimate of
14 potential fall-run Chinook Salmon juvenile production. The output from
15 SALMOD indicated that late fall-run Chinook Salmon production would be
16 similar under Alternative 1 and the No Action Alternative. The analyses
17 attempting to assess the effects on routing, entrainment, and salvage of juvenile
18 salmonids in the Delta suggest that salvage (as an indicator of potential losses of
19 juvenile salmon at the export facilities) of Sacramento River-origin Chinook
20 Salmon is predicted to be higher under Alternative 1 relative to No Action
21 Alternative in every month. Actions under the No Action Alternative intended to
22 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could
23 improve the overall salvage survival of late fall-run Chinook Salmon.

24 Although survival in the Delta may be lower, given the similarity in the
25 SALMOD outputs, it is likely that Alternative 1 and the No Action
26 Alternative would have similar effects on fall-run Chinook Salmon.

27 *Steelhead*

28 Changes in operations that influence temperature and flow conditions that could
29 affect steelhead. The following describes those changes and their potential
30 effects.

31 *Changes in Water Temperature*

32 Changes in water temperature could affect steelhead in the Sacramento, Feather,
33 and American rivers, and Clear Creek. The following describes temperature
34 conditions in those water bodies.

35 *Sacramento River*

36 Long-term average monthly water temperature in the Sacramento River at
37 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
38 difference) to water temperatures under the No Action Alternative. An exception
39 is during September and October of critical dry years when water temperatures
40 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
41 compared to the No Action Alternative and up to 1°F warmer in September of
42 wetter years (Appendix 6B, Table 5-5-1). A similar pattern of changes in
43 temperature generally would be exhibited downstream at Ball's Ferry, Jelly's

1 Ferry, Bend Bridge and Red Bluff, with average monthly temperature differences
2 between scenarios progressively decreasing, except in September (up to a 3.2°F
3 warmer at Red Bluff) during wetter years (Appendix 6B, Table B-9-1).

4 Overall, the temperature differences between Alternative 1 and the No Action
5 Alternative would be relatively minor (less than 0.5°F) and likely would have
6 little effect on steelhead in the Sacramento River. Based on the life history timing
7 for steelhead, the slightly lower water temperatures in September and October of
8 drier years under Alternative 1 may reduce the likelihood of adverse effects on
9 steelhead adults migrating upstream in the Sacramento River. The higher water
10 temperatures in September of wetter years under Alternative 1 may increase the
11 likelihood of adverse effects on steelhead migration compared to the No Action
12 Alternative.

13 *Clear Creek*

14 Average monthly water temperatures in Clear Creek at Igo under Alternative 1 are
15 generally predicted to be similar to (less than 0.5°F differences) water
16 temperatures under the No Action Alternative from September through April and
17 June through August (Appendix 6B, Table B-3-1). Average monthly water
18 temperatures during May under Alternative 1 could be higher by up to 0.8°F than
19 under the No Action Alternative in all water year types. Overall, thermal
20 conditions for steelhead in Clear Creek would be similar under Alternative 1 and
21 the No Action Alternative.

22 *Feather River*

23 Average monthly water temperature in the Feather River in the low flow channel
24 generally were predicted to be similar (less than 0.5°F differences) under
25 Alternative 1 and the No Action Alternative, except during November and
26 December when average monthly water temperatures could be up to 1.4°F lower
27 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
28 temperatures in September under Alternative 1 could be up to 1.3°F warmer than
29 under the No Action Alternative in wetter years. Although temperatures in the
30 river generally become progressively higher in the downstream direction, the
31 differences between Alternative 1 and the No Action Alternative exhibit a similar
32 pattern at the downstream locations (Robinson Riffle and Gridley Bridge), with
33 water temperature differences between Alternative 1 and the No Action
34 Alternative generally decreasing in most water year types. Water temperatures
35 under Alternative 1 are predicted to be somewhat (0.7°F to 1.6°F) warmer on
36 average and up to 4.0°F warmer at the confluence with Sacramento River from
37 July to September in wetter years than under the No Action Alternative.

38 Overall, the temperature differences in the Feather River between Alternative 1
39 and the No Action Alternative would be relatively minor (less than 0.5°F) and
40 likely would have little effect on steelhead in the Feather River. The slightly
41 lower water temperatures in November and December under Alternative 1 would
42 likely have little effect on adult steelhead migration as water temperatures in the
43 Feather River are typically low during this time period. The somewhat higher
44 water temperatures in September of wetter years may increase the likelihood of

1 adverse effects on adult steelhead migrating upstream and juveniles rearing in the
2 Feather River, although the decreased temperatures in September of critical dry
3 years under Alternative 1 may decrease the likelihood of adverse effects on
4 migrating and rearing steelhead in this water year type.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam
7 under Alternative 1 generally would be similar (differences less than 0.5°F) to the
8 No Action Alternative, with the exception of during June and August, when
9 temperatures under Alternative 1 could be as much as 0.9°F lower in below
10 normal years. This pattern generally would persist downstream to Watt Avenue
11 and the mouth, although temperatures under Alternative 1 would be up to 1.6°F
12 and 2.0°F lower, respectively, than under the No Action Alternative in June. In
13 addition, average monthly water temperatures at the mouth generally would be
14 higher under Alternative 1 than the No Action Alternative in September of wetter
15 years when water temperatures under Alternative 1 could be up to 1.7°F warmer.

16 Overall, the temperature differences between Alternative 1 and the No Action
17 Alternative would be relatively minor (less than 0.5°F) and likely would have
18 little effect on steelhead in the American River. The slightly cooler water
19 temperatures in June and August under Alternative 1 may reduce the likelihood of
20 adverse effects on steelhead rearing in the American River compared to the No
21 Action Alternative.

22 *Changes in Exceedances of Water Temperature Thresholds*

23 Changes in water temperature could result in the exceedance of established water
24 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and
25 Feather River. The following describes the extent of those exceedance for each of
26 those streams.

27 *Sacramento River*

28 Steelhead spawning in the mainstem Sacramento River generally occurs in the
29 upper reaches from Keswick Dam downstream to near Balls Ferry, with most
30 spawning concentrated near Redding. Most steelhead, however, spawn in
31 tributaries to the Sacramento River. Spawning generally takes place in the
32 January through March period when water temperatures in the river generally do
33 not exceed 52°F under either Alternative 1 or the No Action Alternative. While
34 there are no established temperature thresholds for steelhead rearing in the
35 mainstem Sacramento River, average monthly temperatures when fry and juvenile
36 steelhead are in the river would generally remain below 56°F at Balls Ferry
37 except in August and September when this water temperature would be exceeded
38 30 to 40 percent of the time under both the No Action Alternative and Second
39 Basis of Comparison. However, water temperatures in the Sacramento River at
40 Balls Ferry would exceed 56°F about 10 percent more often in September under
41 Alternative 1. Overall, thermal conditions for steelhead in the Sacramento River
42 would be similar under Alternative 1 and the No Action Alternative.

1 *Clear Creek*

2 While there are no established temperature thresholds for steelhead spawning in
3 Clear Creek, average monthly water temperatures in the river generally would not
4 exceed 48°F during the spawning period (December to April) under Alternative 1
5 and the No Action Alternative. Similarly, while there are no established
6 temperature thresholds for steelhead rearing in Clear Creek, average monthly
7 temperatures in most months of the year would not exceed 56°F at Igo under both
8 alternatives. Overall, thermal conditions for steelhead in Clear Creek would be
9 similar under Alternative 1 and the No Action Alternative.

10 *Feather River*

11 Average monthly water temperatures under both Alternative 1 and the No Action
12 Alternative would on occasion exceed the water temperature threshold of 56°F
13 established in the Feather River at Robinson Riffle for steelhead spawning and
14 incubation during some months, particularly in October and November, and
15 March and April, when temperature thresholds could be exceeded frequently
16 (Appendix 9N). There would be a 1 percent exceedance of the 56°F threshold in
17 December under the No Action Alternative and no exceedances of the 56°F
18 threshold from December through February under Alternative 1. However, the
19 differences in the frequency of exceedance between Alternative 1 and No Action
20 Alternative during March and April would be relatively small with water
21 temperatures under Alternative 1 exceeding the threshold about 2 percent more
22 frequently in March (20 percent) and the same exceedance frequency (75 percent)
23 as the No Action Alternative in April.

24 The established water temperature threshold of 63°F for rearing from May
25 through August would be exceeded often under both Alternative 1 and the No
26 Action Alternative in May and June, but not at all in July and August. Water
27 temperatures under Alternative 1 would exceed the rearing temperature threshold
28 about 9 percent less frequently than under the No Action Alternative in May, but
29 no more frequently in June. Temperature conditions in the Feather River under
30 Alternative 1 could be less likely to affect steelhead spawning and rearing than
31 under the No Action Alternative because of the reduced frequency of exceedance
32 of the 56°F spawning threshold in March and the increased frequency of
33 exceedance of the 63°F rearing threshold in May.

34 *American River*

35 In the American River, the water temperature threshold for steelhead rearing
36 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly
37 water temperatures would exceed this threshold often under both Alternative 1
38 and No Action Alternative, especially in the July through September period when
39 the threshold is exceeded nearly all of the time. In addition, the magnitude of the
40 exceedance would be high, with average monthly water temperatures sometimes
41 higher than 76°F. The differences in exceedance frequency between Alternative 1
42 and No Action Alternative, however, would be relatively small and only occur in
43 June (1 percent more frequent exceedance under Alternative 1), and in September,
44 when average monthly water temperatures under Alternative 1 would exceed 65°F

1 about 7 percent more frequently than under the No Action Alternative.
2 Temperature conditions in the American River under Alternative 1 could be more
3 likely to result in adverse effects on steelhead rearing than under the No Action
4 Alternative because of the increased frequency of exceedance of the 65°F rearing
5 threshold.

6 *Changes in Weighted Usable Area*

7 The following describes changes in WUA for steelhead in the Sacramento,
8 Feather, and American rivers and Clear Creek.

9 *Sacramento River*

10 Modeling results indicate that, in general, there would be similar amounts of
11 suitable steelhead spawning habitat available from December through March
12 under Alternative 1 and the No Action Alternative (Appendix 9E, Table C-20-4).

13 *Clear Creek*

14 As described above, flows in Clear Creek downstream of Whiskeytown Dam are
15 not anticipated to differ under Alternative 1 relative to the No Action
16 Alternative except in May due to the release of spring attraction flows in
17 accordance with the 2009 NMFS BO under the No Action Alternative. Therefore,
18 there would be no change in the amount of potentially suitable spawning and
19 rearing habitat for steelhead (as indexed by WUA) available under Alternative 1
20 as compared to the No Action Alternative.

21 *Feather River*

22 Flows in the low flow channel of the Feather River are not anticipated to differ
23 under Alternative 1 relative to the No Action Alternative. Therefore, there would
24 be no change in the amount of potentially suitable spawning habitat for steelhead
25 (as indexed by WUA) available under Alternative 1 as compared to the No Action
26 Alternative. The majority of spawning activity by steelhead in the Feather River
27 occurs in this reach with a lesser amount of spawning occurring downstream of
28 the Thermalito Complex.

29 Modeling results indicate that, in general, there would be similar amounts of
30 spawning habitat for steelhead in the Feather River downstream of Thermalito
31 available from December through April under Alternative 1 and the No Action
32 Alternative (Appendix 9E, Table C-22-4).

33 *American River*

34 Modeling results indicate that, in general, there would be similar amounts of
35 spawning habitat for steelhead in the American River downstream of Nimbus
36 Dam available from December through April under Alternative 1 and the No
37 Action Alternative.

38 *Summary of Effects on Steelhead*

39 The multiple model and analysis outputs described above characterize the
40 anticipated conditions for steelhead and their response to change under
41 Alternative 1 and the No Action Alternative. The analysis of the effects of
42 Alternative 1 and the No Action Alternative for steelhead relied on the WUA

1 analysis for habitat and water temperature model output for the rivers at various
2 locations downstream of the CVP and SWP facilities.

3 The WUA analysis indicated that the availability of steelhead spawning and
4 rearing habitat in Clear Creek and steelhead spawning habitat in the Sacramento,
5 Feather and American rivers would be similar under Alternative 1 and the No
6 Action Alternative. The temperature model outputs for each of the steelhead life
7 stages suggest that thermal conditions and effects on steelhead in all of these
8 streams generally would be similar under both scenarios. This conclusion is
9 supported by the water temperature threshold exceedance analysis that indicated
10 that the water temperature thresholds for steelhead spawning and egg incubation
11 would be exceeded less frequently in the Feather River under Alternative 1. The
12 water temperature threshold for steelhead rearing would also be exceeded less
13 frequently in the Feather River and could reduce the potential for adverse effects
14 on the steelhead population in the Feather River.

15 The numerical model results suggest that overall, effects on steelhead could be
16 slightly less adverse under Alternative 1 than the No Action Alternative,
17 particularly in the Feather River. Implementation of the fish passage program
18 under the No Action Alternative intended to address the limited availability of
19 suitable habitat for steelhead in the Sacramento River reaches downstream of
20 Keswick Dam and in the American River could provide a benefit to Central
21 Valley steelhead in the Sacramento and American rivers. This is particularly
22 important in light of anticipated increases in water temperature associated with
23 climate change in 2030. In addition to fish passage, preparation and
24 implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and
25 actions under the No Action Alternative intended to increase the efficiency of the
26 Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No
27 Action Alternative in comparison to Alternative 1. Thus, on balance and over the
28 long term, the adverse effects on steelhead under Alternative 1 would be greater
29 than those under the No Action Alternative.

30 *Green Sturgeon*

31 The effects on Green Sturgeon were analyzed by comparing changes in water
32 temperature and the frequency of temperature threshold exceedance between
33 Alternative 1 and the No Action Alternative. In addition, potential effects on
34 Green Sturgeon during the Delta portion of their life cycle were evaluated based
35 on changes in Delta outflow. The effects are described and summarized below.

36 *Changes in Water Temperature*

37 The effects of Alternative 1 compared to the No Action Alternative on Green
38 Sturgeon were analyzed based on water temperature model outputs and
39 comparisons of the frequency of water temperature threshold exceedances in the
40 Sacramento and Feather rivers.

41 *Sacramento River*

42 As described previously, long-term average monthly water temperature in the
43 Sacramento River at Keswick Dam under Alternative 1 would generally be
44 similar (less than 0.5°F difference) to water temperatures under the No Action

1 Alternative An exception is during September and October of critical dry years
2 when water temperatures could be up to 1.1°F and 0.8°F lower, respectively,
3 under Alternative 1 as compared to the No Action Alternative and up to 1°F
4 warmer in September of wetter years (Appendix 6B). A similar pattern in
5 temperature differences generally would be exhibited at downstream locations
6 along the Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red
7 Bluff, Hamilton City, and Knights Landing), with temperature differences
8 between scenarios at Knights Landing progressively increasing (up to 0.9°F
9 cooler) in June and up to 4.6°F warmer in September during wetter years under
10 Alternative 1 relative to the No Action Alternative.

11 Overall, the temperature differences between Alternative 1 and the No Action
12 Alternative would be relatively minor (less than 0.5°F) and likely would have
13 little effect on Green Sturgeon. Increased temperatures in September are likely
14 not to be lethal, but may increase growth of juvenile green sturgeon if food was
15 not limiting.

16 *Feather River*

17 Average monthly water temperature in the Feather River in the low flow channel
18 generally were predicted to be similar (less than 0.5°F differences) under
19 Alternative 1 and the No Action Alternative, except during November and
20 December when average monthly water temperatures would be up to 1.4°F lower
21 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
22 temperatures in September under Alternative 1 could be up to 1.3°F warmer than
23 under the No Action Alternative in wetter years.

24 Although temperatures in the river would become progressively higher in the
25 downstream directions, the differences between Alternative 1 and the No Action
26 Alternative would exhibit a similar pattern at the downstream locations (Robinson
27 Riffle and Gridley Bridge), with temperatures differences between Alternative 1
28 and the No Action Alternative generally decreasing in most water year types.
29 However, water temperatures under Alternative 1 were predicted to be somewhat
30 (0.7°F to 1.6°F) warmer on average and up to 4.0°F warmer at the confluence
31 with the Sacramento River from July to September in wetter years (Appendix 6B,
32 Table B-23-1).

33 Overall, the temperature differences between Alternative 1 and the No Action
34 Alternative would be relatively minor (less than 0.5°F) and likely would have
35 little effect on Green Sturgeon in the Feather River.

36 *Changes in Exceedances of Water Temperature Thresholds*

37 Changes in water temperature could result in the exceedance of established water
38 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.
39 The following describes the extent of those exceedance for each of those rivers.

40 *Sacramento River*

41 Average monthly water temperatures in the Sacramento River at Bend Bridge
42 under both Alternative 1 and the No Action Alternative would exceed the water
43 temperature threshold of 63°F established for Green Sturgeon larval rearing in

1 August and September, with exceedances under Alternative 1 occurring about
 2 6 percent of the time in August and about 10 percent of the time in September.
 3 This is 1 to 2 percent less frequent than under the No Action Alternative.
 4 Average monthly water temperatures at Bend Bridge could exceed the threshold
 5 by up to 10 degrees (reaching 73°F) during this period. Temperature conditions
 6 in the Sacramento River under Alternative 1 could be less likely to result in
 7 adverse effects on Green Sturgeon rearing than under the No Action
 8 Alternative because of the reduced frequency of exceedance of the 63°F threshold
 9 in August and September.

10 *Feather River*

11 Average monthly water temperatures in the Feather River at Gridley Bridge under
 12 both Alternative 1 and No Action Alternative would exceed the water temperature
 13 threshold of 64°F established for Green Sturgeon spawning, incubation, and
 14 rearing in May, June, and September; no exceedances under either scenarios
 15 would occur in July and August. The frequency of exceedances would be high,
 16 with water temperatures under both Alternative 1 and No Action
 17 Alternative exceeding the threshold in June nearly 100 percent of the time. The
 18 magnitude of the exceedance also would be substantial, with average monthly
 19 water temperatures higher than 72°F in June, and higher than 75°F in July and
 20 August. Water temperatures under Alternative 1 would exceed the threshold
 21 during May about 9 percent less frequently than the No Action Alternative and
 22 about 35 percent more frequently in September. Temperature conditions in the
 23 Feather River under Alternative 1 could be less likely to result in adverse effects
 24 on Green Sturgeon rearing than under the No Action Alternative because of the
 25 reduced frequency of exceedance of the 64°F threshold in May. The increase in
 26 exceedance frequency in September under Alternative 1 may have little effect on
 27 rearing Green Sturgeon as many juvenile sturgeon may have migrated
 28 downstream to the lower Sacramento River and Delta by this time.

29 *Changes in Delta Outflow*

30 As described in Appendix 9P, mean (March to July) Delta outflow was used an
 31 indicator of potential year class strength and the likelihood of producing a strong
 32 year class of sturgeon. The median value over the 82-year CalSim II modeling
 33 period of mean (March to July) Delta outflow was predicted to be 12 percent
 34 lower under Alternative 1 than under the No Action Alternative. In addition, the
 35 likelihood of mean (March to July) Delta outflow exceeding the threshold of
 36 50,000 cfs was the same under both alternatives.

37 *Summary of Effects on Green Sturgeon*

38 The temperature model outputs for the Sacramento and Feather rivers suggest that
 39 thermal conditions and effects on Green Sturgeon in the Sacramento and Feather
 40 rivers generally would be slightly less adverse under Alternative 1. This
 41 conclusion is supported by the water temperature threshold exceedance analysis
 42 that indicated that the water temperature thresholds for Green Sturgeon spawning,
 43 incubation, and rearing would be exceeded less frequently under Alternative 1 in
 44 the Sacramento River. The water temperature threshold for Green Sturgeon

1 spawning, incubation, and rearing would also be exceeded less frequently during
2 some months in the Feather River, but would be exceeded more frequently in
3 September under Alternative 1 and could reduce the potential for adverse effects
4 on Green Sturgeon in the Sacramento and Feather rivers relative to the No Action
5 Alternative. The analysis based on Delta outflows suggests that Alternative 1
6 provides lower mean (March to July) outflows which could result in weaker year
7 classes of juvenile sturgeon relative to the No Action Alternative. In addition,
8 actions under the No Action Alternative intended to increase the efficiency of the
9 Tracy and Skinner Fish Collection Facilities could improve the overall salvage
10 survival of green sturgeon. However, early life stage survival in the natal rivers is
11 crucial in development of a strong year class. Therefore, based primarily on the
12 analysis of water temperatures, Alternative 1 could be less likely to result in
13 adverse effects on Green Sturgeon than the No Action Alternative.

14 *White Sturgeon*

15 Changes in water temperature conditions in the Sacramento River would be the
16 same as those described above for Green Sturgeon in the Sacramento River.
17 Overall, the temperature differences between Alternative 1 and the No Action
18 Alternative would be relatively minor (less than 0.5°F) and likely would have
19 little effect on White Sturgeon in the Sacramento River.

20 The water temperature threshold established for White Sturgeon spawning and
21 egg incubation in the Sacramento River at Hamilton City is 61°F from March
22 through June. Although there would be no exceedances of the threshold in March
23 and April, water temperatures under both Alternative 1 and No Action
24 Alternative would exceed this threshold in May and June. The average monthly
25 water temperatures in May under Alternative 1 would exceed this threshold about
26 49 percent of the time (about 6 percent less frequently than under the No Action
27 Alternative). In June, the average monthly water temperature under Alternative 1
28 would exceed the threshold about 74 percent of the time (about 13 percent less
29 frequently than under the No Action Alternative). Average monthly water
30 temperatures during May and June under Alternative 1 would as high as about
31 64°F, which is below the 68°F threshold considered lethal for White Sturgeon
32 eggs. Temperature conditions in the Sacramento River under Alternative 1 could
33 be less likely to result in adverse effects on White Sturgeon rearing than under the
34 No Action Alternative because of the reduced frequency of exceedance of the
35 61°F threshold in May and June.

36 Changes in Delta outflows would be the same as those described above for Green
37 Sturgeon. Mean (March to July) Delta outflow was predicted to be 12 percent
38 lower under Alternative 1 than under the No Action Alternative. In addition, the
39 likelihood of mean (March to July) Delta outflow exceeding the threshold of
40 50,000 cfs was the same under both alternatives.

41 Overall, the temperature model outputs suggest that thermal conditions and
42 effects on White Sturgeon in the Sacramento River generally would be slightly
43 less adverse under Alternative 1. The analysis based on Delta outflows suggests
44 that Alternative 1 provides lower mean (March to July) outflows which could

1 result in weaker year classes of juvenile Green Sturgeon relative to the No Action
2 Alternative. However, early life stage survival in the natal rivers is crucial in
3 development of a strong year class. Therefore, based primarily on the analysis of
4 water temperatures, Alternative 1 could be less likely to result in adverse effects
5 on White Sturgeon than the No Action Alternative.

6 *Delta Smelt*

7 The potential for effects on Delta Smelt resulting from Alternative 1 as compared
8 to the No Action Alternative were analyzed using changes in proportional
9 entrainment and fall abiotic habitat index values.

10 As described in Appendix 9G, a proportional entrainment regression model
11 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt
12 entrainment, as influenced by OMR flow in December through March. Results
13 indicate that the percentage of entrainment of migrating and spawning adult Delta
14 Smelt under Alternative 1 would be 9 percent (long term average percent
15 entrainment). Percent entrainment of adult Delta Smelt under Alternative 1 would
16 be similar to results under the No Action Alternative.

17 As described in Appendix 9G, a proportional entrainment regression model
18 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta
19 Smelt entrainment, as influenced by OMR flow and location of X2 in March
20 through June. Results indicate that the percentage of entrainment of larval and
21 early juvenile Delta Smelt under Alternative 1 would be 15.5 percent, long-term
22 average, and highest entrainment of 23.6 percent under Critical water year
23 conditions. Percent entrainment of larval and early juvenile Delta Smelt under
24 Alternative 1 would be higher than results under the No Action Alternative, by up
25 to 9.4 percent. Under the No Action Alternative, the long term average percent
26 entrainment would be 8.6 percent, and highest entrainment would occur under
27 Critical water year conditions, at 19.3 percent.

28 The predicted location of Fall X2 position (in September through December) is
29 used as an indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al.
30 (2010) used X2 location as an indicator of the extent of habitat available with
31 suitable salinity for the rearing of older juvenile delta smelt. Feyrer et al. (2010)
32 concluded that when X2 is located downstream (west) of the confluence of the
33 Sacramento and San Joaquin Rivers, at a distance of 70 to 80 km from the Golden
34 Gate Bridge, there is a larger area of suitable habitat. The overlap of the low
35 salinity zone (or X2) with the Suisun Bay/Marsh results in a two-fold increase in
36 the habitat index (Feyrer et al. 2010). The average September through December
37 X2 position in km was used to evaluate the fall abiotic habitat availability for
38 delta smelt under the Alternatives. X2 values simulated in the CalSim II model
39 for each Alternative were averaged over September through December, and
40 compared.

41 Alternative 1 does not include the operations related to the 2008 USFWS BO
42 RPA Component 3 (Action 4), Fall X2 requirement while the No Action
43 Alternative includes it. Therefore, the average September through December X2
44 position under Alternative 1 would be eastward by over 6 km compared to the No

1 Action Alternative during the wetter years. In the drier years September through
2 December average X2 position is similar under both scenarios.

3 Overall, Alternative 1 likely would have adverse effects on Delta Smelt, as
4 compared to the No Action Alternative, primarily due to the potential for
5 increased percentage entrainment during larval and juvenile life stages, and less
6 favorable location of Fall X2 in wetter years, and on average. Given the current
7 condition of the Delta Smelt population, even small differences between
8 alternatives may be important.

9 *Longfin Smelt*

10 The effects of the Alternative 1 as compared to the No Action Alternative were
11 analyzed based on the direction and magnitude of OMR flows during the period
12 (December through June) when adult, larvae, and young juvenile Longfin Smelt
13 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The
14 analysis was augmented with calculated Longfin Smelt abundance index values
15 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions
16 that lower X2 values reflect higher flows and that transporting Longfin Smelt
17 farther downstream leads to greater Longfin Smelt survival. The index value
18 indicates the relative abundance of Longfin Smelt and not the calculated
19 population.

20 The OMR flows would generally be negative in all months under Alternative 1,
21 with the long-term average ranging from -3,700 to -7,400 cfs from December
22 through June (Appendix 5A). The OMR flows generally would be more negative
23 during this time period under Alternative 1 as compared to the No Action
24 Alternative. The greatest differences between alternatives would be in April and
25 May, where long-term average OMR flows would be negative under Alternative 1
26 and positive under the No Action Alternative (Appendix 5A, Table C-17-4). The
27 increase in the magnitude of negative flows, with negative flows in April and
28 May, under Alternative 1 as compared to the No Action Alternative could
29 increase the potential for entrainment of Longfin Smelt at the export facilities.

30 Under Alternative 1, Longfin Smelt abundance index values range from 947
31 under critical water year conditions to a high of 15,822 under wet water year
32 conditions, with a long-term average value of 7,257. Under the No Action
33 Alternative, Longfin Smelt abundance index values range from 1,147 under
34 critical water year conditions to a high of 16,635 under wet water year conditions,
35 with a long-term average value of 7,951.

36 Results indicate that the Longfin Smelt abundance index values would be lower in
37 every water year type under Alternative 1 than they would be under the No Action
38 Alternative, with a long-term average index for Alternative 1 that is almost
39 10 percent lower than the long-term average index for the No Action Alternative.
40 For below normal, dry, and critical water years, the Longfin Smelt abundance
41 index values would be over 20 percent lower under Alternative 1 than they would
42 be under the No Action Alternative, with the greatest difference (26.2 percent)
43 predicted under dry conditions. Based on the Longfin Smelt abundance indices,

1 Alternative 1 likely would have adverse effects on Longfin Smelt, as compared to
2 the No Action Alternative.

3 Overall, based on the increase in frequency and magnitude of negative OMR
4 flows and the lower Longfin Smelt abundance index values, especially in dry and
5 critical years, potential adverse effects on the Longfin Smelt population under
6 Alternative 1 likely would be greater than under the No Action Alternative.

7 *Sacramento Splittail*

8 Under Alternative 1, flows entering the Yolo Bypass generally would be higher
9 than under the No Action Alternative from December through March, especially
10 during wetter years (Appendix 5A, Table C-26-1). These increases would occur
11 during periods of relatively high flow in the bypass, and could slightly increase
12 the area of inundation. Thus, Alternative 1 could result in a slight increase in
13 spawning habitat for Sacramento Splittail as a result of the increased area of
14 potential habitat (inundation). Given the relatively minor changes in flows into
15 the Yolo Bypass, and the inherent uncertainty associated with the resolution of the
16 CalSim II model (average monthly outputs), it is concluded that there would be no
17 definitive difference in effects on Sacramento Splittail between Alternative 1 and
18 the No Action Alternative.

19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes
21 relied on evaluation of changes in available habitat (reservoir storage) and
22 anticipated changes in black bass nesting success.

23 *Changes in Available Habitat (Storage)*

24 Changes in CVP and SWP water supplies and operations under Alternative 1 as
25 compared to the No Action Alternative generally would result in higher reservoir
26 storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels
27 in Shasta Lake, Lake Oroville, and Folsom Lake would be higher under
28 Alternative 1 as compared to the No Action Alternative, as summarized in Tables
29 5.12 through 5.14, in the fall and winter months due to the inclusion of Fall X2
30 criteria under the No Action Alternative.

31 The highest increases in Shasta Lake and Lake Oroville storage could be in excess
32 of 20 percent. Storage in Folsom Lake and New Melones could be increased by
33 up to around 10 percent in some months of some water year types. Additional
34 information related to monthly reservoir elevations is provided in Appendix 5A,
35 CalSim II and DSM2 Modeling. It is anticipated that aquatic habitat within the
36 CVP and SWP water supply reservoirs is not limiting; however, storage volume is
37 an indicator of how much habitat is available to fish species inhabiting these
38 reservoirs. Therefore, the amount of habitat for reservoir fishes could increase
39 under Alternative 1 as compared to the No Action Alternative.

40 *Changes in Black Bass Nesting Success*

41 As shown in Appendix 9F, black bass nest survival in CVP and SWP reservoirs is
42 anticipated to be near 100 percent in March and April due to increasing reservoir
43 elevations. For May and June, the likelihood of nest survival for Largemouth

1 Bass in Shasta Lake being in the 40 to 100 percent range is similar under
2 Alternative 1 and the No Action Alternative; however, nest survival of greater
3 than 40 percent is likely only in about 20 percent of the years evaluated. The
4 likelihood of high nest survival for Smallmouth Bass in Shasta Lake exhibits
5 nearly the same pattern. For Spotted Bass, the likelihood of nest survival being
6 greater than 40 percent is high (nearly 100 percent) from March to May under
7 both Alternative 1 and the No Action Alternative. For June, Spotted Bass nest
8 survival would be less than for May due to greater daily reductions in water
9 surface elevation as Shasta Lake is drawn down. The likelihood of nest survival
10 being greater than 40 percent is about 10 percent less under Alternative 1 as
11 compared to the No Action Alternative.

12 For May and June, the likelihood of nest survival for Largemouth Bass in Lake
13 Oroville being in the 40 to 100 percent range is somewhat (4 to 10 percent) lower
14 under Alternative 1 than under the No Action Alternative. However, in June, nest
15 survival of greater than 40 percent is likely only in about 35 percent of the years
16 evaluated under Alternative 1. The likelihood of high nest survival for
17 Smallmouth Bass in Lake Oroville exhibits nearly the same pattern. For Spotted
18 Bass, the likelihood of nest survival being greater than 40 percent is high (over
19 90 percent) in May under both Alternative 1 and the No Action Alternative with
20 the likelihood of greater than 40 percent survival being similar under
21 Alternative 1 and the No Action Alternative. For June, Spotted Bass nest survival
22 would be less than for May due to greater daily reductions in water surface
23 elevation as Lake Oroville is drawn down. The likelihood of survival being
24 greater than 40 percent is substantially lower (nearly 20 percent) under
25 Alternative 1 as compared to the No Action Alternative.

26 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and
27 May due to increasing reservoir elevations. For June, the likelihood of nest
28 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the
29 40 to 100 percent range is about 5 percent lower under Alternative 1 than the No
30 Action Alternative. For Spotted Bass, nest survival for June would be less than
31 for May due to greater daily reductions in water surface elevation. However, the
32 likelihood of survival being greater than 40 percent is around 5 percent lower
33 under Alternative 1 as compared to the No Action Alternative.

34 *Summary of Effects on Reservoir Fishes*

35 The analysis of the effects of Alternative 1 and the No Action Alternative for
36 reservoir fish relied on CalSim II output for reservoir storage levels and water
37 surface elevation changes as described in Appendix 9F. As described above,
38 reservoir storage is anticipated to be increased under Alternative 1 relative to the
39 No Action Alternative and this increase could affect the amount of warm and cold
40 water habitat available within the reservoirs. However, it is unlikely that aquatic
41 habitat within the CVP and SWP water supply reservoirs is limiting.

42 The analysis of black bass nest survival based on changes in water surface
43 elevation during the spawning period indicated that the likelihood of high
44 (>40 percent) nest survival in most of the reservoirs would be similar in March,
45 April, and May under Alternative 1 and the No Action Alternative, but somewhat

1 lower in June. Most black bass spawning likely occurs prior to June, such that
2 drawdowns during June would likely affect only a small proportion of the
3 spawning population. Thus, it is concluded that effects on black bass nesting
4 success would be similar under Alternative 1 and the No Action Alternative.

5 *Pacific Lamprey*

6 Little information is available on factors that influence populations of Pacific
7 Lamprey in the Sacramento River, but they are likely affected by many of the
8 same factors as salmon and steelhead because of the parallels in their life cycles.

9 *Changes in Water Temperature*

10 The following describes anticipated changes in average monthly water
11 temperature in the Sacramento, Feather, and American rivers and the potential for
12 those changes to affect Pacific Lamprey.

13 *Sacramento River*

14 Long-term average monthly water temperature in the Sacramento River at
15 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
16 difference) to water temperatures under the No Action Alternative. An exception
17 is during September and October of critical dry years when water temperatures
18 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
19 compared to the No Action Alternative and up to 1°F warmer in September of
20 wetter years (Appendix 6B, Table 5-5-1). A similar temperature pattern generally
21 would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge,
22 with average monthly temperatures increasing in a downstream direction and
23 temperature differences between scenarios progressively decreasing except in
24 September (up to 2.8°F warmer) at Bend Bridge) during wetter years under
25 Alternative 1. Due to the similarity of water temperatures under Alternative 1 and
26 the No Action Alternative from January through the summer, there would be little
27 difference in potential effects on Pacific Lamprey adults during their migration,
28 holding, and spawning periods.

29 *Feather River*

30 Long-term average monthly water temperature in the Feather River in the low
31 flow channel generally were predicted to be similar (less than 0.5°F differences)
32 under Alternative 1 and the No Action Alternative, except during November and
33 December when average monthly water temperatures would be up to 1.4°F lower
34 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
35 temperatures in September under Alternative 1 generally could be up to 1.3°F
36 higher than under the No Action Alternative in wetter years. Although
37 temperatures in the river would become progressively higher in the downstream
38 directions, the differences in water temperatures between Alternative 1 and the No
39 Action Alternative would exhibit a similar pattern at the downstream locations
40 (Robinson Riffle and Gridley Bridge), with water temperature differences
41 between Alternative 1 and the No Action Alternative generally decreasing in most
42 water year types. However, water temperatures from July to September under
43 Alternative 1 could be somewhat (0.7°F to 1.6°F) warmer on average and up to
44 4.0°F warmer at the confluence with Sacramento River in wetter years.

1 Due to the similarity of water temperatures under Alternative 1 and the No Action
2 Alternative from January through the summer, there would be little difference in
3 potential effects on Pacific Lamprey adults during their migration, holding, and
4 spawning periods under Alternative 1 and the No Action Alternative.

5 *American River*

6 Average monthly water temperatures in the American River at Nimbus Dam
7 under Alternative 1 generally would be similar (differences less than 0.5°F) to the
8 No Action Alternative, with the exception of during June and August, when water
9 temperatures under Alternative 1 could be as much as 0.9°F lower in below
10 normal years. This pattern generally would persist downstream to Watt Avenue
11 and the mouth, although temperatures under Alternative 1 would be up to 1.6°F
12 and 2.0°F lower, respectively, than under the No Action Alternative in June. In
13 addition, average monthly water temperatures at the mouth generally would be
14 higher under Alternative 1 than the No Action Alternative in September of wetter
15 years when water temperatures under Alternative 1 could be up to 1.7°F warmer.
16 Due to the similarity of water temperatures under Alternative 1 and the No Action
17 Alternative from January through the summer, there would be little difference in
18 potential effects on Pacific Lamprey adults during their migration, holding, and
19 spawning periods.

20 *Summary of Effects on Pacific Lamprey*

21 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up
22 to around 72°F during their entire life history. Based on the similar water
23 temperatures during their spawning and incubation period under Alternative 1, it
24 is likely that conditions for and effects on Pacific Lamprey in the Sacramento,
25 Feather, and American rivers would be similar under Alternative 1 and the No
26 Action Alternative. This conclusion likely applies to other species of lamprey
27 that inhabit these rivers (e.g., River Lamprey).

28 *Striped Bass, American Shad, and Hardhead*

29 Changes in operations influence temperature and flow conditions that could affect
30 Striped Bass, American Shad, and Hardhead. The following describes those
31 changes and their potential effects.

32 *Changes in Water Temperature*

33 Changes in water temperature that affect Striped Bass, American Shad, and
34 Hardhead could occur in the Sacramento, Feather, and American rivers. The
35 following describes temperature conditions in those water bodies.

36 *Sacramento River*

37 Long-term average monthly water temperatures in the Sacramento River at
38 Keswick Dam under Alternative 1 would generally be similar (less than 0.5°F
39 difference) to water temperatures under the No Action Alternative. An exception
40 is during September and October of critical dry years when water temperatures
41 could be up to 1.1°F and 0.8°F lower, respectively, under Alternative 1 as
42 compared to the No Action Alternative and up to 1°F warmer in September of
43 wetter years (Appendix 6B, Table 5-5-1). A similar water temperature pattern

1 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend
2 Bridge, with average monthly water temperatures increasing in a downstream
3 direction and temperature differences between scenarios progressively increasing
4 (up to 0.9°F cooler) in June and up to 4.6°F warmer in September during the
5 wetter years under Alternative 1 relative to the No Action Alternative. In general,
6 Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than
7 salmonids. Therefore, it is unlikely that the slightly reduced temperatures during
8 some months would have adverse effects on these species.

9 *Feather River*

10 Average monthly water temperature in the Feather River in the low flow channel
11 generally were predicted to be similar (less than 0.5°F differences) under
12 Alternative 1 and the No Action Alternative, except during November and
13 December when average monthly water temperatures would be up to 1.4°F lower
14 in some water year types (Appendix 6B, Table B-20-1). Average monthly water
15 temperatures in September under Alternative 1 could be up to 1.3°F warmer than
16 under the No Action Alternative in the wetter years. Although temperatures in the
17 river would become progressively lower in the downstream directions, the
18 differences between Alternative 1 and No Action Alternative would exhibit a
19 similar pattern at the downstream locations (Appendix 6B, Table B-23-1). As
20 described above for the Sacramento River, Striped Bass, American Shad, and
21 Hardhead can tolerate higher temperatures than salmonids. Therefore, it is
22 unlikely that the slightly reduced temperatures during some months would have
23 adverse effects on these species in the Feather River.

24 *American River*

25 Average monthly water temperatures in the American River at Nimbus Dam
26 under Alternative 1 generally would be similar (differences less than 0.5°F) to the
27 No Action Alternative, with the exception of during June and August, when
28 differences under Alternative 1 could be as much as 0.9°F lower in below normal
29 years. This pattern generally would persist downstream to Watt Avenue and the
30 mouth, although temperatures under Alternative 1 would be up to 1.6°F and 2.0°F
31 lower, respectively, than under the No Action Alternative in June. As described
32 above for the Sacramento River, Striped Bass, American Shad, and Hardhead can
33 tolerate higher temperatures than salmonids. Therefore, it is unlikely that the
34 slightly reduced temperatures during some months would have adverse effects on
35 these species in the American River.

36 *Changes in Position of X2*

37 Alternative 1 would result in a more eastward X2 position as compared to the No
38 Action Alternative during April and May, with similar values in June
39 (Appendix 5A, Section C Table C-16-1). Based on Kimmerer (2002) and
40 Kimmerer et al. (2009), this change in X2 would likely reduce the survival index
41 and the habitat index as measured by salinity for Striped Bass and abundance and
42 habitat index for American Shad.

1 *Summary of Effects on Striped Bass, American Shad, and Hardhead*

2 In general, Striped Bass, American Shad, and Hardhead can tolerate higher
3 temperatures than salmonids. Based on the similar water temperatures during
4 their spawning and incubation period under Alternative 1, it is likely that thermal
5 conditions for and effects on Striped Bass, American Shad, and Hardhead in the
6 Sacramento, Feather, and American rivers would be similar under Alternative 1
7 and the No Action Alternative. Overall, however, Alternative 1 likely would have
8 slightly greater potential for adverse effects on Striped Bass and American Shad
9 as compared to the No Action Alternative, primarily due to the potential for
10 reduced survival during larval and juvenile life stages, and less favorable location
11 of Spring X2 on average.

12 *Stanislaus River/Lower San Joaquin River*

13 *Fall-Run Chinook Salmon*

14 Changes in operations influence temperature and flow conditions that could affect
15 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam
16 and in the San Joaquin River below Vernalis. The following describes those
17 changes and their potential effects.

18 *Changes in Water Temperature (Stanislaus River)*

19 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
20 under Alternative 1 and the No Action Alternative generally would be similar
21 (differences less than 0.5°F), with small differences in critical dry years when
22 Alternative 1 would 0.8°F and 1.3°F cooler on average than under the No Action
23 Alternative during June and September, respectively, and 0.7°F warmer in
24 November (Appendix 6B, Table B-1-1).

25 Downstream at Orange Blossom Bridge, average monthly water temperatures in
26 October under Alternative 1 would be higher in all water year types than under
27 the No Action Alternative by as much as 1.9°F. In most other months, water
28 temperatures under Alternative 1 and the No Action Alternative generally would
29 be similar. An exception to this pattern occurs in April when average monthly
30 water temperatures in all water year types would be higher under Alternative 1 by
31 as much as about 1.2°F (Appendix 6B, Table B-18-1).

32 This water temperature pattern would continue downstream to the confluence
33 with the San Joaquin River, although temperatures would progressively increase,
34 as would the magnitude of difference between Alternative 1 and No Action
35 Alternative. Increases in average monthly water temperatures in October and
36 April would be more pronounced under Alternative 1, with average differences as
37 much as 2.7°F in October and 2.0 F in April (Appendix 6B, Table B-19-1)
38 relative to the No Action Alternative. The magnitude of differences in average
39 monthly water temperatures between Alternative 1 and the No Action
40 Alternative in May and June also would increase relative to the upstream
41 locations with average June water temperatures being 2.4°F cooler under
42 Alternative 1 in wet years.

1 Based on the life history timing for fall-run Chinook Salmon, the higher water
 2 temperatures in October under Alternative 1 may increase the likelihood of
 3 adverse effects on fall-run Chinook Salmon spawning and egg incubation as
 4 compared to the No action Alternative.

5 *Changes in Exceedance of Water Temperature Thresholds Appendix*

6 While specific water temperature thresholds for fall-run Chinook Salmon in the
 7 Stanislaus River are not established, temperatures generally considered suitable
 8 for fall-run Chinook Salmon spawning (56°F) would be exceeded in October and
 9 November about 30 and 25 percent of the time, respectively at Goodwin Dam
 10 under Alternative 1 (Appendix 6B, Figures B-17-1 and B-17-2). Similar
 11 exceedances would occur under the No Action Alternative, although slightly more
 12 frequently in November. Water temperatures for rearing generally would be
 13 below 56°F, except in May when average monthly water temperatures would
 14 reach about 60°F under both Alternative 1 and the No action
 15 Alternative (Appendix 6B, Figure B-17-8).

16 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run
 17 Chinook Salmon spawning (56°F) would be exceeded frequently under both
 18 Alternative 1 and the No Action Alternative during October and November.
 19 Under Alternative 1, average monthly water temperatures would exceed 56°F
 20 about 85 percent of the time in October. This, would be about 28 percent more
 21 frequently than under the No Action Alternative. In November, average monthly
 22 water temperatures would exceed 56°F about 28 percent of the time under
 23 Alternative 1, which would be about 5 percent less frequent than under the No
 24 Action Alternative (Appendix 6B, Figure B-18-2).

25 From January through May, rearing fall-run Chinook Salmon would be subjected
 26 to average monthly water temperatures that exceed 56° in March (less than
 27 10 percent of the time) and May (about 20 percent of the time) under
 28 Alternative 1, which is about 10 percent less frequently than under the No Action
 29 Alternative in May (Appendix 6B, Figure B-18-8).

30 *Changes in Egg Mortality (Stanislaus River)*

31 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg
 32 mortality rate is predicted to be around 7 percent, with higher mortality rates (in
 33 excess of 15 percent) occurring in critical dry years under Alternative 1. Overall,
 34 egg mortality in the Stanislaus River would be similar under Alternative 1 and the
 35 No Action Alternative (Appendix 9C, Table B-1).

36 *Changes in Delta Hydrodynamics*

37 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in
 38 the Delta during the months of April, May and June. Near the confluence of the
 39 San Joaquin River and the Mokelumne River, the median proportion of positive
 40 velocities was slightly lower under Alternative 1 relative to the No Action
 41 Alternative in April and May and similar in June (Appendix 9K). In Old River
 42 downstream of the facilities, the median proportion of positive velocities was
 43 substantially lower in April and May under Alternative 1 relative to No Action

1 Alternative but became more similar in June. In Old River upstream of the
2 facilities, the median proportion of positive velocities was slightly to moderately
3 lower for Alternative 1 relative to No Action Alternative in April and May,
4 respectively and moderately lower in June. On the San Joaquin River
5 downstream of the Head of Old River, the median proportion of positive
6 velocities was slightly to moderately higher under Alternative 1 relative to No
7 Action Alternative in April and May, respectively, whereas values were similar
8 in June.

9 *Changes in Junction Entrainment*

10 Median entrainment probabilities at the Head of Old River were much lower
11 under Alternative 1 relative to the No Action Alternative during April and May.
12 The median entrainment probability was similar under both alternatives in the
13 month of June (Appendix 9L). At the Turner Cut junction, median entrainment
14 probabilities under Alternative 1 were slightly higher than under the No Action
15 Alternative in June. During April and May, entrainment probabilities were more
16 divergent with moderately higher values for Alternative 1 relative to No Action
17 Alternative. Overall, entrainment was slightly lower at the Columbia Cut junction
18 relative to Turner Cut but patterns of entrainment between these two alternatives
19 were similar. Patterns at the Middle River and Old River junctions were similar
20 to those observed at Columbia and Turner Cut junctions.

21 *Summary of Effects on Fall-Run Chinook Salmon*

22 In the Stanislaus River, the analysis of the effects of Alternative 1 and the No
23 Action Alternative for fall-run Chinook Salmon relied on the water temperature
24 model output for the rivers at various locations downstream of Goodwin Dam.
25 The temperature model outputs for each of the fall-run Chinook Salmon life
26 stages suggest that thermal conditions and effects on fall-run Chinook Salmon in
27 the Stanislaus River generally would be similar under both scenarios, although
28 water temperatures could be somewhat less suitable for fall-run Chinook Salmon
29 spawning/egg incubation under Alternative 1. This conclusion is supported by the
30 water temperature threshold exceedance analysis that indicated that suitable water
31 temperatures for fall-run Chinook Salmon spawning and egg incubation would be
32 exceeded slightly less frequently in November, but substantially more frequently
33 in October under Alternative 1. Suitable water temperatures for fall-run Chinook
34 Salmon rearing would be exceeded somewhat less frequently under Alternative 1.
35 Results of the analysis using Reclamation's salmon mortality model indicate that
36 there would be little difference in fall-run Chinook Salmon egg mortality under
37 Alternative 1 and the No Action Alternative.

38 Implementation of a fish passage project under the No Action Alternative,
39 although intended to address the limited availability of suitable habitat for
40 steelhead in the Stanislaus River reaches downstream of Goodwin Dam, could
41 provide some benefit to fall-run Chinook Salmon if passage for adult fall-run
42 Chinook Salmon was provided and additional habitat could be accessed. Any
43 potential benefit to fall-run Chinook Salmon under the No Action Alternative
44 relative to Alternative 1 is uncertain. The potential benefits of actions under the
45 No Action Alternative intended to increase the efficiency of the Tracy and

1 Skinner Fish Collection Facilities could improve the overall salvage survival of
2 fall-run Chinook Salmon relative to Alternative 1.

3 The results of the numerical models suggest that Alternative 1 is less likely to
4 result in adverse effects on fall-run Chinook Salmon than the No Action
5 Alternative. However, discerning a meaningful difference between these two
6 scenarios based on the quantitative results is not possible because of the similarity
7 in results (generally differences less than 5 percent) and the inherent uncertainty
8 of the models. In addition, adverse effects of the No Action Alternative could be
9 balanced by the potentially beneficial effects resulting from the RPA actions
10 evaluated qualitatively for the No Action Alternative. Overall, given the small
11 differences in the numerical model results and the inherent uncertainty in the
12 temperature model, as well as the potential for benefits associated with the RPA
13 actions under the No Action Alternative, it is concluded that there would be no
14 definitive difference in effects on fall-run Chinook Salmon between Alternative 1
15 and the No Action Alternative.

16 *Steelhead*

17 Changes in operations that influence temperature and flow conditions in the
18 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below
19 Vernalis could affect steelhead. The following describes those changes and their
20 potential effects.

21 *Changes in Water Temperature (Stanislaus River)*

22 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
23 under Alternative 1 and the No Action Alternative generally would be similar
24 (differences less than 0.5°F), with small differences in critical dry years when
25 water temperatures under Alternative 1 would 0.8°F and 1.3°F cooler on average
26 than under the No Action Alternative during June and September, respectively,
27 and 0.7°F warmer in November (Appendix 6B, Table B-17-1).

28 Downstream at Orange Blossom Bridge, average monthly water temperatures in
29 October under Alternative 1 would be higher in all water year types than the No
30 Action Alternative by as much as 1.9°F. In most other months, water
31 temperatures under Alternative 1 and the No Action Alternative generally would
32 be similar (less than 0.5°F differences), except in April when average monthly
33 water temperatures in all water year types would be higher under Alternative 1 by
34 as much as about 1.2°F in the drier years (Appendix 6B, Table B-18-1).

35 This water temperature pattern would continue downstream to the confluence
36 with the San Joaquin River, although temperatures would progressively increase,
37 as would the magnitude of difference between Alternative 1 and the No Action
38 Alternative. Increases in average monthly water temperatures in October and
39 April would be more pronounced under Alternative 1, with average differences as
40 much as 2.7°F (Appendix 6B, Table B-19-1) relative to the No Action
41 Alternative. The magnitude of differences in average monthly water temperatures
42 between Alternative 1 and the No Action Alternative in May and June also would

1 increase relative to the upstream locations with average June water temperatures
2 being 2.4°F cooler under Alternative 1 in wet years.

3 Overall, the water temperature differences between Alternative 1 and the No
4 Action Alternative would be relatively minor (less than 0.5°F) and likely would
5 have little effect on steelhead in the Stanislaus River. Based on the life history
6 timing for steelhead, the slightly lower temperatures in June and September of
7 drier years under Alternative 1 may decrease the likelihood of adverse effects to
8 steelhead rearing in the Stanislaus River; the higher temperatures in October
9 under Alternative 1 may increase the likelihood of adverse effects on adult
10 steelhead during their upstream migration.

11 *Changes in Exceedance of Water Temperature Thresholds*
12 *(Stanislaus River)*

13 Average monthly water temperatures in the Stanislaus River at Orange Blossom
14 Bridge would frequently exceed the temperature threshold (56°F) established for
15 adult steelhead migration under both Alternative 1 and No Action
16 Alternative during October and November. Under Alternative 1, average monthly
17 water temperatures would exceed 56°F about 85 percent of the time in October
18 which is about 28 percent more frequently than under the No Action
19 Alternative (Appendix 6B, Figure B-18-1). In November, average monthly water
20 temperatures would exceed 56°F about 28 percent of the time under Alternative 1,
21 which would be about 5 percent less frequent than under the No Action
22 Alternative (Appendix 6B, Figure B-18-2).

23 From January through May, the temperature threshold at Orange Blossom Bridge
24 is 55°F, which is intended to support steelhead spawning. This threshold would
25 not be exceeded under either Alternative 1 or No Action Alternative during
26 January or February. From March through May, however, exceedances would
27 occur under both Alternative 1 and the No Action Alternative in each month, with
28 the threshold most frequently exceeded (43 percent) under Alternative 1 in May
29 (Appendix 9N). Water temperatures under Alternative 1 would exceed the
30 threshold 5 percent less frequently in March, 6 percent less frequently in May,
31 and 17 percent more frequently in April than under the No Action Alternative.

32 From June through November, the temperature threshold of 65°F established to
33 support steelhead rearing would be exceeded by both Alternative 1 and No Action
34 Alternative in all months but November, and would exceed the threshold by
35 16 percent of the time in July under both Alternative 1 and the No Action
36 Alternative. The differences between Alternative 1 and the No Action
37 Alternative range from 1 percent less frequent exceedance in October to 4 percent
38 more frequent exceedance in June under the No Action Alternative.

39 Average monthly water temperatures also would exceed the threshold (52°F)
40 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles
41 upstream of Knights Ferry, average monthly water temperatures under
42 Alternative 1 would exceed 52°F in March, April, and May about 9 percent,
43 31 percent, and 66 percent of the time, respectively. Water temperatures under

1 Alternative 1 would result in exceedances occurring about 1 to 2 percent more
2 frequently during the January through May period. Farther downstream at Orange
3 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and
4 would be exceeded less frequently. The magnitude of the exceedance also would
5 be less. Average monthly water temperatures under Alternative 1 and the No
6 Action Alternative would not exceed the threshold during January through March.
7 In April and May, exceedances of 8 percent and 10 percent would occur under
8 Alternative 1, which represent a frequency of about 6 percent more than the No
9 Action Alternative in April and about an 8 percent lower frequency in May.

10 Overall, the differences in exceedance frequency between Alternative 1 and the
11 No Action Alternative would be relatively small, with the exception of substantial
12 differences in the frequency of exceedances in October when the average monthly
13 water temperatures under Alternative 1 would exceed the threshold for adult
14 steelhead migration about 28 percent more frequently and in April during the
15 spawning period when the exceedance frequency would be about 17 percent
16 more. Given the frequency of exceedance under both Alternative 1 and No
17 Action Alternative and the generally stressful temperature conditions in the river,
18 the substantial differences in October and April under Alternative 1 suggest that
19 there would be more potential to result in adverse effects on steelhead under
20 Alternative 1 than under the No Action Alternative. Even during months when
21 the differences would be relatively small, the slightly higher frequency of
22 exceedances under Alternative 1 suggest that there would be more potential to
23 result in adverse effects on steelhead under Alternative 1 than under the No
24 Action Alternative.

25 *Changes in Delta Hydrodynamics*

26 San Joaquin River-origin steelhead generally move through the Delta during
27 spring; however, there is less information on their timing relative to Chinook
28 Salmon. Thus, hydrodynamics in the entire January through June period have the
29 potential to affect juvenile steelhead. For a description of potential hydrodynamic
30 effects on steelhead, see the descriptions for winter-run Chinook Salmon in the
31 Sacramento Basin and fall-run Chinook Salmon in the San Joaquin River
32 basin above.

33 *Summary of Effects on Steelhead*

34 The analysis of the effects of Alternative 1 and the No Action Alternative for
35 steelhead relied on the water temperature model output for the rivers at various
36 locations downstream of Goodwin Dam. The temperature model outputs for each
37 of the steelhead life stages suggest that thermal conditions and effects on
38 steelhead in all of these streams generally would be similar under both scenarios,
39 although water temperatures could be somewhat less suitable for steelhead rearing
40 under Alternative 1. Water temperatures could be somewhat more suitable during
41 the adult upstream migration period under Alternative 1 than the No Action
42 Alternative. This conclusion is supported by the water temperature threshold
43 exceedance analysis that indicated that the water temperature threshold for
44 steelhead migration would be exceeded substantially more frequently on October,
45 but somewhat more frequently in November under Alternative 1. The water

1 temperature threshold for steelhead spawning would also be exceeded
2 substantially more frequently in May, but somewhat less frequently in other
3 months under Alternative 1. The water temperature threshold for steelhead
4 rearing generally would be exceeded less frequently under Alternative 1 while the
5 temperature thresholds for smoltification would be exceeded more frequently in
6 most months.

7 The differences in the magnitude and frequency of exceedance of suitable
8 temperatures for the various lifestages under Alternative 1 could affect the
9 potential for adverse effects on the steelhead populations in the Stanislaus River.
10 However, the direction and magnitude of this effect is uncertain. Implementation
11 of the fish passage program under the No Action Alternative intended to address
12 the limited availability of suitable habitat for steelhead in the Stanislaus River
13 reaches downstream of Goodwin Dam could provide a benefit to Central Valley
14 steelhead in the Stanislaus River. This is particularly important in light of
15 anticipated increases in water temperature associated with climate change in
16 2030. Thus, it is concluded that the potential for adverse effects on steelhead
17 under Alternative 1 would be greater, principally because Alternative 1 does not
18 include fish passage to address water temperatures critical to steelhead
19 sustainability over the long term with climate change by 2030.

20 *White Sturgeon*

21 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River
22 upstream of the confluence with the Stanislaus River. While flows in the San
23 Joaquin River upstream of the Stanislaus River are expected to be similar under all
24 alternatives, flow contributions from the Stanislaus River could influence water
25 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may
26 occur during the spring and early summer. The magnitude of influence on water
27 temperature would depend on the proportional flow contribution of the Stanislaus
28 River and the temperatures in both the Stanislaus and San Joaquin rivers. The
29 potential for an effect on White Sturgeon eggs and larvae would be influenced by
30 the proportion of the population occurring in the San Joaquin River. In
31 consideration of this uncertainty, it is not possible to distinguish potential effects
32 on White Sturgeon between alternatives.

33 *Reservoir Fishes*

34 The analysis of effects associated with changes in operation on reservoir fishes
35 relied on evaluation of changes in available habitat (reservoir storage) and
36 anticipated changes in black bass nesting success.

37 Changes in CVP and SWP water supplies and operations under Alternative 1 as
38 compared to the No Action Alternative would result in higher storage levels in
39 New Melones Reservoir under Alternative 1 as compared to the No Action
40 Alternative, as summarized in Table 5.16, due to lower instream releases to
41 support fish flows under Alternative 1.

42 Storage in New Melones could be increased by up to around 10 percent in some
43 months of some water year types under Alternative 1 compared to the No Action
44 Alternative. Additional information related to monthly reservoir elevations is

1 provided in Appendix 5A, CalSim II and DSM2 Modeling. Assuming that
2 storage volume is an indicator of how much habitat is available to fish species
3 inhabiting the reservoir, the amount of habitat for reservoir fishes could be
4 increased under Alternative 1 as compared to the No Action Alternative.

5 As shown in Appendix 9F, Largemouth Bass and Smallmouth Bass nest survival
6 is anticipated to always be above 40 percent under both Alternative 1 and the No
7 Action Alternative in March. For April, the likelihood that nest survival of
8 Largemouth Bass and Smallmouth Bass is between 40 and 100 percent is
9 reasonably high (nearly 80 percent), although about 13 percent higher under
10 Alternative 1 as compared to the No Action Alternative. For May, nest survival is
11 anticipated to be similar under Alternative 1 and the No Action Alternative. For
12 June, the likelihood of survival being greater than 40 percent for Largemouth
13 Bass and Smallmouth Bass in New Melones Reservoir is about 8 percent lower
14 under Alternative 1 as compared to the No Action Alternative. For Spotted Bass,
15 nest survival from March through June is anticipated to be near 100 percent in
16 every year under both Alternative 1 and No Action Alternative. Most black bass
17 spawning likely occurs prior to June, such that drawdowns during June would
18 likely affect only a small proportion of the spawning population. Thus, it is
19 concluded that effects on black bass nesting success would be similar under
20 Alternative 1 and the No Action Alternative.

21 *Other species*

22 Changes in operations that influence temperature and flow conditions in the
23 Stanislaus River downstream of Keswick Dam and the San Joaquin River at
24 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

25 As described above, average monthly water temperatures in the Stanislaus River
26 at Goodwin Dam under Alternative 1 and No Action Alternative generally would
27 be similar. Downstream at Orange Blossom Bridge, average monthly water
28 temperatures in the November to March period under Alternative 1 generally
29 would be similar to, although somewhat lower than, under the No Action
30 Alternative. In April and October, average monthly water temperatures in all
31 water year types would be higher under Alternative 1 and in September, water
32 temperatures would be lower under Alternative 1 compared to the No Action
33 Alternative. This temperature pattern would continue downstream to the
34 confluence with the San Joaquin River, although temperatures would
35 progressively increase, as would the magnitude of difference between
36 Alternative 1 and No Action Alternative (Appendix 6B, Table B-19-1).

37 In general, lamprey species can tolerate higher temperatures than salmonids, up to
38 around 72°F during their entire life history. Because lamprey ammocoetes remain
39 in the river for several years, any substantial flow reductions or temperature
40 increases could result in adverse effects on larval lamprey. Given the similar
41 flows and temperatures during their spawning and incubation period, it is likely
42 that the potential to affect lamprey species in the Stanislaus and San Joaquin
43 rivers would be similar under Alternative 1 and the No Action Alternative.

1 In general, Striped Bass and Hardhead also can tolerate higher temperatures than
2 salmonids. Given the similar temperatures during their spawning and incubation
3 period, it is likely that the potential to affect Striped Bass and Hardhead in the
4 Stanislaus and San Joaquin rivers would be similar under Alternative 1 and the
5 No Action Alternative.

6 *San Francisco Bay Area Region*

7 *Killer Whale*

8 Southern Resident killer whales (Southern Residents) are thought to rely heavily
9 upon salmon as their main source of prey (about 96 percent of their diet)
10 throughout the areas and times for which reliable data on prey consumption are
11 available (Ford and Ellis 2006). Studies have indicated that Chinook Salmon
12 generally constitute a large percentage of the Southern Resident salmon diet, with
13 some indications that Chinook Salmon are strongly preferred at certain times in
14 comparison to other salmonids (Ford and Ellis 2006; Hanson et al. 2007). Results
15 have also suggested that Chinook Salmon from ESUs from California to British
16 Columbia are being consumed by Southern Residents (Hanson et al. 2007).

17 Best available data on the abundance and composition of Central Valley Chinook
18 Salmon indicates that approximately 75 percent of all Central Valley-origin
19 Chinook Salmon available for consumption by Southern Residents are produced
20 by Central Valley fall-run Chinook Salmon hatcheries (Palmer-Zwhalen and
21 Kormos 2012; Table 9). Most Central Valley hatchery fall-run Chinook Salmon
22 production is released directly into San Francisco Bay, and thus bypass potential
23 impacts from water project operations. Even where there might be a nexus with
24 water project operations, the purpose of Central Valley fall-run Chinook Salmon
25 hatchery programs is to produce large numbers of fish independent of freshwater
26 conditions. Since fall-run Chinook Salmon hatcheries came on-line more than
27 forty years ago, the only period of exceptionally low returns was principally
28 attributed to unusual ocean conditions (Lindley et al. 2007).

29 Ocean commercial and recreational fisheries annually harvest hundreds of
30 thousands of Chinook salmon. The Northwest Region of NMFS (NMFS 2009c)
31 used a model that estimates prey reduction associated with the salmon fishery and
32 which considers the metabolic requirements of Southern Residents and the
33 remaining levels of prey availability. Their analysis concluded that the salmon
34 fishery was not likely to result in jeopardy for Southern Residents. Given
35 conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run
36 Chinook Salmon available for Southern Residents are produced by Central Valley
37 hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base
38 for killer whales would not be appreciably affected by any of the alternatives.

39 **9.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

40 As described in Chapter 3, Description of Alternatives, Alternative 1 is identical
41 to the Second Basis of Comparison.

1 **9.4.3.3 Alternative 2**

2 The CVP and SWP operations under Alternative 2 are identical to the CVP and
3 SWP operations under the No Action Alternative, as described in Chapter 3,
4 Description of Alternatives. Alternative 2 would not include implementation of
5 fish passage actions under the 2009 NMFS BO. As described in Chapter 4,
6 Approach to Environmental Analysis, Alternative 2 is compared to the No Action
7 Alternative and the Second Basis of Comparison.

8 **9.4.3.3.1 Alternative 2 Compared to the No Action Alternative**

9 *Trinity River Region*

10 The CVP and SWP operations under Alternative 2 are identical to the CVP and
11 SWP operations under the No Action Alternative. Therefore, fish and aquatic
12 resources conditions at Trinity Lake and along the Trinity River and lower
13 Klamath River under Alternative 2 would be the same as under the No Action
14 Alternative.

15 *Central Valley Region*

16 The CVP and SWP operations under Alternative 2 are identical to the CVP and
17 SWP operations under the No Action Alternative. Therefore, physical conditions
18 that affect aquatic resources under Alternative 2 would be the same as under the
19 No Action Alternative. However, salmonid survival could be less under
20 Alternative 2 due to the lack of fish passage actions to move fish to portions of the
21 Sacramento, American, and Stanislaus rivers that would provide cooler
22 temperatures for spawning and rearing under the No Action Alternative. In
23 addition, Alternative 2 would not include various actions that would occur under
24 the No Action Alternative intended to benefit salmonids and sturgeon, such as
25 structural improvements for temperature control on the American River; gravel
26 augmentation, floodplain restoration and inundation flows, and freshwater
27 migratory habitat restoration in the Stanislaus River; and measures to increase the
28 efficiency of the Tracy and Skinner Fish Collection Facilities. Thus, it is
29 concluded that the potential for adverse effects on salmonids and sturgeon under
30 Alternative 2 would be greater than under the No Action Alternative.

31 *San Francisco Bay Area Region*

32 *Killer Whale*

33 It is unlikely that the Chinook Salmon prey base of killer whales, supported
34 heavily by hatchery production of fall-run Chinook Salmon, would be appreciably
35 affected by any of the alternatives.

36 **9.4.3.3.2 Alternative 2 Compared to the Second Basis of Comparison**

37 *Trinity River Region*

38 The CVP and SWP operations under Alternative 2 are identical to the CVP and
39 SWP operations under the No Action Alternative. Therefore, changes in aquatic
40 resources at Trinity Lake and along the Trinity River and lower Klamath River
41 under Alternative 2 as compared to the Second Basis of Comparison would be the

1 same as the impacts described in Section 10.4.4.1, No Action
2 Alternative Compared to the Second Basis of Comparison.

3 *Central Valley Region*

4 The CVP and SWP operations under Alternative 2 are identical to the CVP and
5 SWP operations under the No Action Alternative. Therefore, changes in physical
6 conditions that affect aquatic resources in the Central Valley Region under
7 Alternative 2 as compared to the Second Basis of Comparison would be the same
8 as the impacts described for the No Action Alternative Compared to the Second
9 Basis of Comparison. Actions to provide fish passage to portions of the
10 Sacramento, American, and Stanislaus rivers upstream of their dams would not be
11 undertaken under Alternative 2 or the Second Basis of Comparison.

12 *San Francisco Bay Area Region*

13 *Killer Whale*

14 As described above for the comparison of Alternative 1 to the No Action
15 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
16 supported heavily by hatchery production of fall-run Chinook Salmon, would be
17 appreciably affected by any of the alternatives.

18 **9.4.3.4 Alternative 3**

19 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
20 under Alternative 3 are similar to the Second Basis of Comparison with modified
21 OMR flow criteria and New Melones Reservoir operations. Alternative 3 also
22 includes the following items that are not included in the No Action Alternative or
23 the Second Basis of Comparison and would affect fish and aquatic resources.

- 24 • Implement predator control programs for black bass, Striped Bass, and
25 Sacramento Pikeminnow to protect salmonids and Delta Smelt as follows:
 - 26 – Black bass catch limit changed to allow catch of 12-inch fish with a bag
27 limit of 10
 - 28 – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag
29 limit of 5
 - 30 – Establish a Sacramento Pikeminnow sport-fishing reward program with a
31 8-inch limit at \$2/fish
- 32 • Establish a trap and haul program for juvenile salmonids entering the Delta
33 from the San Joaquin River in March through June as follows:
 - 34 – Begin operation of downstream migrant fish traps upstream of the Head of
35 Old River on the San Joaquin River
 - 36 – “Barge” all captured juvenile salmonids through the Delta, release at
37 Chipps Island.
 - 38 – Tag subset of fish in order to quantify effectiveness of the program
 - 39 – Attempt to capture 10 percent to 20 percent of out-migrating juvenile
40 salmonids

- 1 • Work with Pacific Fisheries Management Council, CDFW, and NMFS to
2 minimize harvest mortality of natural origin Central Valley Chinook Salmon,
3 including fall-run Chinook Salmon, by evaluating and modifying ocean
4 harvest for consistency with Viable Salmonid Population Standards; including
5 harvest management plan to show that abundance, productivity, and diversity
6 (age-composition) are not appreciably reduced.

7 As described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is
8 compared to the No Action Alternative and the Second Basis of Comparison.

9 **9.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

10 *Trinity River Region*

11 *Coho Salmon*

12 The analysis of effects associated with changes in operation on Coho Salmon was
13 conducted using temperature model outputs for Lewiston Dam to anticipate the
14 likely effects on conditions in the Trinity River downstream of Lewiston Dam for
15 Coho Salmon.

16 Long-term average monthly water temperatures in the Trinity River at Lewiston
17 Dam under Alternative 3 generally would be similar to the temperatures that
18 would occur under the No Action Alternative (Appendix 6B, Table B-1-2). An
19 exception occurs during November when long-term average water temperatures
20 are increased by 3.3°F under Alternative 3 relative to the No Action Alternative in
21 critical years. In addition, water temperatures under Alternative 3 could be as
22 much as 1.5°F cooler than under the No Action Alternative in December of below
23 normal years. Overall, the temperature differences between Alternative 3 and the
24 No Action Alternative would be relatively minor and likely would have little
25 effect on Coho Salmon in the Trinity River. The higher water temperatures in
26 November of critical years and lower temperatures in December of below normal
27 years under Alternative 3 would likely have little effect on Coho Salmon as water
28 temperatures in the Trinity River are typically low during this time period.

29 The USFWS established a water temperature threshold of 56°F for Coho Salmon
30 spawning in the reach of the Trinity River from Lewiston to the confluence with
31 the North Fork Trinity River from October through December. Although not
32 entirely reflective of water temperatures throughout the reach, the temperature
33 model provides average monthly water temperature outputs for Lewiston Dam,
34 which may provide perspective on temperature conditions in the reach below.
35 Under Alternative 3, the spawning temperature threshold would be exceeded
36 about 6 percent of the time in October, about 2 percent less frequently than under
37 the No Action Alternative. In November, average water temperatures under
38 Alternative 3 would not exceed the threshold, whereas average monthly water
39 temperatures the No Action Alternative would exceed the threshold about
40 2 percent of the time. The threshold would not be exceeded in December under
41 either scenario (Appendix 9N).

1 Overall, the temperature model outputs for each of the Coho Salmon life stages
2 suggest that the temperature of water released at Lewiston Dam generally would
3 be similar under both scenarios, although the exceedance of water temperature
4 thresholds would be less frequent under Alternative 3. Given the similarity of the
5 results and the inherent uncertainty associated with the resolution of the
6 temperature model (average monthly outputs), it is concluded that Alternative 3
7 and the No Action Alternative are likely to have similar effects on the Coho
8 Salmon population in the Trinity River.

9 *Spring-run Chinook Salmon*

10 The analysis of effects associated with changes in operation on spring-run
11 Chinook Salmon was conducted using temperature model outputs for Lewiston
12 Dam to anticipate the likely effects on conditions in the Trinity River downstream
13 of Lewiston Dam.

14 As described above for Coho Salmon, the differences in long-term average
15 monthly water temperatures between Alternative 3 and the No Action
16 Alternative would be relatively minor (less than 0.5°F) and likely would have
17 little effect on spring-run Chinook Salmon in the Trinity River. The substantially
18 higher (3.3°F) water temperatures in November of critical dry years and lower (by
19 1.5°F) in December of below normal years under Alternative 3 would likely have
20 little effect on spring-run Chinook Salmon as water temperatures in the Trinity
21 River are typically low during this time period.

22 In July, water temperatures in the Trinity River at Lewiston Dam would not
23 exceed the 60°F threshold for spring-run Chinook Salmon holding under
24 Alternative 3, although this threshold would be exceeded 1 percent of the time
25 under the No Action Alternative. Under both Alternative 3 and the No Action
26 Alternative, average monthly water temperatures in the Trinity River at Lewiston
27 Dam would exceed 60°F two percent of the time in August. In September, the
28 threshold for spawning (56°F) would be exceeded under both scenarios about
29 9 percent of the time. Overall, the differences in the frequency of threshold
30 exceedance between Alternative 3 and the No Action Alternative would be
31 relatively minor. However, temperature conditions under Alternative 3 could be
32 slightly less likely to affect spring-run Chinook Salmon holding than under the No
33 Action Alternative because of the reduced frequency of exceedance of the 60°F
34 threshold at Lewiston Dam in July.

35 The majority of spring-run Chinook Salmon in the Trinity River are produced in
36 the South Fork Trinity watershed. Although the water temperature and flow
37 changes could have slight beneficial effects on spring-run Chinook Salmon in the
38 Trinity River, these effects would not occur in every year and are not anticipated
39 to be substantial based on the relatively small differences in flows and water
40 temperatures under Alternative 3 as compared to the No Action Alternative.

41 Overall, Alternative 3 is likely to have similar effects on the spring-run Chinook
42 Salmon population in the Trinity River as compared to the No Action Alternative.
43 However, the implementation of the Hatchery Management Plan (RPA
44 Action II.6.3) under the No Action Alternative could reduce the impacts of

1 hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity
2 River, and increase the genetic diversity and diversity of run-timing for these
3 stocks relative to Alternative 3.

4 *Fall-Run Chinook Salmon*

5 The analysis of effects associated with changes in operation on fall-run Chinook
6 Salmon was conducted using temperature model outputs for Lewiston Dam to
7 anticipate the likely effects on conditions in the Trinity River downstream of
8 Lewiston Dam. The Reclamation Salmon Survival Model also was applied to
9 assess changes in egg mortality.

10 As described above for Coho Salmon, the temperature differences between
11 Alternative 3 and No Action Alternative would be relatively minor (less than
12 0.5°F) and likely would have little effect on fall-run Chinook Salmon in the
13 Trinity River. The higher water temperatures (as much as 3.3°F) in November of
14 critical years (and lower temperatures in December) under Alternative 3 would
15 likely have little effect on fall-run Chinook Salmon as water temperatures in the
16 Trinity River are typically low during this time period.

17 The temperature threshold and months during which it applies for fall-run
18 Chinook Salmon are the same as those for Coho Salmon. Under Alternative 3,
19 the 56°F threshold for fall-run Chinook Salmon spawning would be exceeded
20 about 6 percent of the time in October, about 2 percent less frequently than under
21 the No Action Alternative. In November and December, average water
22 temperatures under Alternative 3 would not exceed the threshold, whereas
23 average monthly water temperatures the No Action Alternative would exceed the
24 threshold about 2 percent of the time in November, with no exceedances in
25 December. Overall, the differences in the frequency of threshold exceedance
26 between Alternative 3 and the No Action Alternative would be relatively minor.
27 Temperature conditions under the Alternative 3 could be slightly less likely to
28 affect fall-run Chinook Salmon spawning than under the No Action
29 Alternative because of the slightly reduced frequency of exceedance of the 56°F
30 threshold at Lewiston Dam in October. However, this would occur prior to the
31 peak spawning period (November-December) for fall-run Chinook Salmon.

32 The temperatures described above for the Trinity River downstream of Lewiston
33 Dam are reflected in the analysis of egg mortality using the Reclamation model
34 (Appendix 9C). For fall-run Chinook Salmon in the Trinity River, the long-term
35 average egg mortality rate is predicted to be relatively low (around 4 percent),
36 with higher mortality rates (over 10 percent) occurring in critical dry years under
37 Alternative 3 (Appendix 9C, Table B-5). Overall, egg mortality under
38 Alternative 3 and the No Action Alternative would be similar in all water year
39 types.

40 Although the water temperature and flow changes suggest a lower potential for
41 adverse effects on fall-run Chinook Salmon in the Trinity River, these effects
42 would not occur in every year and are not anticipated to be substantial based on
43 the relatively small differences in flows and water temperatures (and similar egg
44 mortality) under Alternative 3 as compared to the No Action Alternative.

1 Overall, Alternative 3 is likely to have similar effects on fall-run Chinook Salmon
2 in the Trinity River as compared to the No Action Alternative. However, the
3 implementation of the Hatchery Management Plan (RPA Action II.6.3) under the
4 No Action Alternative could reduce the impacts of hatchery Chinook Salmon on
5 natural fall-run Chinook Salmon in the Trinity River, and increase the genetic
6 diversity and diversity of run-timing for these stocks relative to Alternative 3.

7 *Steelhead*

8 The analysis of effects associated with changes in operation on steelhead was
9 conducted using temperature model outputs for Lewiston Dam to anticipate the
10 likely effects on conditions in the Trinity River downstream of Lewiston Dam.

11 As described above for Coho Salmon, the temperature differences between
12 Alternative 3 and No Action Alternative would be relatively minor (less than
13 0.5°F) and likely would have little effect on steelhead in the Trinity River. In
14 critical dry years, increased water temperatures in November under Alternative 3
15 could increase the likelihood of adverse effects on migrating adult steelhead,
16 although water temperatures are relatively low at this time of year.

17 The temperature threshold and months during which it applies for steelhead are
18 the same as those for Coho Salmon. Overall, the differences in the frequency of
19 threshold exceedance between Alternative 3 and the No Action Alternative would
20 be relatively minor and are unlikely to affect steelhead spawning in the Trinity
21 River. While average monthly temperatures would be similar overall, the slight
22 reduction in the frequency of threshold exceedance provided by Alternative 3
23 during warm periods in October and November suggest that temperature
24 conditions under Alternative 3 could be slightly less likely to affect steelhead than
25 under the No Action Alternative.

26 Although water temperatures under Alternative 3 suggest a slightly lower
27 potential for adverse effects on steelhead in the Trinity River, the relatively small
28 differences in flows and water temperatures under Alternative 3 as compared to
29 the No Action Alternative would likely have similar effects on steelhead in the
30 Trinity River as compared to the No Action Alternative.

31 *Green Sturgeon*

32 Changes in operations that influence temperature and flow conditions in the
33 Trinity River downstream of Lewiston Dam could influence Green Sturgeon. The
34 following describes those changes and their potential effects.

35 As described in the Affected Environment, Green Sturgeon spawn in the lower
36 reaches of the Trinity River during April through June, and water temperatures
37 above about 63°F are believed stressful to embryos (Van Eenennaam et al. 2005).
38 Average monthly water temperature conditions during April through June in the
39 Trinity River at Lewiston Dam under Alternative 3 are similar and do not exceed
40 58°F during this period. Water temperatures in the downstream reaches where
41 Green Sturgeon spawn would be higher, although temperature conditions likely
42 would be controlled by other factors (e.g., ambient air temperatures and tributary
43 inflows) rather than water operations at Trinity and Lewiston dams. Therefore,

1 given the similarities between average monthly water temperatures at Lewiston
2 Dam under Alternative 3 and the No Action Alternative, it is likely that
3 temperature conditions for Green Sturgeon in the Trinity River and lower
4 Klamath River and estuary would be similar under both scenarios.

5 *Reservoir Fishes*

6 The analysis of effects associated with changes in operation on reservoir fishes
7 relied on evaluation of changes in available habitat (reservoir storage) and
8 anticipated changes in black bass nesting success.

9 Changes in CVP water supplies and operations under Alternative 3 as compared
10 to the No Action Alternative would result in higher reservoir storage in Trinity
11 Lake. Storage in Trinity Lake could be increased up to around 10 percent in some
12 months of some water year types. Additional information related to monthly
13 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.

14 Aquatic habitat in Trinity Lake may not be limiting; however, storage volume is
15 an indicator of how much habitat is available to fish species inhabiting these
16 reservoirs. Therefore, the amount of habitat for reservoir fishes could be
17 increased somewhat under Alternative 3 as compared to the No Action
18 Alternative.

19 Results of the bass nesting success analysis are presented in Appendix 9F,
20 Reservoir Fish Analysis Documentation. Bass nest survival in Trinity Lake is
21 predicted to be near 100 percent in March and April due to increasing reservoir
22 elevations. For May, the likelihood of survival for Largemouth and Smallmouth
23 Bass in Trinity Lake being in the 40 to 100 percent range would be similar under
24 Alternative 3 and the No Action Alternative. For June, the likelihood of survival
25 being greater than 40 percent for Largemouth and Smallmouth Bass would be
26 somewhat lower than in May and would be similar under Alternative 3 and the No
27 Action Alternative. For Spotted Bass, the likelihood of survival being greater
28 than 40 percent would be 100 percent in May under both Alternative 3 and the No
29 Action Alternative. For June, Spotted Bass survival in Trinity Lake would be less
30 than for May due to greater daily reductions in water surface elevation. The
31 likelihood of survival being greater than 40 percent would be similar (near
32 100 percent) under Alternative 3 and the No Action Alternative.

33 Overall, the comparison of storage and the analysis of nesting suggest that effects
34 of Alternative 3 on reservoir fishes would be similar to those under the No Action
35 Alternative.

36 *Pacific Lamprey*

37 Little information is available on factors that influence populations of Pacific
38 Lamprey in the Trinity River, but they are likely affected by many of the same
39 factors as salmon and steelhead because of the parallels in their life cycles. On
40 average, the temperature of water released at Lewiston Dam under Alternative 3
41 would be similar to (within 0.5°F) (Appendix 6B). The highest increases in flow
42 would be less than 10 percent in the Trinity River, with a smaller relative increase
43 in the lower Klamath River and Klamath River estuary (Appendix 5A).

1 Overall, it is likely that effects on Pacific Lamprey would be similar under both
2 Alternative 3 and the No Action Alternative. This conclusion likely also applies
3 to other species of lamprey that inhabit the Trinity and lower Klamath rivers
4 (e.g., River Lamprey).

5 *Eulachon*

6 It is uncertain whether Eulachon has been extirpated from the Klamath River.
7 Given that the highest increases in flow would be less than 10 percent in the
8 Trinity River (Appendix 5A), with a smaller relative increase in the lower
9 Klamath River and Klamath River estuary, and that water temperatures in the
10 Klamath River (Appendix 6B) would be unlikely to be affected by changes
11 upstream at Lewiston Dam, it is likely that Alternative 3 would have a similar
12 potential to influence Eulachon in the Klamath River as the No Action
13 Alternative.

14 *Sacramento River System*

15 *Winter-run Chinook Salmon*

16 Changes in operations that influence temperature and flow conditions in the
17 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
18 Salmon. The following describes those changes and their potential effects.

19 *Changes in Water Temperature*

20 Average monthly water temperature in the Sacramento River at Keswick Dam
21 under Alternative 3 generally would be similar to (less than 0.5°F difference)
22 water temperatures under the No Action Alternative during most months of the
23 year (Appendix 6B, Table B-5-2). In September, average water temperatures in
24 wetter years could be increased by up to 0.8°F and decreased by up to 1.2°F in
25 critical years. A similar temperature pattern generally would be exhibited
26 downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with average monthly
27 temperatures progressively increasing in the downstream direction (e.g., average
28 difference of about 2°F between Keswick Dam and Bend Bridge) (Appendix 6B,
29 Table B-8-2). The water temperature differences between Alternative 3 and the
30 No Action Alternative in September of wetter years would increase to as high as
31 2.6°F warmer under Alternative 3, while the differences in drier years could reach
32 1.0°F cooler in September of drier years.

33 Overall, the temperature differences between Alternative 3 and the No Action
34 Alternative would be relatively minor (less than 0.5°F) and likely would have
35 little effect on winter-run Chinook Salmon in the Sacramento River. The
36 increased water temperatures in September of wetter years under Alternative 3
37 could increase the likelihood of adverse effects on winter-run Chinook Salmon
38 egg incubation and fry rearing during this water year type. The slightly lower
39 water temperatures in September of drier years under Alternative 3 could reduce
40 the likelihood of adverse effects on winter-run Chinook Salmon fry rearing in or
41 outmigrating from the Sacramento River. There would be little difference in
42 potential effects on spawning of winter-run Chinook Salmon due to the similar

1 water temperatures during the April to June time period under Alternative 3 as
2 compared to the No Action Alternative.

3 *Changes in Exceedances of Water Temperature Thresholds*

4 With the exception of April, average monthly water temperatures under both
5 Alternative 3 and the No Action Alternative would show exceedances of the water
6 temperature threshold of 56°F established in the Sacramento River at Ball's Ferry
7 for winter-run Chinook Salmon spawning and egg incubation in every month,
8 with exceedances under both as high as about 49 percent and 42 percent,
9 respectively, in some months. Under Alternative 3, the temperature threshold
10 generally would be exceeded less frequently than it would under the No Action
11 Alternative (by about 2 percent to 4 percent) in June through August, with the
12 temperature threshold in September exceeded about 6 percent more frequently
13 under Alternative 3 than the No Action Alternative. Farther downstream at Bend
14 Bridge, the frequency of exceedances would increase, with exceedances under
15 both Alternative 3 and the No Action Alternative as high as nearly 90 percent in
16 some months. Under Alternative 3, temperature exceedances generally would be
17 less frequent (by up to 8 percent) than under the No Action Alternative, with the
18 exception of September, when exceedances under Alternative 3 would be about
19 26 percent more frequent.

20 Overall, there would be substantial differences in the frequency of threshold
21 exceedance between Alternative 3 and the No Action Alternative, particularly in
22 September. While temperature conditions under Alternative 3 could be less likely
23 to affect winter-run Chinook Salmon egg incubation than under the No Action
24 Alternative because of the reduced frequency of exceedance of the 56°F threshold
25 from April through August, the substantial increase in the frequency of
26 exceedance in September under Alternative 3 may increase the likelihood of
27 adverse effects on winter-run Chinook Salmon egg incubation during this limited
28 portion of the spawning and egg incubation period.

29 *Changes in Egg Mortality*

30 The temperatures described above for the Sacramento River downstream of
31 Keswick Dam are reflected in the analysis of egg mortality using Reclamation's
32 salmon mortality model (Appendix 9C). For winter-run Chinook Salmon in the
33 Sacramento River, the long-term average egg mortality rate is predicted to be
34 relatively low (around 5 percent), with higher mortality rates (exceeding
35 25 percent) occurring in critical dry years under Alternative 3. In critical dry
36 years the average egg mortality rate would be 6 percent less than under the No
37 Action Alternative (Appendix 9C, Table B-4). Overall, winter-run Chinook
38 Salmon egg mortality in the Sacramento River under Alternative 3 and the No
39 Action Alternative would be similar, except in critical dry water years.

40 *Changes in Weighted Usable Area*

41 As an indicator of the amount of suitable spawning habitat for winter-run Chinook
42 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
43 in general, there would be similar amounts of spawning habitat available from
44 April through August under Alternative 3 as compared to the No Action

1 Alternative (Appendix 9E, Weighted Usable Area Analysis). Modeling results
2 also indicate that, in general, there would be similar amounts of suitable fry
3 rearing habitat available from June through October under Alternative 3. Similar
4 to the results for fry rearing WUA, modeling results indicate that there would be
5 similar amounts of suitable juvenile rearing habitat available during the juvenile
6 rearing period from July to May under Alternative 3 and the No Action
7 Alternative.

8 *Changes in SALMOD Output*

9 SALMOD results indicate that potential juvenile production would be similar
10 under Alternative 3 as compared to the No Action Alternative (Appendix 9D,
11 Table B-4-6).

12 *Changes in Delta Passage Model Output*

13 The Delta Passage Model predicted similar estimates of annual Delta survival
14 across the 81-year time period for winter-run Chinook Salmon between
15 Alternative 3 and the No Action Alternative (Appendix 9J). Median Delta
16 survival would be 0.354 for Alternative 3 and 0.349 for the No Action
17 Alternative.

18 *Changes in Delta Hydrodynamics*

19 Winter-run Chinook Salmon smolts are most abundant in the Delta during
20 January, February, and March. On the Sacramento River near the confluence of
21 Georgiana Slough, the median proportion of positive velocities under
22 Alternative 3 was indistinguishable from the No Action
23 Alternative (Appendix 9K). On the San Joaquin River near the Mokelumne River
24 confluence, the median proportion of positive velocities would be
25 indistinguishable between these two alternatives. In Old River downstream of the
26 facilities, the median proportion of positive velocities would be similar under
27 Alternative 3 and the No Action Alternative in January, February, and March. In
28 Old River upstream of the facilities, the median proportion of positive velocities
29 also would be similar under Alternative 3 and the No Action Alternative in these
30 months. On the San Joaquin River downstream of Head of Old River, the percent
31 of positive velocities would be similar under both alternatives in January,
32 February and March.

33 *Changes in Junction Entrainment*

34 For all junctions examined, entrainment probabilities for both scenarios would be
35 similar under Alternative 3 and the No Action Alternative from January through
36 March (Appendix 9L).

37 *Changes in Salvage*

38 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar
39 under Alternative 3 relative to No Action Alternative during the three months
40 when winter-run Chinook Salmon are most abundant in the Delta (January,
41 February, March; (Appendix 9M).

1 *Changes in Oncorhynchus Bayesian Analysis Output*

2 Escapement of winter-run Chinook Salmon and Delta survival was modeled by
3 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook
4 salmon. Escapement was generally lower under Alternative 3 as compared to the
5 No Action Alternative (Appendix 9I). The median abundance under Alternative 3
6 was higher in only 5 of the 22 years of simulation (1971 to 2002), and there was
7 typically greater than a 25 percent chance that Alternative 3 values would be
8 lower than under the No Action Alternative. Median delta survival was
9 consistently lower (by approximately 7 percent) under Alternative 3 as compared
10 to the No Action Alternative. However, the probability intervals indicated that no
11 difference between scenarios was a likely outcome. Thus delta survival was not
12 responsible for the temporal patterns in relative escapement. Since the ocean
13 conditions were equivalent across scenarios, the differences under Alternative 3
14 were likely due to differences in survival in the life stages upstream of the delta
15 (i.e., due to differences in temperature and flow at Bend Bridge).

16 *Changes in Interactive Object-Oriented Simulation Output*

17 The IOS model predicted similar adult escapement trajectories for winter-run
18 Chinook Salmon between Alternative 3 and the No Action Alternative across the
19 81 years (Appendix 9H). Under Alternative 3 median adult escapement was
20 4,025 and under the No Action Alternative, median escapement was 3,935.

21 Similar to adult escapement, the IOS model predicted similar egg survival time
22 trajectories for winter-run Chinook Salmon between Alternative 3 and No Action
23 Alternative across the 81 water years. Under Alternative 3 median egg survival
24 was 0.987 and under the No Action Alternative median egg survival was 0.990.

25 *Changes in Predator Management*

26 The fish predator assemblage of the Delta is dominated by invasive predators,
27 with the exception of the Sacramento Pikeminnow (Brown and Michniuk 2007;
28 Nobriga and Feyrer 2007, National Research Council 2010; Cavallo et al. 2012,
29 NRC 2012, Brown 2013). With the exception of Striped Bass, there is little
30 population-level information for fish predators including Largemouth Bass and
31 Sacramento Pikeminnow and there is even less information for Smallmouth Bass
32 and White and Channel Catfish (Grossman et al. 2013). It is important to note
33 that, in addition to predation by native and non-native fishes, there has been
34 extensive modification of the hydrology, loss of tidal freshwater wetlands,
35 increases in non-native submerged aquatic vegetation such as *Egeria densa*, and
36 other effects of human population growth within the Delta, which also
37 undoubtedly influence the survival of salmonids in the Delta (Brown and
38 Michniuk 2007; National Research Council 2010, 2012).

39 Bowen et al. (2009 and 2010) describe salmonid behavior in the vicinity of the
40 Head of Old River Barrier and predation from the release point upstream at
41 Durham Ferry. Predation in this short reach seemed to be increased during the
42 lower flows in 2009 and during later release in 2010. While this two year study
43 observed a variable and negative relationship between flow and survival past a
44 Head of Old River Barrier, there remains uncertainty in this due to the actual

1 barrier structures implemented and how they affected predator habitat in this
2 reach.

3 Although it is well documented that Striped Bass can feed heavily on juvenile
4 salmon and steelhead in the rivers, as they migrate seaward, many of the salmon
5 eaten are likely to be hatchery-reared fish; juveniles from natural spawning may
6 be more wary and encounter lower predation rates. It is thought that predation on
7 hatchery-reared juveniles may buffer wild fish from such predation (Moyle and
8 Bennett 2010). Much of the predation on juvenile salmon seems to take in place
9 in conjunction with artificial structures and release practices. These include
10 releases of fish from hatcheries and those trucked to the estuary from the export
11 facilities in the south Delta (DWR 2010).

12 In general, Striped Bass are opportunistic predators that tend to forage on
13 whatever prey are most abundant, from benthic invertebrates to their own young
14 to juvenile salmon and American Shad (Stevens 1966, Moyle 2002, Nobriga and
15 Feyrer 2008). Striped Bass are unlikely to be a major predator of Delta Smelt
16 because Delta Smelt are semi-transparent (making them hard to see in turbid
17 water) and do not school, unlike more favored prey such as Threadfin Shad,
18 juvenile Striped Bass, and Mississippi Silverside. Delta Smelt were a minor item
19 in Striped Bass diets when they were highly abundant in the early 1960s
20 (Stevens 1966), as well as in recent years at record low abundance (Nobriga and
21 Feyrer 2008).

22 Predator control measures are included in Alternative 3, including an increased
23 bag limit (10/day) with a minimum size limit of 12 inches on Striped Bass and
24 black bass. In addition, a sport reward program for Sacramento Pikeminnow
25 (\$2/fish > 8 inches) would be implemented to encourage fishing for and removal
26 of this native predatory fish.

27 A number of studies have been conducted on predation effects in the Delta, and a
28 recent (2013) workshop was held to assess the status of information and
29 potentially establish conclusions regarding the importance of fish predation on
30 salmonid populations in the Delta (Grossman et al. 2013). The workshop
31 concluded that:

32 “Available data and analyses have generated valuable information
33 regarding aspects of the predation process in the Delta but do not provide
34 unambiguous and comprehensive estimates of fish predation rates on
35 juvenile salmon or steelhead nor on population-level effects for these
36 species in the Delta.”

37 And:

38 “Juvenile salmon are clearly consumed by fish predators and several
39 studies indicate that the population of predators is large enough to
40 effectively consume all juvenile salmon production. However, given
41 extensive flow modification, altered habitat conditions, native and non-
42 native fish and avian predators, temperature and dissolved oxygen
43 limitations, and overall reduction in historical salmon population size, it is

1 not clear what proportion of juvenile mortality can be directly attributed to
2 fish predation. Fish predation may serve as the proximate mechanism of
3 mortality in a large proportion of the population but the ultimate causes of
4 mortality and declines in productivity are less clear.”

5 The proposed bag and size limits are intended and expected to encourage more
6 fishing effort for and greater harvest of Striped Bass and black bass species,
7 resulting in a reduction in the Striped Bass and black bass populations throughout
8 the Delta. It is reasonable to assume that removing or relaxing restrictions on the
9 harvest of these predatory species would lead to a substantial reduction in their
10 number. However, whether or not this reduction would lead to a substantial
11 benefit or population-level effect on salmonid populations is unknown
12 (Moyle and Bennett 2010). For the proposed (under Alternative 3) predator
13 reduction program to be effective, it must be true that predation by Striped Bass
14 and black bass regulates populations of salmon, steelhead, and smelt, with
15 predation by other species (other fish, birds, marine mammals, etc.) playing a
16 minor role. The program may not be effective, or the effectiveness would be
17 reduced if other predators exhibit compensatory increases in predation if Striped
18 Bass and black bass are removed.

19 As noted above, the modification of the hydrology, loss of tidal freshwater
20 wetlands, increases in non-native submerged aquatic vegetation, and other effects
21 of human population growth within the Delta play a role in the survival of
22 salmonids in the Delta and contribute to the uncertainty that any predator
23 reduction program will have the desired results. It is unknown whether reducing
24 Striped bass and black bass populations can measurably compensate for the large
25 changes to the estuary and watershed, which also contribute to reduced
26 populations of salmon, steelhead and smelt.

27 In addition to the proposed bag and size limits, Alternative 3 includes a proposal
28 to implement a sport reward program for Sacramento Pikeminnow to encourage
29 fishing for and removal of predatory Sacramento Pikeminnow. It is unknown
30 whether a Sacramento Pikeminnow bounty would be feasible under California
31 regulations. Currently, the Sacramento Pikeminnow is regulated under CCR
32 Title 14, section 5.95 (no limit or season), sections 2.25 and 2.30 (bow and arrow
33 and spear fishing) and section 1.87 (no wastage of fish). Therefore, any fishing
34 practice, derby or bounty program in which the Sacramento Pikeminnow is
35 wasted would be in violation of the regulations. In addition, Sacramento
36 Pikeminnow is listed as a "game fish" in commission regulations (CCR Title 14,
37 section 230) and a permit is required before any prizes can be offered to
38 take them.

39 Regardless of whether a Sacramento Pikeminnow reward system is feasible to
40 implement, the effectiveness of such a program is not assured. This same
41 approach to predator reduction is ongoing in the Columbia River through the
42 Northern Pikeminnow (*Ptychocheilus oregonensis*) Sport-Reward Program
43 sponsored by Bonneville Power Administration that began in 1991. The program
44 seeks to maintain 10 to 20 percent exploitation rate on Northern Pikeminnow
45 throughout the Columbia River by paying anglers \$4 to \$8 to harvest fish >

1 228 mm (>9 inches) in total length. In 2012, a total of 158,159 fish were
2 harvested in the sport-reward fishery. Vouchers for 156,837 untagged fish were
3 submitted for payment totaling rewards of \$1,016,672. System-wide pikeminnow
4 exploitation efforts suggest that the desired 10 to 20 percent exploitation rate has
5 been achieved for a number of years (Porter 2012). The program has removed
6 over 2.2 million fish from 1998-2009 and is believed to have reduced predation
7 on juvenile salmonids; however, predation estimates have varied widely and
8 positive effects on salmonid populations have been difficult to detect (Carey et al.
9 2012).

10 Control of undesired and invasive fishes is a common fishery management
11 strategy (Kolar et al. 2010). However, changes in predator abundance produced
12 via removal, augmentation, or invasion can produce unintended consequences
13 (Polis and Strong 1996). It is possible that other species on which Striped Bass
14 prey, such as Mississippi Silverside, would increase in abundance, causing harm
15 by competing with and preying on desired species, particularly Delta Smelt.
16 Mississippi Silversides are important in the diets of 1 to 3 year old Striped Bass;
17 predation by Striped Bass could be regulating the silverside population. Reducing
18 Striped Bass predation pressure on Mississippi Silversides may increase their
19 numbers, which could have negative effects on Delta Smelt through predation on
20 eggs and larvae (Bennett and Moyle 2006).

21 The predator reduction program under Alternative 3 is intended to improve the
22 survival of listed species (e.g., salmonids and Delta Smelt) by reducing predation
23 on these species. As described above, the program may be difficult to implement,
24 may not be effective, and may cause unintended harm to other native Delta fish
25 species. Consequently, the outcome of the predator management program is
26 highly uncertain. Compared to the No Action Alternative, which does not include
27 a predator reduction program, Alternative 3 may or may not provide a benefit to
28 salmonids and may result in an adverse effect on Delta smelt.

29 *Changes in Ocean Salmon Harvest*

30 Alternative 3 includes an action to change ocean salmon harvest for the purpose
31 of increasing escapement of adult winter-run Chinook Salmon as well as other
32 runs. The following outlines the benefits and challenges associated with such a
33 program.

34 Central Valley origin Chinook Salmon of all races are harvested in commercial
35 and recreational fisheries off the coast of California. Central Valley origin fall-
36 run Chinook Salmon are the primary target of this harvest. Harvested Chinook
37 Salmon between Point Conception and Bodega Bay were found to be composed
38 of 89-95 percent Central Valley fall-run Chinook Salmon (Winans et al. 2001).
39 More recent studies have shown most Central Valley fall-run Chinook Salmon are
40 produced by hatcheries, and are not of natural origin. Barnett-Johnson et al.
41 (2007) analyzed otolith microstructure from harvested Chinook Salmon and
42 estimated 90 percent were of hatchery origin. Palmer-Zwhalen and Kormos
43 (2012; Table 9) reported data indicating spawning-escapement for Central Valley
44 fall-run Chinook Salmon was composed of 75 percent hatchery origin fish.

1 Despite the relatively high abundance of hatchery-produced fall-run Chinook
2 Salmon, ocean fisheries are often constrained to protect ESA-listed Chinook
3 Salmon stocks (including Sacramento winter-run and spring-run Chinook Salmon,
4 and Coastal Chinook Salmon), which constitute less than 10 percent of available
5 Chinook Salmon (Winans et al. 2001). This “mixed-stock” fishery is managed by
6 using stock-specific differences in ocean distribution, age at maturity, size-at-date,
7 and/or timing of river entry to help minimize harvest of sensitive stocks.
8 However, such management strategies are only partially effective.

9 For example, spring-run Chinook Salmon return to freshwater in the spring and
10 thus avoid most ocean harvest during the year in which they mature. However,
11 spring-run Chinook Salmon that mature at age 4 (or older) are subjected to a full
12 season of harvest at “impact levels” comparable to those directed at Central
13 Valley fall-run Chinook Salmon. Harvest managers define “impact rate” as the
14 proportion of a particular stock that will suffer mortality associated with the ocean
15 fishery. Fall-run Chinook Salmon often experience impact rates between 40 and
16 70 percent.

17 Thus, the impact of ocean harvest varies substantially by stock, but all stocks are
18 impacted by harvest directed at the most abundant Chinook Salmon population
19 (typically hatchery origin fall-run Chinook Salmon). Several analyses are
20 available that provide a basis for assessing how harvest management identified in
21 Alternative 3 would affect Central Valley Chinook Salmon populations. Though
22 there are political and societal considerations for changes in ocean harvest
23 management, there are no technical or scientific constraints. We have the tools,
24 the knowledge and the ability to manage Chinook ocean harvest in whatever way
25 is needed. As such, Alternative 3 is, from a technical and scientific level,
26 entirely feasible.

27 Alternative 3 calls for ocean harvest to be managed with the standard of causing
28 no appreciable reduction in viability criteria for natural origin Chinook Salmon.
29 This alternative is addressed separately for Central Valley spring-run, winter-run,
30 and fall-run Chinook Salmon.

31 *Spring-Run Chinook Salmon.*

32 Fifteen years have elapsed since NMFS last updated its spring-run Chinook
33 Salmon ocean harvest Biological Opinion (NMFS 2000). The 2000 BO did not
34 report an estimated “impact rate” for the ocean harvest impact on spring-run
35 Chinook Salmon. The BO reached a non-jeopardy opinion for the impacts of
36 ocean harvest primarily by referring to the growth in Central Valley spring-run
37 Chinook Salmon population which was occurring at that time. Though NMFS
38 (2010) did not provide a quantitative analysis of spring-run Chinook Salmon
39 harvest, Grover et al. (2004) estimated that two thirds of spring-run Chinook
40 Salmon matured at age 4, indicating that a large fraction of the spring-run
41 Chinook Salmon population is annually subject to high impact rates (40 to
42 70 percent), which would greatly influence population productivity and
43 abundance. Harvest of age-3 spring-run Chinook Salmon is likely to be
44 comparable to that experienced by winter-run Chinook Salmon (which also
45 mature and return to fresh water, missing most of the ocean fishing season).

1 Though a comparable analysis for spring-run Chinook Salmon is not available,
2 Winship et al. (2013) applied a simulation model that showed a 25 percent impact
3 rate (much less than that likely experienced by age 4 spring-run Chinook Salmon)
4 on winter-run Chinook Salmon substantially decreased population abundance and
5 population resiliency relative to alternatives with less harvest.

6 Harvest pressure of this intensity can also alter diversity in age at-maturity, a
7 critical factor for population viability (NMFS 2010). The ocean fishery is thought
8 to select against fish that mature later because fish that would do so are vulnerable
9 to harvest for more years (Ricker 1981; Hankin and Healey 1986; Sierra and
10 Lackey 2015), and age at maturity has moderate heritability (Hankin et al. 1993).
11 As such, reduced ocean harvest would contribute substantially to age at-maturity
12 diversity (certainly demographically, if not genetically) and thereby enhance
13 population viability. A downward shift in size and age at maturity also affect
14 fitness by reducing fecundity and reproductive rates (Calduch-Verdiell et al.
15 2014). Larger females generally have larger and more numerous eggs
16 (Wertheimer et al. 2004), both of which provide reproductive advantages. Larger
17 eggs produce larger juveniles, which tend to have higher survival rates
18 (Quinn 2005) and are more resistance to temperature extremes. Since size and
19 age-at-maturity are heritable, selection for earlier adult maturity leads to a
20 feedback loop in which younger and smaller adults produce offspring that mature
21 earlier at smaller sizes. Change in body size may also influence spawning habitat
22 use where larger fish occupy areas with coarser substrate that smaller fish may not
23 be able to use. Thus, advantages of diversity in age at-maturity could be
24 especially important in degraded and thermally stressful habitats typical of
25 Central Valley tributaries.

26 *Winter-Run Chinook Salmon*

27 NMFS updated their winter-run Chinook Salmon ocean harvest BO in 2010
28 (NMFS 2010) and concluded:

29 *The effect of harvest and indirect mortality associated with the salmon*
30 *ocean fishery reduces the reproductive capability of this population, and*
31 *subsequently the entire ESU, by 10-25 percent per brood, when ocean*
32 *fisheries occur at a level similar to what has been observed for most of the*
33 *last decade south of Point Arena, California.*

34 *There is concern about the relatively high impact rate for age-4 fish and*
35 *the consequences of this relative to the genetic diversity of winter-run. If*
36 *age at maturity is strongly related to a genetic component, the removal of*
37 *older fish at a high rate before they can return to spawn, however few of*
38 *these individuals in the population there might be, could theoretically*
39 *reduce the potential for that trait to pass on to successive generation. The*
40 *change in an average life history trait over time, such as age at maturity,*
41 *has been suggested as evidence for fisheries induced evolution in some*
42 *situations (Law 2000; Kuparinen and Merilä 2007; Hard et al. 2008).*

1 NMFS has since implemented changes in ocean harvest regulations intended to
2 reduce impacts, but the effectiveness of those programs is unclear. Winship et al.
3 (2013) applied a simulation model and showed that all current winter-run
4 Chinook Salmon harvest alternatives substantially decreased population
5 abundance and population extinction risk relative to closing recreational and
6 commercial fisheries south of Point Arena. While closing these fisheries may not
7 be a realistic management alternative, Winship et al. (2013) did not consider
8 intermediate harvest management strategies such as a mark-selective fishery
9 (Pyper et al. 2012) or quota based fishing seasons. Currently, about 90 percent of
10 winter-run Chinook Salmon mature at age-3. As identified in the winter-run
11 Chinook Salmon harvest BO (NMFS 2010), diversity in age at maturity is an
12 important viability criterion likely to be adversely impacted by current harvest
13 management; winter-run Chinook Salmon currently maturing at age-4 are
14 subjected to impact rates comparable to those targeting fall-run Chinook Salmon
15 (40 to 70 percent). Given information presented in the spring-run Chinook
16 Salmon section, it seems likely that in the absence of this harvest, winter-run
17 Chinook Salmon would have a larger fraction of their population maturing at
18 age-4 or possibly older. Age-4 and older winter-run Chinook Salmon would
19 enhance demographic population viability, but also benefit the population by
20 more effectively spawning in coarse substrates, and producing more, larger, and
21 more thermally tolerant eggs.

22 *Fall-Run Chinook Salmon.*

23 As indicated previously, fall-run Chinook Salmon produced by Central Valley
24 hatcheries are the most abundant stock harvested off the coast of California. The
25 current management of Central Valley fall-run Chinook Salmon makes no
26 distinction between natural and hatchery fish, and, as such, harvest of natural
27 origin fall-run Chinook Salmon appears to occur at a much higher rate than
28 population productivity can sustain. The recently convened California HSRG
29 concluded:

30 *“Fishery harvests that are sustained at high levels by targeting abundant*
31 *hatchery-origin fish may over-exploit naturally reproducing salmonids*
32 *and may also induce selection on maturation schedule and other traits...*
33 *fishery exploitation rates must be in alignment with the productivity of*
34 *naturally reproducing salmon stocks for the recommendations in this*
35 *report to be successful at conserving natural salmonid populations”*
36 *(p. 19)*

37 *“The California HSRG also believes that an aggregate escapement target*
38 *for [the Central Valley natural stocks] that includes returns to hatcheries*
39 *lacks biological support. The target could theoretically be met if all fish*
40 *returned to hatcheries and none returned to natural spawning areas, or if*
41 *all fish in natural spawning areas were of hatchery origin” (p. 21).*

42 Quantitative analyses of current ocean harvest impacts to natural origin fall-run
43 Chinook Salmon are not currently available. However, impact rates combined
44 with relatively low abundances of natural origin fall-run Chinook Salmon indicate
45 adverse impacts to population viability are likely severe. Changes in harvest

1 strategies which could more effectively target hatchery origin fall Chinook while
2 better protecting natural origin fish would yield substantial benefits. Pyper et al.
3 (2012) analyzed one alternative, a mark-selective fishery, and found that natural
4 origin spawning escapement would increase from 24 to 48 percent.

5 Managing ocean salmon harvest as described in Alternative 3 would contribute to
6 the abundance, productivity and diversity viability criteria for natural origin
7 spring-run, winter-run, and fall-run Chinook Salmon.

8 *Summary of Effects on Winter-Run Chinook Salmon*

9 The multiple model and analysis outputs described above characterize the
10 anticipated conditions for winter-run Chinook Salmon and their response to
11 change under Alternative 3 as compared to the No Action Alternative. For the
12 purpose of analyzing effects on winter-run Chinook Salmon and developing
13 conclusions, greater reliance was placed on the outputs from the two life cycle
14 models, IOS and OBAN because they each integrate the available information to
15 produce single estimates of winter-run Chinook Salmon escapement. The output
16 from IOS indicated that winter-run Chinook Salmon escapement would be similar
17 under both scenarios, whereas the OBAN results indicated that escapement under
18 Alternative 3 would be lower than under the No Action Alternative.

19 These model results suggest that effects on winter-run Chinook Salmon would be
20 similar under both scenarios, with a small likelihood that winter-run Chinook
21 Salmon escapement would be lower under Alternative 3 than under the No Action
22 Alternative. This potential distinction between the two scenarios, however, may
23 be increased due to the benefits of implementation of fish passage under the No
24 Action Alternative. This potential beneficial effect and its magnitude would
25 depend on the success of the fish passage program. In addition, RPA actions
26 intended to increase the efficiency of the Tracy and Skinner Fish Collection
27 Facilities could improve the overall salvage survival of winter-run Chinook
28 Salmon.

29 The ocean harvest restriction component of Alternative 3 could increase winter-
30 run Chinook Salmon numbers by reducing ocean harvest and the predator control
31 measures under Alternative 3 could reduce predation on juvenile winter-run
32 Chinook Salmon and thereby increase survival.

33 Overall, given the small differences, distinguishing a clear difference between
34 alternatives is difficult. The non-operational components associated with
35 Alternative 3 could benefit winter-run Chinook Salmon relative to the No Action
36 Alternative over the short term if successful; however, these measures would not
37 address the long-term temperature challenges in the river downstream of Shasta
38 Dam that would be addressed under the No Action Alternative if fish passage is
39 successful. Even though the success of fish passage is uncertain, it is concluded
40 that the potential for adverse effects on winter-run Chinook Salmon under
41 Alternative 3 would be greater than those under the No Action Alternative,
42 principally because Alternative 3 does not include a strategy to address water
43 temperatures critical to winter-run Chinook Salmon sustainability over the long
44 term with climate change by 2030.

1 *Spring-run Chinook Salmon*

2 Changes in operations that influence temperature and flow conditions in the
3 Sacramento River downstream of Keswick Dam could affect spring-run Chinook
4 Salmon. The following describes those changes and their potential effects.

5 *Changes in Water Temperature*

6 Changes in water temperature that could affect spring-run Chinook Salmon could
7 occur in the Sacramento River, Clear Creek, and Feather River. The following
8 describes temperature conditions in those water bodies.

9 *Sacramento River*

10 Average monthly water temperature in the Sacramento River at Keswick Dam
11 under Alternative 3 relative to the No Action Alternative generally would be
12 similar to (less than 0.5°F differences) water temperatures under the No Action
13 Alternative during most months of the year (Appendix 6B, Table B-5-2). In
14 September, average water temperatures in wetter years would be increased by up
15 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature
16 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,
17 Bend Bridge, and Red Bluff, with average monthly temperatures progressively
18 increasing in the downstream direction (e.g., average difference of about 3°F
19 between Keswick Dam and Red Bluff). The water temperature differences
20 between Alternative 3 and the No Action Alternative in September of wetter years
21 would increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while
22 the differences in water temperatures in September associated with Alternative 3
23 during drier years would remain similar to the differences at upstream locations.

24 Overall, the temperature differences between Alternative 3 and the No Action
25 Alternative would be relatively minor (less than 0.5°F) and likely would have
26 little effect on spring-run Chinook Salmon in the Sacramento River. The
27 increased water temperatures in September of wetter years under Alternative 3
28 could increase the likelihood of adverse effects on spring-run Chinook Salmon
29 spawning and egg incubation during this water year type. The slightly lower
30 water temperatures in September of drier years under Alternative 3 would reduce
31 the likelihood of adverse effects on spring-run Chinook Salmon spawning and egg
32 incubation in the Sacramento River as compared to the No Action Alternative.
33 There would be little difference in potential effects on spring-run Chinook
34 Salmon holding in other summer months due to the similar water temperatures
35 during this time period under Alternative 3 and the No Action Alternative.

36 *Clear Creek*

37 Average monthly water temperatures in Clear Creek at Igo under Alternative 3
38 would be similar to (less than 0.5°F differences) water temperatures under the No
39 Action Alternative with the exception of May when average monthly
40 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)
41 than the No Action Alternative (Appendix 6B, Table B-3-2). The lower water
42 temperatures in May associated with the No Action Alternative reflect the effects
43 of the additional water that would be discharged from Whiskeytown Dam to meet
44 the spring attraction flow requirements to promote attraction of spring-run

1 Chinook Salmon into the creek. Overall, water temperature conditions for
2 spring-run Chinook Salmon in Clear Creek would be similar under Alternative 3
3 and the No Action Alternative.

4 *Feather River*

5 Average monthly water temperatures in the Feather River low flow channel under
6 Alternative 3 generally would be similar (within 0.5°F) to water temperatures
7 under the No Action Alternative, except in November and December (differences
8 as much as 1.6°F lower in December in below normal water years) (Appendix 6B,
9 Table B-20-2). In September average monthly water temperatures under
10 Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years than
11 under the No Action Alternative. Although temperatures in the river would
12 become progressively higher in the downstream direction, the differences between
13 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the
14 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures
15 under Alternative 3 and the No Action Alternative generally becoming more
16 similar at the confluence with the Sacramento River, except in September when
17 the water temperature under Alternative 3 could be up to 4.4 °F higher than under
18 the No Action Alternative and in June when temperatures under Alternative 3
19 could be up to 0.8°F cooler in drier years (Appendix 6B, Table B-23-2).

20 Overall, the temperature differences in the Feather River between Alternative 3
21 and the No Action Alternative would be relatively minor (less than 0.5°F) and
22 likely would have little effect on spring-run Chinook Salmon in the Feather River.
23 The somewhat lower water temperatures in November and December under
24 Alternative 3 would likely have little effect on spring-run Chinook Salmon as
25 water temperatures in the Feather River are typically low during this time period.
26 The somewhat higher water temperatures in September of wetter years may
27 increase the likelihood of adverse effects on spring-run Chinook Salmon egg
28 incubation and fry rearing in the Feather River. There would be little difference
29 in potential for adverse effects on spring-run Chinook Salmon holding over the
30 summer due to the similar water temperatures during this time period under
31 Alternative 3 and the No Action Alternative.

32 *Changes in Exceedances of Water Temperature Thresholds*

33 Changes in water temperature could result in the exceedance of established water
34 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,
35 Clear Creek, and Feather River. The following describes the extent of those
36 exceedance for each of those water bodies.

37 *Sacramento River*

38 Average monthly water temperatures under both Alternative 3 and the No Action
39 Alternative would show exceedances of the water temperature threshold of 56°F
40 established in the Sacramento River at Red Bluff for spring-run Chinook Salmon
41 (spawning and egg incubation) in October, November, and again in April. The
42 exceedances would occur at the greatest frequency in October (78 percent of the
43 time under Alternative 3). The water temperature threshold would be exceeded
44 less frequently in November (8 percent of the time) and not exceeded at all during

1 December through March under Alternative 3. As water temperatures warm in
2 the spring, the threshold would be exceeded in April by 14 percent under
3 Alternative 3. In the months when the greatest frequency of exceedances occur
4 (October, November, and April), model results generally indicate that the
5 threshold would be exceeded less frequently (by up to 4 percent in October) under
6 Alternative 3 than under the No Action Alternative. Temperature conditions in
7 the Sacramento River under Alternative 3 could be less likely to affect spring-run
8 Chinook Salmon egg incubation than under the No Action Alternative because of
9 the decreased frequency of exceedance of the 56°F threshold in October,
10 November, and April.

11 *Clear Creek*

12 Average monthly water temperatures under both Alternative 3 and the No Action
13 Alternative would not exceed the water temperature threshold of 60°F established
14 in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning and rearing in
15 June through August. However, water temperatures under Alternative 3 would
16 exceed the water temperature threshold of 56°F established for spawning in
17 September and October about 12 percent to 11 percent of the time, respectively.
18 Water temperatures under Alternative 3 could exceed the threshold about
19 4 percent less frequently than under the No Action Alternative in September and
20 about 2 percent less frequently in October. Temperature conditions in Clear
21 Creek under Alternative 3 could be less likely to affect spring-run Chinook
22 Salmon spawning than under the No Action Alternative because of the decreased
23 frequency of exceedance of the 56°F threshold in September and October.
24 However, this difference may be partially offset if the thermal stress reduction
25 measures associated with 2009 NMFS BO RPA Action I.1.5 under the No Action
26 Alternative are successful in improving water temperatures in Clear Creek.

27 *Feather River*

28 Average monthly water temperatures under both Alternative 3 and the No Action
29 Alternative would exceed the water temperature threshold of 56°F established in
30 the Feather River at Robinson Riffle for spring-run Chinook Salmon egg
31 incubation and rearing) during some months, particularly in October and
32 November, and March and April, when temperature thresholds could be exceeded
33 frequently (Appendix 9N). The frequency of exceedance would be highest
34 (about 97 percent) in October, a month in which average monthly water could get
35 as high as about 68°F under Alternative 3. However, water temperatures under
36 Alternative 3 would exceed the temperature threshold about 1 percent less
37 frequently than the No Action Alternative from October to December, and
38 1 percent more frequently in March.

39 The established water temperature threshold of 63°F for rearing during May
40 through August would be exceeded often under both Alternative 3 and the No
41 Action Alternative in May and June, but not at all in July and August. Water
42 temperatures under Alternative 3 would exceed the rearing temperature threshold
43 about 5 percent less frequently than under the No Action Alternative in May, with
44 the same likelihood of exceedance in June. Temperature conditions in the Feather
45 River under Alternative 3 could be less likely to affect spring-run Chinook

1 Salmon spawning and rearing than under the No Action Alternative because of
2 the decreased frequency of exceedance of the water temperature thresholds.

3 *Changes in Egg Mortality*

4 The temperature differences described above are reflected in the analysis of egg
5 mortality using the Reclamation model (Appendix 9C). For spring-run Chinook
6 Salmon in the Sacramento River, the long-term average egg mortality rate is
7 predicted to be relatively high (exceeding 20 percent), with high mortality rates
8 (around 80 percent) occurring in critical dry years under Action Alternative 3. In
9 critical dry years the average egg mortality rate would be 6.6 percent less under
10 Alternative 3 than under the No Action Alternative (Appendix 9C, Table B-3).
11 Overall, spring-run Chinook Salmon egg mortality in the Sacramento River under
12 Alternative 3 and the No Action Alternative would be similar, except in critical
13 dry water years.

14 *Changes in Weighted Usable Area*

15 Weighted usable area curves are available for spring-run Chinook Salmon in
16 Clear Creek. As described above, flows in Clear Creek downstream of
17 Whiskeytown Dam are not anticipated to differ under Alternative 3 relative to the
18 No Action Alternative except in May due to the release of spring attraction flows
19 in accordance with the 2009 NMFS BO under the No Action Alternative.
20 Therefore, there would be no change in the amount of potentially suitable
21 spawning and rearing habitat for spring-run Chinook Salmon (as indexed by
22 WUA) available under Alternative 3 as compared to the No Action Alternative.

23 *Changes in SALMOD Output*

24 SALMOD results indicate that potential juvenile production would be similar
25 under Alternative 3 and the No Action Alternative (Appendix 9D, Table B-3-6).

26 *Changes in Delta Passage Model Output*

27 The Delta Passage Model predicted similar estimates of annual Delta survival
28 across the 81-year time period for spring-run Chinook Salmon between
29 Alternative 3 and the No Action Alternative (Appendix 9J). Median Delta survival
30 was 0.286 for Alternative 3 and 0.296 for the No Action Alternative.

31 *Changes in Delta Hydrodynamics*

32 Spring-run Chinook Salmon are most abundant in the Delta from March through
33 May. Near the junction of Georgiana Slough, the median proportion of time that
34 velocity would be positive was similar in March, April, and May under both
35 alternatives (Appendix 9K). Near the confluence of the San Joaquin River and
36 the Mokelumne River, the median proportion of positive velocities would be
37 similar in March and slightly to moderately, lower under Alternative 3 relative to
38 the No Action Alternative in April and May, respectively. A similar pattern was
39 observed in the San Joaquin River downstream of the Head of Old River
40 (Appendix 9K). In Old River upstream of the facilities, the median proportion of
41 positive velocities would be slightly higher in April and May under Alternative 3
42 relative to the No Action Alternative and similar in March. In Old River
43 downstream of the facilities, the median proportion of positive velocities would

1 be similar in March and substantially lower in April and May under Alternative 3
2 relative to the No Action Alternative.

3 *Changes in Junction Entrainment*

4 Entrainment at Georgiana Slough would be similar under both alternatives during
5 March, April and May, when spring-run Chinook Salmon are most abundant in
6 the Delta (Appendix 9L). At the Head of Old River, median entrainment
7 probabilities would be slightly greater under Alternative 3 during April and May,
8 whereas probabilities would be similar in March. At the Turner Cut junction,
9 median entrainment probabilities under Alternative 3 and the No Action
10 Alternative would be similar in March. During April and May, entrainment
11 probabilities would be more divergent with slightly higher values for
12 Alternative 3 relative to the No Action Alternative. Overall, entrainment was
13 slightly lower at the Columbia Cut junction relative to Turner Cut, but patterns of
14 entrainment between these two alternatives would be similar with moderately
15 higher values for median entrainment in April and May under Alternative 3.
16 Patterns at the Middle River and Old River junctions would be similar to those
17 observed at Columbia and Turner Cut junctions.

18 *Changes in Salvage*

19 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar
20 under Alternative 3 and the No Action Alternative in every month except during
21 April, May, and June (Appendix 9M). Spring-run Chinook Salmon smolts
22 migrating through the Delta would be most susceptible in the months of March,
23 April, and May. Predicted values in April and May indicated a substantially
24 larger fraction of fish salvaged under Alternative 3 relative to the No Action
25 Alternative. Predicted median salvage was similar in March under Alternative 3
26 and the No Action Alternative.

27 *Summary of Effects on Spring-Run Chinook Salmon*

28 The multiple model and analysis outputs described above characterize the
29 anticipated conditions for spring-run Chinook Salmon and their response to
30 change under Alternative 3 and the No Action Alternative. For the purpose of
31 analyzing effects on spring-run Chinook Salmon in the Sacramento River, greater
32 reliance was placed on the outputs from the SALMOD model because it integrates
33 the available information on temperature and flows to produce estimates of
34 mortality for each life stage and an overall, integrated estimate of potential
35 spring-run Chinook Salmon juvenile production. The output from SALMOD
36 indicated that spring-run Chinook Salmon production in the Sacramento River
37 would be similar under Alternative 3 and the No Action Alternative.

38 The analyses attempting to assess the effects on routing, entrainment, and salvage
39 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
40 potential losses of juvenile salmon at the export facilities) of Sacramento River-
41 origin Chinook Salmon is predicted to be greater under Alternative 3 relative to
42 the No Action Alternative.

43 In Clear Creek and the Feather River, the analysis of the effects of Alternative 3
44 and the No Action Alternative for spring-run Chinook Salmon relied on output

1 from the WUA analysis and water temperature output for Clear Creek at Igo, and
2 in the Feather River low flow channel and downstream of the Thermalito
3 complex. The WUA analysis suggests that there would be little difference in the
4 availability of spawning and rearing habitat in Clear Creek. The temperature
5 model outputs suggest that thermal conditions and effects on each of the
6 spring-run Chinook Salmon life stages generally would be similar under both
7 scenarios in Clear Creek and the Feather River, although water temperatures
8 could be somewhat less suitable for spring-run Chinook Salmon holding and
9 spawning/egg incubation in the Feather River under Alternative 3. This
10 conclusion is supported by the water temperature threshold exceedance analysis
11 that indicated that water temperature thresholds for spawning and egg incubation
12 would be exceeded slightly more frequently under Alternative 3 than under the
13 No Action Alternative in Clear Creek and the Feather River. Because of the
14 inherent uncertainty associated with the resolution of the temperature model
15 (average monthly outputs), the slightly greater likelihood of exceeding water
16 temperature thresholds under Alternative 3 could increase the potential for
17 adverse effects on spring-run Chinook Salmon in the Feather River. Given the
18 similarity of the results, Alternative 3 and the No Action Alternative are likely to
19 have similar effects on the spring-run Chinook Salmon population in Clear Creek.

20 These model results suggest that overall, effects on spring-run Chinook Salmon
21 could be slightly more adverse under Alternative 3 than under the No Action
22 Alternative. The potential differences between the two scenarios, however, may
23 be even larger due to the benefits of implementation of fish passage under the No
24 Action Alternative intended to address the limited availability of suitable habitat
25 for spring-run Chinook Salmon in the Sacramento River reaches downstream of
26 Shasta Dam. This potential beneficial effect and its magnitude would depend on
27 the success of the fish passage program. In addition, RPA actions intended to
28 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could
29 improve the overall salvage survival of spring-run Chinook Salmon under the No
30 Action Alternative.

31 The ocean harvest restriction component of Alternative 3 could increase spring-
32 run Chinook Salmon numbers by reducing ocean harvest and the trap and haul
33 program and predator control measures under Alternative 3 could reduce
34 predation on juvenile spring-run Chinook Salmon and thereby increase survival.

35 Although the operational components associated with Alternative 3 could have
36 greater adverse effects on spring-run Chinook Salmon than the No Action
37 Alternative, the non-operational components associated with Alternative 3 could
38 benefit spring-run Chinook Salmon relative to the No Action Alternative over the
39 short term if successful. However, these measures would not address the long-
40 term temperature challenges in the river downstream of Shasta Dam that would be
41 addressed under the No Action Alternative if fish passage is successful. Even
42 though the success of fish passage is uncertain, it is concluded that the potential
43 for adverse effects on spring-run Chinook Salmon under Alternative 3 clearly
44 would be greater than those under the No Action Alternative, principally because
45 Alternative 3 does not include a strategy to address water temperatures critical to

1 spring-run Chinook Salmon sustainability over the long term with climate change
2 by 2030.

3 *Fall-Run Chinook Salmon*

4 Changes in operations that influence temperature and flow conditions in the
5 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
6 Whiskeytown Dam, Feather River downstream of Oroville Dam and American
7 River downstream of Nimbus could affect fall-run Chinook Salmon. The
8 following describes those changes and their potential effects.

9 *Changes in Water Temperature*

10 Changes in water temperature could affect fall-run Chinook Salmon in the
11 Sacramento, Feather, and American rivers, and Clear Creek. The following
12 describes temperature conditions in those water bodies.

13 *Sacramento River*

14 Average monthly water temperature in the Sacramento River at Keswick Dam
15 under Alternative 3 relative to the No Action Alternative generally would be
16 similar (less than 0.5°F differences) water temperatures under the No Action
17 Alternative during most months of the year (Appendix 6B, Table B-5-2). In
18 September, average water temperatures in wetter years could be increased by up
19 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature
20 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,
21 Bend Bridge, Red Bluff, Hamilton City, and Knights Landing, with average
22 monthly temperatures progressively increasing in the downstream direction
23 (e.g., average difference in September of about 9°F between Keswick Dam and
24 Knights Landing). The water temperature differences between Alternative 3 and
25 the No Action Alternative in September of wetter years would increase to as high
26 as 4.4°F warmer under Alternative 3 at Knight's Landing, while the differences in
27 water temperatures in September associated with Alternative 3 during drier years
28 would remain similar to upstream locations.

29 Overall, the water temperature differences between Alternative 3 and the No
30 Action Alternative would be relatively minor (less than 0.5°F) and likely would
31 have little effect on fall-run Chinook Salmon in the Sacramento River. The
32 increased water temperatures in September of wetter years under Alternative 3
33 could increase the likelihood of adverse effects on early spawning fall-run
34 Chinook Salmon during this water year type. The slightly lower water
35 temperatures in September of drier years under Alternative 3 would reduce the
36 likelihood of adverse effects on early spawning fall-run Chinook Salmon in the
37 Sacramento River as compared to the No Action Alternative.

38 *Clear Creek*

39 Average monthly water temperatures in Clear Creek at Igo under Alternative 3
40 would be similar to (less than 0.5°F differences) water temperatures under the No
41 Action Alternative with the exception of May when average monthly
42 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)
43 than the No Action Alternative (Appendix 6B, Table B-3-2). Alternative 32). As

1 described above for spring-run Chinook Salmon, the lower water temperatures in
2 May associated with the No Action Alternative reflect the effects of the additional
3 water that would be discharged from Whiskeytown Dam to meet the 2009 NMFS
4 BO RPA spring attraction flow requirements.

5 Under Alternative 3, temperature conditions at Igo would be similar to water
6 temperatures under the No Action Alternative. However, these temperature
7 outputs are at a location upstream of most fall-run Chinook Salmon spawning and
8 rearing in Clear Creek. Temperatures where fall-run Chinook Salmon inhabit the
9 creek would be somewhat higher as indicated by average monthly temperatures at
10 the confluence with the Sacramento River, although these temperatures would be
11 similar under Alternative 3 and the No Action Alternative. Overall, effects on
12 fall-run Chinook Salmon in Clear Creek due to temperature differences between
13 Alternative 3 and the No Action Alternative would be relatively minor.

14 *Feather River*

15 Average monthly water temperatures in the Feather River at the low flow channel
16 under the Alternative 3 relative generally would be similar (within 0.5°F) to water
17 temperatures under the No Action Alternative generally would be, except in
18 November and December (differences as much as 1.6°F lower in December in
19 below normal water years) (Appendix 6B, Table B-20-2). In September average
20 monthly water temperatures under Alternative 3 could be somewhat higher (up to
21 about 1.5°F) in wetter years than under the No Action Alternative. Although
22 temperatures in the river would become progressively higher in the downstream
23 direction, the differences between Alternative 3 and the No Action
24 Alternative would exhibit a similar pattern at the downstream locations (Robinson
25 Riffle and Gridley Bridge), with temperatures under Alternative 3 and the No
26 Action Alternative generally becoming more similar at the confluence with the
27 Sacramento River, except in September when water temperatures under
28 Alternative 3 could be up to 4.4 °F higher than under the No Action
29 Alternative and in June when temperatures under Alternative 3 could be up to
30 0.8°F cooler in drier years.

31 Overall, the temperature differences in the Feather River between Alternative 3
32 and the No Action Alternative would be relatively minor (less than 0.5°F) and
33 likely would have little effect on fall-run Chinook Salmon in the Feather River.
34 The somewhat lower water temperatures in November and December under
35 Alternative 3 would likely have little effect on fall-run Chinook Salmon as water
36 temperatures in the Feather River are typically low during this time period. The
37 somewhat higher water temperatures in September of wetter years may increase
38 the likelihood of adverse effects on early spawning fall-run Chinook Salmon in
39 these water year types.

40 *American River*

41 Long term average monthly water temperatures in the American River at Nimbus
42 Dam under Alternative 3 generally would be similar (differences less than 0.5°F)
43 to those under the No Action Alternative (Appendix 6B, Table B-12-2). This
44 pattern generally would persist downstream to Watt Avenue and the mouth

1 although the temperature differences between scenarios would increase in June
 2 and September (Appendix 6B, Tables b-13-2 and B-13-2 and B-14-2). In June
 3 water temperatures could be up to 0.7°F lower under Alternative 3 than under the
 4 No Action Alternative in some water year types. In September, average monthly
 5 water temperatures at the mouth generally would be higher under Alternative 3
 6 than under the No Action Alternative, especially in wetter water year types when
 7 the water temperatures under Alternative 3 could be up to 1.6°F warmer.

8 Overall, the temperature differences in the American River between Alternative 3
 9 and the No Action Alternative would be relatively minor (less than 0.5°F) and
 10 likely would have little effect on fall-run Chinook Salmon in the American River.
 11 The lower water temperatures in June under Alternative 3 may reduce the
 12 likelihood of adverse effects on fall-run Chinook Salmon rearing in the American
 13 River if they were present. Higher water temperatures during September under
 14 Alternative 3 would have little effect on fall-run Chinook Salmon spawning in the
 15 American River because most spawning occurs later in November.

16 *Changes in Exceedances of Water Temperature Thresholds*

17 Changes in water temperature could result in the exceedance of water
 18 temperatures that are protective of fall-run Chinook Salmon in the Sacramento
 19 River, Clear Creek, Feather River, and American River. The following describes
 20 the extent of those exceedances for each of those water bodies.

21 *Sacramento River*

22 Average monthly water temperatures under both Alternative and the No Action
 23 Alternative would show exceedances of the water temperature threshold of 56°F
 24 established in the Sacramento River at Red Bluff for fall-run Chinook Salmon
 25 (spawning and egg incubation) in October, November, and again in April. The
 26 exceedances would occur at the greatest frequency in October (78 percent of the
 27 time under Alternative 3). The water temperature threshold would be exceeded
 28 less frequently in November (8 percent of the time) and not exceeded at all during
 29 December through March under Alternative 3. As water temperatures warm in
 30 the spring, the threshold would be exceeded in April by 14 percent under
 31 Alternative 3. In the months when the greatest frequency of exceedances occur
 32 (October, November, and April), model results generally indicate that the
 33 threshold would be exceeded less frequently (by up to 4 percent in October) under
 34 Alternative 3 than under the No Action Alternative. Temperature conditions in
 35 the Sacramento River under Alternative 3 could be less likely to affect fall-run
 36 Chinook Salmon spawning and egg incubation than under the No Action
 37 Alternative because of the decreased frequency of exceedance of the 56°F
 38 threshold in October, November, and April.

39 *Clear Creek*

40 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during
 41 October through December (USFWS 2015). Average monthly water
 42 temperatures at Igo during this period generally remain below 56°F, except in
 43 October. Under Alternative 3, 56°F would be exceeded in October about
 44 10 percent of the time as compared to 12 percent under the No Action Alternative.

1 At the confluence with the Sacramento River, average monthly water
2 temperatures would be warmer, with 56°F exceeded about 15 percent of the time
3 under Alternative 3 and slightly more frequently under the No Action
4 Alternative (Appendix 6B, Figure B-4-1). During November and December,
5 average monthly water temperatures generally would remain below 56°F at both
6 locations. Temperature conditions in Clear Creek under Alternative 3 could be
7 less likely to affect fall-run Chinook Salmon spawning and egg incubation than
8 under the No Action Alternative because of the reduced frequency of exceedance
9 of the 56°F threshold in October.

10 For fall-run Chinook Salmon rearing (January through August), the exceedances
11 described previously for spring-run Chinook Salmon would apply, with the
12 average monthly temperatures remaining below the 60°F threshold in all months
13 Downstream at the mouth of Clear Creek, average monthly water temperatures
14 would exceed the 60°F threshold often during the summer, but the frequency of
15 exceedance would be similar under Alternative 3 and the No Action
16 Alternative (Appendix 6B Figures). Temperature conditions for fall-run Chinook
17 Salmon rearing in Clear Creek would be similar under Alternative 3 and the No
18 Action Alternative.

19 *Feather River*

20 Average monthly water temperatures under both Alternative 3 and the No Action
21 Alternative would exceed the water temperature threshold of 56°F established in
22 the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and
23 rearing during some months, particularly in October, November, March, and
24 April, when temperature thresholds would be exceeded frequently
25 (Appendix 9N). The frequency of exceedance would be greatest in October,
26 when average monthly temperatures under both Alternative 3 and the No Action
27 Alternative would be above the threshold in nearly every year. The magnitude of
28 the exceedances would be high as well, with average monthly temperatures in
29 October reaching about 68°F. Similarly, the threshold would be exceeded under
30 both alternatives about 85 percent of the time in April. However, water
31 temperatures under Alternative 3 could exceed temperature thresholds about
32 1-4 percent less frequently than under the No Action Alternative. Temperature
33 conditions in the Feather River under Alternative 3 could be less likely to affect
34 fall-run Chinook Salmon spawning and egg incubation than under the No Action
35 Alternative because of the reduced frequency of exceedance of the 56°F threshold
36 from October through April.

37 *Changes in Egg Mortality*

38 The analysis of fall-run Chinook Salmon included the application of the
39 Reclamation Salmon Survival Model. The following describes the differences in
40 egg mortality for the Sacramento, Feather, and American rivers based on the
41 model output.

1 *Sacramento River*

2 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg
3 mortality rate is predicted to be around 17 percent, with higher mortality rates (in
4 excess of 35 percent) occurring in critical dry years under Alternative 3. Overall,
5 egg mortality would be similar under Alternative 3 and the No Action Alternative in
6 all water year types (Appendix 9C, Table B-1).

7 *Feather River*

8 For fall-run Chinook Salmon in the Feather River, the long-term average egg
9 mortality rate is predicted to be relatively low (around 6 percent), with higher
10 mortality rates (around 14.6 percent) occurring in critical dry years under
11 Alternative 3. Overall, egg mortality would be similar under Alternative 3 and
12 the No Action Alternative in all water year types (Appendix 9C, Table B-7).

13 *American River*

14 For fall-run Chinook Salmon in the American River, the long-term average egg
15 mortality rate is predicted to range from approximately 22 to 25 percent in all
16 water year types under Alternative 3. Overall, egg mortality would be similar
17 under Alternative 3 and the No Action Alternative in all water year types
18 (Appendix 9C, Table B-6).

19 *Changes in Weighted Usable Area*

20 Weighted usable area, which is influenced by flow, is a measure of habitat
21 suitability. The following describes changes in WUA for fall-run Chinook
22 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

23 *Sacramento River*

24 As an indicator of the amount of suitable spawning habitat for fall-run Chinook
25 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
26 in general, there would be greater amounts of spawning habitat available from
27 September and November under Alternative 3 as compared to the No Action
28 Alternative; fall-run spawning WUA would be similar in October and December
29 (Appendix 9E, Table C-11-2). The increase in long-term average spawning WUA
30 in September under Alternative 3 (prior to the peak spawning period) would be
31 relatively large (around 20 percent), with a smaller increase in November (around
32 15 percent) which comprises the peak spawning period for fall-run Chinook
33 Salmon. Results for the reach from Battle Creek to Deer Creek show the same
34 pattern in changes in WUA for spawning fall-run Chinook Salmon between
35 Alternative 3 and the No Action Alternative (Appendix 9E, Table C-10-2).
36 Overall, spawning habitat availability could be increased under Alternative 3
37 relative to the No Action Alternative.

38 Modeling results indicate that, in general, there would be similar amounts of
39 suitable fry rearing habitat available from December to March under Alternative 3
40 (Appendix 9E, Table C-12-2). Similar to the results for fry rearing WUA,
41 modeling results indicate that, there would be similar amounts of suitable juvenile
42 rearing habitat available during the juvenile rearing period from February to June
43 (Appendix 9E, Table C-13-2).

1 *Clear Creek*

2 Flows in Clear Creek below Whiskeytown Dam are not anticipated to differ under
3 Alternative 3 relative to the No Action Alternative except in May due to the
4 release of spring attraction flows in accordance with the 2009 NMFS BO under
5 the No Action Alternative. Therefore, there would be no change in the amount of
6 potentially suitable spawning and rearing habitat for fall-run Chinook Salmon (as
7 indexed by WUA) available under Alternative 3 as compared to the No Action
8 Alternative.

9 *Feather River*

10 Flows in the low flow channel of the Feather River are not anticipated to differ
11 under Alternative 3 relative to the No Action Alternative. Therefore, there would
12 be no change in the amount of potentially suitable spawning habitat for fall-run
13 Chinook Salmon (as indexed by WUA) available under Alternative 3 as compared
14 to the No Action Alternative. The majority of spawning activity by fall-run
15 Chinook Salmon in the Feather River occurs in this reach with a lesser amount of
16 spawning occurring downstream of the Thermalito Complex.

17 Modeling results indicate that, in general, there would be greater amounts of
18 spawning habitat available in September under Alternative 3 as compared to the
19 No Action Alternative. The increase in long-term average spawning WUA during
20 September (prior to the peak spawning period) would be relatively large (around
21 30 percent), with similar amounts of spawning WUA for fall-run Chinook Salmon
22 predicted during other months. Overall, spawning habitat availability would be
23 somewhat similar under Alternative 3 relative to the No Action Alternative.

24 *American River*

25 Modeling results indicate that, in general, there would be similar amounts of
26 spawning habitat available for fall-run Chinook Salmon in the American River
27 from October to December under Alternative 3 as compared to the No Action
28 Alternative (Appendix 9E, Table C-25-2).

29 *Changes in SALMOD Output*

30 SALMOD results indicate that potential juvenile production would be similar
31 under Alternative 3 and the No Action Alternative, but up to 5 percent greater
32 under Alternative 3 in critical dry years.

33 *Changes in Delta Passage Model Output*

34 The Delta Passage Model predicted similar estimates of annual Delta survival
35 across the 81-year time period for fall-run Chinook Salmon between Alternative 3
36 and the No Action Alternative (Appendix 9J). Median Delta survival was
37 0.246 for Alternative 3 and 0.245 for the No Action Alternative.

38 *Changes in Delta Hydrodynamics*

39 Fall-run Chinook Salmon smolts are most abundant in the Delta during the
40 months of April, May and June. At the junction of Georgiana Slough and the
41 Sacramento River, the median proportion of positive velocities would be similar
42 in April, May and June under Alternative 3 and the No Action
43 Alternative (Appendix 9K). Near the confluence of the San Joaquin River and the

1 Mokelumne River, the median proportion of positive velocities would be slightly
2 lower under Alternative 3 relative to the No Action Alternative in April and May
3 and similar in June. On Old River downstream of the facilities, the median
4 proportion of positive velocities would be substantially lower in April and May
5 under Alternative 3 relative to the No Action Alternative, but would be only
6 moderately lower in June. In Old River upstream of the facilities, the median
7 proportion of positive velocities would be similar for Alternative 3 relative to the
8 No Action Alternative in June. In April and May, values for Alternative 3 would
9 be slightly higher under Alternative 3 relative to the No Action Alternative. On
10 the San Joaquin River downstream of the Head of Old River, the median
11 proportion of positive velocities would be similar under Alternative 3 relative to
12 the No Action Alternative in April, May, and June.

13 *Changes in Junction Entrainment*

14 The median entrainment at Georgiana Slough under Alternative 3 would be
15 slightly greater in June relative to the No Action Alternative (Appendix 9L). In
16 April and May, median entrainment would be almost identical under both
17 alternatives. At the Head of Old River junction, entrainment under Alternative 3
18 would be slightly higher in April, May, and June relative to the No Action
19 Alternative. Median entrainment into Turner Cut would be slightly greater under
20 Alternative 3 during April, and May and similar in June. At the Columbia Cut
21 junction, entrainment would be moderately higher under Alternative 3 during
22 April and May, whereas entrainment would be slightly higher in June.
23 Entrainment probabilities at the Middle River junction from April through June
24 would be moderately greater under Alternative 3 relative to the No Action
25 Alternative. A similar pattern would be observed at the Old River junction.

26 *Changes in Salvage*

27 Salvage of Sacramento River-origin Chinook Salmon is predicted to be similar
28 under Alternative 3 and No Action Alternative in every month except April, May,
29 and June (Appendix 9M). Fall-run Chinook Salmon smolts migrating through the
30 Delta would be most susceptible in the months of April, May, and June.
31 Predicted values in April and May indicated a substantially increased fraction of
32 fish salvaged under Alternative 3 relative to the No Action Alternative and a
33 moderately increased fraction salvaged in June under Alternative 3.

34 *Summary of Effects on Fall-Run Chinook Salmon*

35 The multiple model and analysis outputs described above characterize the
36 anticipated conditions for fall-run Chinook Salmon and their response to change
37 under Alternative 3 and the No Action Alternative. For the purpose of analyzing
38 effects on fall-run Chinook Salmon in the Sacramento River, greater reliance was
39 placed on the outputs from the SALMOD model because it integrates the
40 available information on temperature and flows to produce estimates of mortality
41 for each life stage and an overall, integrated estimate of potential fall-run Chinook
42 Salmon juvenile production. The output from SALMOD indicated that fall-run
43 Chinook Salmon production would be similar in most water year types under
44 Alternative 3 and the No Action Alternative, but up to 5 percent greater under
45 Alternative 3 than under the No Action Alternative in critical dry years.

1 The analyses attempting to assess the effects on routing, entrainment, and salvage
2 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
3 potential losses of juvenile salmon at the export facilities) of Sacramento
4 River-origin Chinook Salmon is predicted to be greater under Alternative 3
5 relative to the No Action Alternative.

6 In Clear Creek and the Feather and American rivers, the analysis of the effects of
7 Alternative 3 and the No Action Alternative for fall-run Chinook Salmon relied
8 on the WUA analysis for habitat and water temperature model output for the
9 rivers at various locations downstream of the CVP and SWP facilities. The WUA
10 analysis indicated that the availability of spawning and rearing habitat in Clear
11 Creek and spawning habitat in the Feather and American rivers would be similar
12 under Alternative 3 and the No Action Alternative. The temperature model
13 outputs for each of the fall-run Chinook Salmon life stages suggest that thermal
14 conditions and effects on fall-run Chinook Salmon in all of these streams
15 generally would be similar under both scenarios. The water temperature threshold
16 exceedance analysis that indicated that the water temperature thresholds for
17 fall-run Chinook Salmon spawning and egg incubation would be exceeded
18 slightly less frequently in the Feather River and Clear Creek under Alternative 3
19 and could reduce the potential for adverse effects on the fall-run Chinook Salmon
20 populations in Clear Creek and the Feather River. Results of the analysis using
21 Reclamation's salmon mortality model indicate that there would be slightly
22 reduced fall-run Chinook Salmon egg mortality in the Feather River under
23 Alternative 3 compared to the No Action Alternative.

24 These model results suggest that overall, effects on fall-run Chinook Salmon
25 could be slightly less adverse under Alternative 3 than the No Action Alternative.
26 This potential distinction between the two scenarios, however, may be partially
27 offset by the benefits of implementation of fish passage under the No Action
28 Alternative intended to address the limited availability of suitable habitat for
29 winter-run and spring-run Chinook Salmon in the Sacramento River reaches
30 downstream of Keswick Dam. This potential benefit, however, would only apply
31 if passage is provided for fall-run Chinook Salmon that allows access to
32 additional habitat. In addition, RPA actions under the No Action
33 Alternative intended to increase the efficiency of the Tracy and Skinner Fish
34 Collection Facilities could improve the overall salvage survival of fall-run
35 Chinook Salmon. The ocean harvest restriction component of Alternative 3 could
36 increase fall-run Chinook Salmon numbers by reducing ocean harvest and the trap
37 and haul program and predator control measures under Alternative 3 could reduce
38 predation on juvenile fall-run Chinook Salmon and thereby increase survival.

39 Overall, the results of the numerical models suggest the potential for less adverse
40 effects on fall-run Chinook Salmon under Alternative 3 as compared to the No
41 Action Alternative. However, discerning a meaningful difference between these
42 two scenarios based on the quantitative results is not possible because of the
43 similarity in results (generally differences less than 5 percent) and the inherent
44 uncertainty of the models. In addition, adverse effects of the No Action
45 Alternative could be offset by the potentially beneficial effects resulting from the

1 RPA actions evaluated qualitatively for the No Action Alternative. Adverse
2 effects of Alternative 3 could be offset by the potentially beneficial effects
3 resulting from predator control and ocean harvest restrictions. Thus, it is
4 concluded that the effects on fall-run Chinook Salmon would be similar under
5 Alternative 3 and the No Action Alternative.

6 *Late Fall-Run Chinook Salmon*

7 Changes in operations that influence temperature and flow conditions in the
8 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook
9 Salmon. The following describes those changes and their potential effects.

10 *Changes in Water Temperature*

11 Average monthly water temperature in the Sacramento River at Keswick Dam
12 under Alternative 3 relative to the No Action Alternative generally would be
13 similar to (less than 0.5°F differences) water temperatures under the No Action
14 Alternative during most months of the year (Appendix 6B, Table B-5-2). In
15 September, average water temperatures in wetter years could be increased by up
16 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature
17 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,
18 Bend Bridge, Red Bluff, Hamilton City, and Knights Landing, with average
19 monthly temperatures progressively increasing in the downstream direction
20 (e.g., average difference in September of about 9°F between Keswick Dam and
21 Knights Landing). The temperature differences between Alternative 3 and the No
22 Action Alternative in September of wetter years would increase to as high as
23 4.4°F warmer under Alternative 3 at Knight's Landing, while the differences in
24 water temperatures in September associated with Alternative 3 during drier years
25 would remain similar to upstream locations.

26 Overall, the temperature differences between Alternative 3 and the No Action
27 Alternative would be relatively minor (less than 0.5°F) and likely would have
28 little effect on late fall-run Chinook Salmon in the Sacramento River. The
29 likelihood of adverse effects on late fall-run Chinook Salmon spawning and egg
30 incubation would be similar under Alternative 3 and the No Action
31 Alternative due to similar water temperatures during the January to May time
32 period. Because late fall-run Chinook Salmon have an extended rearing period,
33 the similar water temperatures during the summer under Alternative 3 and the No
34 Action Alternative would have similar effects on rearing fry and juvenile late fall-
35 run Chinook Salmon in the Sacramento River. The slightly higher water
36 temperatures under Alternative 3 in September of wetter years may increase the
37 likelihood of adverse effects on fry and juvenile late fall-run Chinook Salmon
38 rearing in the Sacramento River during this limited time period.

39 *Changes in Exceedances of Water Temperature Thresholds*

40 Average monthly water temperatures under both Alternative and the No Action
41 Alternative would show exceedances of the water temperature threshold of 56°F
42 established in the Sacramento River at Red Bluff for Chinook Salmon (spawning
43 and egg incubation) in October, November, and again in April. The exceedances
44 would occur at the greatest frequency in October (78 percent of the time under

1 Alternative 3). The water temperature threshold would be exceeded less
2 frequently in November (8 percent of the time) and not exceeded at all during
3 December through March under Alternative 3. As water temperatures warm in
4 the spring, the threshold would be exceeded in April by 14 percent under
5 Alternative 3. In the months when the greatest frequency of exceedances occur
6 (October, November, and April), model results generally indicate that the
7 threshold would be exceeded less frequently (by up to 4 percent in October) under
8 Alternative 3 than under the No Action Alternative. Temperature conditions in
9 the Sacramento River under Alternative 3 could be less likely to affect late fall-
10 run Chinook Salmon spawning and egg incubation than under the No Action
11 Alternative because of the decreased frequency of exceedance of the 56°F
12 threshold in October, November, and April.

13 *Changes in Egg Mortality*

14 For late fall-run Chinook Salmon in the Sacramento River, the long-term average
15 egg mortality rate is predicted to range from approximately 1.8 to nearly 5 percent
16 in all water year types under Alternative 3. Overall, egg mortality would be
17 similar under Alternative 3 and the No Action Alternative (Appendix 9C,
18 Table B-2) in all water year types.

19 *Changes in Weighted Usable Area*

20 Modeling results indicate that there would be similar amounts of spawning habitat
21 available for late fall-run Chinook Salmon in the Sacramento River from January
22 through April under Alternative 3 as compared to the No Action
23 Alternative (Appendix 9E, Table C-14-4).

24 Modeling results indicate that, in general, there would be similar amounts of
25 suitable late fall-run Chinook Salmon fry rearing habitat available during April
26 and May under Alternative 3 and the No Action Alternative (Appendix 9E,
27 Table C-15-4).

28 A substantial fraction of late fall run Chinook Salmon juveniles overwinter in
29 the Sacramento River before emigrating, which allows them to avoid predation
30 through both their larger size and greater swimming ability. One implication of
31 this life history strategy is that rearing habitat is most likely the limiting factor for
32 late-fall-run Chinook Salmon, especially if availability of cool water determines
33 the downstream extent of spawning habitat for late-fall-run salmon. Modeling
34 results indicate that, there would generally be similar amounts of suitable juvenile
35 rearing habitat available from December through August under Alternative 3 and
36 the No Action Alternative. There could an increase in the amount of late fall-run
37 Chinook Salmon juvenile rearing WUA in September and November of up to
38 nearly 10 percent (Appendix 9E, Table C-16-4). Overall, late fall-run juvenile
39 rearing habitat availability would be similar under Alternative 3 and the No
40 Action Alternative.

41 *Changes in SALMOD Output*

42 SALMOD results indicate that potential juvenile production would be the same
43 under Alternative 3 and the No Action Alternative (Appendix 9D, Table B-2-6).

1 *Changes in Delta Passage Model Output*

2 For late fall-run Chinook Salmon, Delta survival was predicted to be slightly
3 lower for Alternative 3 versus the No Action Alternative for all 81 years
4 simulated by the Delta Passage Model (Appendix 9J). Median Delta survival
5 across all years was 0.199 for Alternative 3 and 0.244 for the No Action
6 Alternative.

7 *Changes in Delta Hydrodynamics*

8 The late fall-run Chinook Salmon migration period overlaps with the winter-run.
9 See the section on hydrodynamic analysis for winter-run Chinook Salmon for
10 potential effects on late fall-run Chinook Salmon.

11 *Changes in Junction Entrainment*

12 Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic
13 that of winter-run Chinook Salmon due to the overlap in timing. See the section
14 on winter-run Chinook Salmon entrainment for potential effects on late fall-run
15 Chinook Salmon.

16 *Changes in Salvage*

17 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run
18 Chinook Salmon due to the overlap in timing. See the section on winter-run
19 Chinook Salmon entrainment for potential effects on late fall-run Chinook
20 Salmon.

21 *Summary of Effects on Late Fall-Run Chinook Salmon*

22 The multiple model and analysis outputs described above characterize the
23 anticipated conditions for late fall-run Chinook Salmon and their response to
24 change under Alternative 3 and the No Action Alternative. For the purpose of
25 analyzing effects on late fall-run Chinook Salmon and developing conclusions,
26 greater reliance was placed on the outputs from the SALMOD model because it
27 integrates the available information on temperature and flows to produce
28 estimates of mortality for each life stage and an overall, integrated estimate of
29 potential fall-run Chinook Salmon juvenile production. The output from
30 SALMOD indicated that late fall-run Chinook Salmon production would be
31 similar under Alternative 3 and the No Action Alternative.

32 The analyses attempting to assess the effects on routing, entrainment, and salvage
33 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
34 potential losses of juvenile salmon at the export facilities) of Sacramento
35 River-origin Chinook Salmon is predicted to be similar under Alternative 3
36 relative to the No Action Alternative. Actions under the No Action
37 Alternative intended to increase the efficiency of the Tracy and Skinner Fish
38 Collection Facilities could improve the overall salvage survival of late fall-run
39 Chinook Salmon.

40 Overall, the results of the numerical models suggest that potential effects on late
41 fall-run Chinook Salmon would be similar for Alternative 3 and the No Action
42 Alternative. Discerning a meaningful difference between these two scenarios
43 based on the quantitative results is not possible because of the similarity in results

1 (generally differences less than 5 percent) and the inherent uncertainty of the
2 models. Because fish passage under the No Action Alternative is not expected to
3 directly benefit late fall-run Chinook Salmon, the non-operational actions
4 intended to benefit salmonids under both alternatives are expected to balance.
5 Thus, it is concluded that the effects on late fall-run Chinook Salmon would be
6 similar under Alternative 3 and the No Action Alternative.

7 *Steelhead*

8 Changes in operations that influence temperature and flow conditions that could
9 affect steelhead. The following describes those changes and their potential
10 effects.

11 *Changes in Water Temperature*

12 Changes in water temperature could affect steelhead in the Sacramento, Feather,
13 and American rivers, and Clear Creek. The following describes temperature
14 conditions in those water bodies.

15 *Sacramento River*

16 Average monthly water temperature in the Sacramento River at Keswick Dam
17 under Alternative 3 relative to the No Action Alternative generally would be
18 similar (less than 0.5°F differences) water temperatures under the No Action
19 Alternative during most months of the year (Appendix 6B, Table B-5-2). In
20 September, average water temperatures in wetter years could be increased by up
21 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature
22 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,
23 Bend Bridge, and Red Bluff, with average monthly temperatures progressively
24 increasing in the downstream direction (e.g., average difference of about 3°F
25 between Keswick Dam and Red Bluff). The water temperature differences
26 between Alternative 3 and the No Action Alternative in September of wetter years
27 would increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while
28 the differences in water temperatures in September associated with Alternative 3
29 during drier years would remain similar to upstream locations.

30 Overall, the water temperature differences between Alternative 3 and the No
31 Action Alternative would be relatively (less than 0.5°F) minor and likely would
32 have little effect on steelhead in the Sacramento River. The increased water
33 temperatures in September of wetter years under Alternative 3 could increase the
34 likelihood of adverse effects on migrating adult steelhead during this water year
35 type. The slightly lower water temperatures in September of drier years under
36 Alternative 3 could reduce the likelihood of adverse effects on migrating adult
37 steelhead during drier years as compared to the No Action Alternative.

38 *Clear Creek*

39 Average monthly water temperatures in Clear Creek at Igo under Alternative 3
40 would be similar to (less than 0.5°F differences) water temperatures under the No
41 Action Alternative with the exception of May when average monthly
42 temperatures under Alternative 3 would be somewhat higher (up to about 0.8°F)
43 than the No Action Alternative. As described above for spring-run Chinook

1 Salmon, the lower water temperatures in May associated with the No Action
2 Alternative reflect the effects of the additional water that would be discharged
3 from Whiskeytown Dam to meet the 2009 NMFS BO RPA spring attraction flow
4 requirements. Overall, thermal conditions for steelhead in Clear Creek would be
5 similar under Alternative 3 and the No Action Alternative.

6 *Feather River*

7 Average monthly water temperatures in the Feather River at the low flow channel
8 under the Alternative 3 relative generally would be similar (within 0.5°F) to water
9 temperatures under the No Action Alternative except in November and December
10 (differences as much as 1.6°F in December in below normal water years)
11 (Appendix 6B, Table B-20-2). In September average monthly water temperatures
12 under Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years
13 than under the No Action Alternative. Although temperatures in the river would
14 become progressively higher in the downstream direction, the differences between
15 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the
16 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures
17 under Alternative 3 and the No Action Alternative generally becoming more
18 similar among months at the confluence with the Sacramento River, except in
19 September when water temperatures under Alternative 3 could be up to 4.4 °F
20 higher than under the No Action Alternative and in June when temperatures under
21 Alternative 3 could be up to 0.8°F cooler in drier years.

22 Overall, the temperature differences in the Feather River between Alternative 3
23 and the No Action Alternative would be relatively minor (less than 0.5°F) and
24 likely would have little effect on steelhead in the Feather River. The somewhat
25 higher water temperatures in September of wetter years may increase the
26 likelihood of adverse effects on migrating adult steelhead during this water year
27 type. The somewhat lower water temperatures in in November and December
28 under Alternative 3 also could reduce the likelihood of adverse effects on
29 steelhead adults migrating upstream and juveniles migrating downstream in the
30 Feather River as compared to the No Action Alternative.

31 *American River*

32 Long term average monthly water temperatures in the American River at Nimbus
33 Dam under Alternative 3 generally would be similar (differences less than 0.5°F)
34 to those under the No Action Alternative (Appendix 6B, Table B-12-2). This
35 pattern generally would persist downstream to Watt Avenue and the mouth,
36 although the temperature differences between scenarios would increase in June
37 and September (Appendix 6B, Tables B-13-2 and B-13-2 and B-14-2). In June
38 water temperatures could be up to 0.7°F lower under Alternative 3 than under the
39 No Action Alternative in some water year types. In September, average monthly
40 water temperatures at the mouth generally would be higher under Alternative 3
41 than under the No Action Alternative, especially in wetter water year types when
42 the water temperatures under Alternative 3 could be up to 1.6°F warmer.

1 Overall, the temperature differences between Alternative 3 and the No Action
2 Alternative would be minor (less than 0.5°F) and likely would have little effect on
3 steelhead in the American River. The somewhat higher water temperatures in
4 September of wetter years may increase the likelihood of adverse effects on
5 migrating adult steelhead during this water year type. The cooler water
6 temperatures in June under Alternative 3 may reduce the likelihood of adverse
7 effects on steelhead rearing in the American River compared to the No Action
8 Alternative.

9 *Changes in Exceedances of Water Temperature Thresholds*

10 Changes in water temperature could result in the exceedance of established water
11 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and
12 Feather River. The following describes the extent of those exceedance for each of
13 those streams.

14 *Sacramento River*

15 As described in the life history accounts, steelhead spawning in the mainstem
16 Sacramento River generally occurs in the upper reaches from Keswick Dam
17 downstream to near Balls Ferry, with most spawning concentrated near Redding.
18 Most steelhead, however, spawn in tributaries to the Sacramento River.
19 Spawning generally takes place in the January through March period when water
20 temperatures in the river generally do not exceed 52°F under either Alternative 3
21 or the No Action Alternative. While there are no established temperature
22 thresholds for steelhead rearing in the mainstem Sacramento River, average
23 monthly temperatures when fry and juvenile steelhead are in the river would
24 generally remain below 56°F at Balls Ferry except in August and September
25 when this temperature would be exceeded 30 to 40 percent of the time under both
26 Alternative 3 and the No Action Alternative. However, water temperatures in the
27 Sacramento River at Balls Ferry would exceed 56°F about 10 percent more often
28 in September under Alternative 3. Overall, thermal conditions for steelhead in the
29 Sacramento River would be more likely to result in adverse effects on steelhead
30 under Alternative 3 than under the No Action Alternative because of the increased
31 frequency of exceedance of 56°F in September.

32 *Clear Creek*

33 While there are no established temperature thresholds for steelhead spawning in
34 Clear Creek, average monthly water temperatures in the river generally would not
35 exceed 49°F during the spawning period (December to April) under Alternative 3
36 and the No Action Alternative. Similarly, while there are no established
37 temperature thresholds for steelhead rearing in Clear Creek, average monthly
38 temperatures in most months of the year would not exceed 56°F at Igo under both
39 alternatives. Overall, thermal conditions for steelhead in Clear Creek would be
40 similar under Alternative 3 and the No Action Alternative.

41 *Feather River*

42 Average monthly water temperatures in the Feather River at Robinson Riffle
43 would on occasion exceed the water temperature threshold of 56°F established for
44 steelhead spawning and incubation during some months, particularly in October

1 and November, and March and April, when temperature thresholds could be
2 exceeded frequently (Appendix 9N). There would be a 1 percent exceedance of
3 the 56°F threshold in December under the No Action Alternative and no
4 exceedances of the 56°F threshold from December through February under
5 Alternative 3. However, the differences in the frequency of exceedance between
6 Alternative 3 and No Action Alternative during March and April would be
7 relatively small with water temperatures under Alternative 3 exceeding the
8 threshold about 1 percent more frequently in March (19 percent) and the same
9 exceedance frequency (75 percent) as the No Action Alternative in April.

10 The established water temperature threshold of 63°F for rearing during May
11 through August would be exceeded often under both Alternative 3 and the No
12 Action Alternative in May and June, but not at all in July and August. Water
13 temperatures under Alternative 3 would exceed the rearing temperature threshold
14 about 5 percent less frequently than under the No Action Alternative in May, but
15 no more frequently in June. Temperature conditions in the Feather River under
16 Alternative 3 could be less likely to affect steelhead spawning and rearing than
17 under the No Action Alternative because of the reduced frequency of exceedance
18 of the spawning and rearing thresholds.

19 *American River*

20 In the American River, the water temperature threshold for steelhead rearing
21 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly
22 water temperatures would exceed this threshold often under both Alternative 3
23 and the No Action Alternative, especially in the July through September period
24 when the threshold is exceeded nearly all of the time. In addition, the magnitude
25 of the exceedance would be high, with average monthly water temperatures
26 sometimes higher than 76°F. The differences between Alternative 3 and No
27 Action Alternative, however, would be relatively small (differences within
28 2 percent), except in September, when water temperatures under Alternative 3
29 would exceed 65°F about 7 percent more frequently than under the No Action
30 Alternative. Temperature conditions in the American River under Alternative 3
31 could be more likely to affect steelhead rearing than under the No Action
32 Alternative because of the increased frequency of exceedance of the 65°F rearing
33 threshold.

34 *Changes in Weighted Usable Area*

35 The following describes changes in WUA for steelhead in the Sacramento,
36 Feather, and American rivers and Clear Creek.

37 *Sacramento River*

38 Modeling results indicate that, in general, there would be similar amounts of
39 suitable steelhead spawning habitat available from December through March
40 under Alternative 3 as compared to the No Action Alternative (Appendix 9E,
41 Table C-20-2).

1 *Clear Creek*

2 Flows in Clear Creek below Whiskeytown Dam are not anticipated to differ under
3 Alternative 3 relative to the No Action Alternative except in May due to the
4 release of spring attraction flows in accordance with the 2009 NMFS BO under
5 the No Action Alternative. Therefore, there would be no change in the amount of
6 potentially suitable spawning and rearing habitat for steelhead (as indexed by
7 WUA) available under Alternative 3 as compared to the No Action Alternative.

8 *Feather River*

9 Flows in the low flow channel of the Feather River are not anticipated to differ
10 under Alternative 3 relative to the No Action Alternative. Therefore, there would
11 be no change in the amount of potentially suitable spawning habitat for steelhead
12 (as indexed by WUA) available under Alternative 3 as compared to the No Action
13 Alternative. The majority of spawning activity by steelhead in the Feather River
14 occurs in this reach with a lesser amount of spawning occurring downstream of
15 the Thermalito Complex.

16 Modeling results indicate that, in general, there would be similar amounts of
17 spawning habitat for steelhead in the Feather River below Thermalito available
18 from December through April under Alternative 3 and the No Action Alternative.

19 *American River*

20 Modeling results indicate that, in general, there would be similar amounts of
21 spawning habitat for steelhead in the American River downstream of Nimbus
22 Dam available from December through April under Alternative 3 and the No
23 Action Alternative.

24 *Summary of Effects on Steelhead*

25 The multiple model and analysis outputs described above characterize the
26 anticipated conditions for steelhead and their response to change under
27 Alternative 3 and the No Action Alternative. The analysis of the effects of
28 Alternative 3 and the No Action Alternative for steelhead relied on the WUA
29 analysis for habitat and water temperature model output for the rivers at various
30 locations downstream of the CVP and SWP facilities. The WUA analysis
31 indicated that the availability of steelhead spawning and rearing habitat in Clear
32 Creek and steelhead spawning habitat in the Sacramento, Feather and American
33 rivers would be similar under Alternative 3 and the No Action Alternative. The
34 temperature model outputs for each of the steelhead life stages suggest that
35 thermal conditions and effects on steelhead could be slightly less adverse for
36 some life stages in various rivers under Alternative 3. This conclusion is
37 supported by the water temperature threshold exceedance analysis that indicated
38 that the water temperature thresholds for steelhead spawning and egg incubation
39 would be exceeded less frequently in the Feather River under Alternative 3. The
40 water temperature threshold for steelhead rearing would also be exceeded less
41 frequently in the Feather River. However, the water temperature threshold for
42 steelhead rearing in the American River would be exceeded more frequently
43 under Alternative 3 than under the No Action Alternative. The reduced frequency
44 of exceedance of temperature thresholds under Alternative 3 could reduce the
45 potential for adverse effects on the steelhead population in the Feather River

1 while the increased frequency of exceedance could increase the likelihood of
2 adverse effects on steelhead rearing in the American River.

3 These model results suggest that overall, effects on steelhead could be slightly
4 less adverse under Alternative 3 than the No Action Alternative, particularly in
5 the Feather River. Implementation of the fish passage program under the No
6 Action Alternative intended to address the limited availability of suitable habitat
7 for steelhead in the Sacramento and American river could provide a benefit to
8 Central Valley steelhead in the Sacramento and American rivers. This is
9 particularly important in light of anticipated increases in water temperature
10 associated with climate change in 2030. In addition to fish passage, preparation
11 and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and
12 actions under the No Action Alternative intended to increase the efficiency of the
13 Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No
14 Action Alternative in comparison to Alternative 3. Thus, on balance and over the
15 long term, the adverse effects on steelhead under Alternative 3 would be greater
16 than those under the No Action Alternative.

17 *Green Sturgeon*

18 The effects on Green Sturgeon were analyzed by comparing changes in water
19 temperature and the frequency of temperature threshold exceedance between
20 Alternative 3 and the No Action Alternative. In addition, potential effects on
21 Green Sturgeon during the Delta portion of their life cycle were evaluated based
22 on changes in Delta outflow. The effects are described and summarized below.

23 *Changes in Water Temperature*

24 Changes in water temperature could affect Green Sturgeon in the Sacramento and
25 Feather rivers. The following describes temperature conditions in those water
26 bodies.

27 *Sacramento River*

28 Average monthly water temperature in the Sacramento River at Keswick Dam
29 under Alternative 3 relative to the No Action Alternative generally would be
30 similar (less than 0.5°F differences) water temperatures under the No Action
31 Alternative during most months of the year (Appendix 6B, Table B-5-2). In
32 September, average water temperatures in wetter years could be increased by up
33 to 0.8°F and decreased by up to 1.2°F in critical years. A similar temperature
34 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,
35 Bend Bridge, and Red Bluff, with average monthly temperatures progressively
36 increasing in the downstream direction (e.g., average difference of about 3°F
37 between Keswick Dam and Red Bluff). The temperature differences between
38 Alternative 3 and the No Action Alternative in September of wetter years would
39 increase to as high as 3.0°F warmer under Alternative 3 at Red Bluff, while the
40 differences in water temperatures in September associated with Alternative 3
41 during drier years would remain similar to upstream locations.

42 Overall, the temperature differences between Alternative 3 and the No Action
43 Alternative would be relatively minor (less than 0.5°F). The similar water
44 temperatures during most months suggest that temperature-related effects on

1 Green Sturgeon would likely be similar under Alternative 3 and the No Action
2 Alternative.

3 *Feather River*

4 Average monthly water temperatures in the Feather River at the low flow channel
5 under the Alternative 3 relative generally would be similar (within 0.5°F) to water
6 temperatures under the No Action Alternative except in November and December
7 (differences as much as 1.6°F in December in below normal water years)
8 (Appendix 6B, Table B-20-2). In September average monthly water temperatures
9 under Alternative 3 could be somewhat higher (up to about 1.5°F) in wetter years
10 than under the No Action Alternative. Although temperatures in the river would
11 become progressively higher in the downstream direction, the differences between
12 Alternative 3 and the No Action Alternative would exhibit a similar pattern at the
13 downstream locations (Robinson Riffle and Gridley Bridge), with temperatures
14 under Alternative 3 and the No Action Alternative generally becoming more
15 similar at the confluence with the Sacramento River, except in September when
16 the water temperature under Alternative 3 could be up to 4.4 °F higher than under
17 the No Action Alternative and in June when temperatures under Alternative 3
18 could be up to 0.8°F cooler in drier years.

19 Overall, the temperature differences between Alternative 3 and the No Action
20 Alternative would be relatively minor (less than 0.5°F). The similar water
21 temperatures during most months suggest that temperature-related effects on
22 Green Sturgeon would likely be similar under Alternative 3 and the No Action
23 Alternative. The somewhat higher water temperatures in September under
24 Alternative 3 could affect spawning by Green Sturgeon in the Feather River.

25 *Changes in Exceedances of Water Temperature Thresholds*

26 Changes in water temperature could result in the exceedance of established water
27 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.
28 The following describes the extent of those exceedance for each of those rivers.

29 *Sacramento River*

30 Average monthly water temperatures in the Sacramento River at Bend Bridge
31 under both Alternative 3 and the No Action Alternative would exceed the water
32 temperature threshold of 63°F established for Green Sturgeon larval rearing in
33 August and September, with exceedances under Alternative 3 occurring about
34 6 percent of the time in August relative the No Action Alternative (7 percent), and
35 about 9 percent of the time in September relative to 12 percent under the No
36 Action Alternative. Average monthly water temperatures at Bend Bridge could
37 be as high as about 73°F during this period. Temperature conditions in the
38 Sacramento River under Alternative 3 could be less likely to affect Green
39 Sturgeon rearing than under the No Action Alternative because of the reduced
40 frequency of exceedance of the 63°F threshold in August and September.

1 *Feather River*

2 Average monthly water temperatures in the Feather River at Gridley Bridge under
3 both Alternative 3 and the No Action Alternative would exceed the water
4 temperature threshold of 64°F established for Green Sturgeon spawning,
5 incubation, and rearing in May, June, and September; no exceedances under either
6 condition would occur in July and August. The frequency of exceedances would
7 be high, with both Alternative 3 and the No Action Alternative exceeding the
8 threshold in June nearly 100 percent of the time. The magnitude of the
9 exceedance also would be substantial, with average monthly temperatures higher
10 than 72°F in June, and higher than 75°F in July and August. Water temperatures
11 under Alternative 3 would exceed the threshold for May about 7 percent less
12 frequently than the No Action Alternative and about 33 percent more frequently
13 in September. Temperature conditions in the Feather River under Alternative 3
14 could be less likely to result in adverse effects on Green Sturgeon rearing than
15 under the No Action Alternative because of the reduced frequency of exceedance
16 of the 64°F threshold in May. The increase in exceedance frequency in
17 September under Alternative 3 may have little effect on rearing Green Sturgeon as
18 many juvenile sturgeon may have migrated downstream to the lower Sacramento
19 River and Delta by this time.

20 *Changes in Delta Outflow*

21 As described in Appendix 9P, mean (March to July) Delta outflow was used an
22 indicator of potential year class strength and the likelihood of producing a strong
23 year class of sturgeon. The median value over the 82-year CalSim II modeling
24 period of mean (March to July) Delta outflow was predicted to be 9 percent lower
25 under the Alternative 3 than under the No Action Alternative. In addition, the
26 likelihood of mean (March to July) Delta outflow exceeding the threshold of
27 50,000 cfs was the same under both alternatives.

28 *Summary of Effects on Green Sturgeon*

29 The analysis of the effects of Alternative 3 and the No Action Alternative for
30 Green Sturgeon relied on water temperature model output for the Sacramento and
31 Feather rivers at various locations downstream of Shasta Dam and the Thermalito
32 complex. The temperature model outputs for each of these rivers suggest that
33 thermal conditions and effects on Green Sturgeon in the Sacramento and Feather
34 rivers generally would be slightly less adverse under Alternative 3. This
35 conclusion is supported by the water temperature threshold exceedance analysis
36 that indicated that the water temperature thresholds for Green Sturgeon spawning,
37 incubation, and rearing would be exceeded less frequently under Alternative 3 in
38 the Sacramento River. The water temperature threshold for Green Sturgeon
39 spawning, incubation, and rearing would also be exceeded less frequently during
40 some months in the Feather River but would be exceeded substantially more
41 frequently in September under Alternative 3 and could increase the potential for
42 adverse effects on Green Sturgeon in the Sacramento and Feather rivers relative to
43 the No Action Alternative. The analysis based on Delta outflows suggests that
44 Alternative 3 provides lower mean (March to July) outflows which could result in
45 weaker year classes of juvenile Green Sturgeon relative to the No Action

1 Alternative. In addition, actions under the No Action Alternative intended to
2 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could
3 improve the overall salvage survival of green sturgeon. However, early life stage
4 survival in the natal rivers is crucial in development of a strong year class.
5 Therefore, based primarily on the analysis of water temperatures, Alternative 3
6 could be less likely to result in adverse effects on Green Sturgeon than the No
7 Action Alternative.

8 *White Sturgeon*

9 Changes in water temperature conditions in the Sacramento and Feather rivers
10 would be the same as those described above for Green Sturgeon. Overall, the
11 temperature differences between Alternative 3 and the No Action
12 Alternative would be relatively minor (less than 0.5°F) and likely would have
13 little effect on White Sturgeon in the Sacramento and Feather rivers.

14 The water temperature threshold established for White Sturgeon spawning and
15 egg incubation in the Sacramento River at Hamilton City is 61°F during March
16 through June. Both Alternative 3 and the No Action Alternative would exceed
17 this threshold in May and June. The average monthly water temperatures in May
18 under Alternative 3 would exceed this threshold about 49 percent of the time
19 (about 6 percent less frequently than the No Action Alternative). In June, the
20 temperature under Alternative 3 would exceed the threshold about 74 percent of
21 the time (about 13 percent less frequently than the No Action Alternative).
22 Average monthly water temperatures during May and June under Alternative 3
23 would as high as about 65°F, which is below the 68°F threshold considered lethal
24 for White Sturgeon eggs. Temperature conditions in the Sacramento River under
25 Alternative 3 could be less likely to result in adverse effects on White Sturgeon
26 rearing than under the No Action Alternative because of the reduced frequency of
27 exceedance of the 61°F threshold in May and June.

28 The analysis of the effects of Alternative 3 and the No Action Alternative for
29 White Sturgeon relied on water temperature model output for the Sacramento
30 River at various locations downstream of Shasta Dam. The temperature model
31 outputs suggest that thermal conditions and effects on White Sturgeon in the
32 Sacramento River generally would be less adverse under Alternative 3. This
33 conclusion is supported by the water temperature threshold exceedance analysis
34 that indicated that the water temperature thresholds for White Sturgeon spawning,
35 incubation, and rearing would be exceeded less frequently under Alternative 3 in
36 the Sacramento River. The reduced frequency of exceedance of water
37 temperature thresholds under Alternative 3 could reduce the potential for adverse
38 effects on White Sturgeon in the Sacramento River relative to the No Action
39 Alternative.

40 Changes in Delta outflows would be the same as those described above for Green
41 Sturgeon. Mean (March to July) Delta outflow was predicted to be 9 percent
42 lower under Alternative 3 than under the No Action Alternative. In addition, the
43 likelihood of mean (March to July) Delta outflow exceeding the threshold of
44 50,000 cfs was the same under both alternatives.

1 Overall, the temperature model outputs suggest that thermal conditions and
2 effects on White Sturgeon in the Sacramento River generally would be slightly
3 less adverse under Alternative 3. The analysis based on Delta outflows suggests
4 that Alternative 3 provides lower mean (March to July) outflows which could
5 result in weaker year classes of juvenile Green Sturgeon relative to the No Action
6 Alternative. However, early life stage survival in the natal rivers is crucial in
7 development of a strong year class. Therefore, based primarily on the analysis of
8 water temperatures, Alternative 3 could be less likely to result in adverse effects
9 on White Sturgeon than the No Action Alternative.

10 *Delta Smelt*

11 As described in Appendix 9G, a proportional entrainment regression model
12 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt
13 entrainment, as influenced by OMR flow in December through March. Results
14 indicate that the percentage of entrainment of migrating and spawning adult Delta
15 Smelt under Alternative 3 would be 7.3 to 8.5 percent, depending on the water
16 year type, with a long term average percent entrainment of 7.9 percent. Percent
17 entrainment of adult Delta Smelt under Alternative 3 would be similar to results
18 under the No Action Alternative.

19 As described in Appendix 9G, a proportional entrainment regression model
20 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta
21 Smelt entrainment, as influenced by OMR flow and location of X2 in March
22 through June. Results indicate that the percentage of entrainment of larval and
23 early juvenile Delta Smelt under Alternative 3 would be 5.6 to 20.5 percent,
24 depending on the water year type, with a long term average percent entrainment
25 of 12.7 percent, and highest entrainment under Critical water year conditions.
26 Percent entrainment of larval and early juvenile Delta Smelt under Alternative 3
27 would be similar to results under the No Action Alternative, except in above- and
28 below-normal years when entrainment would be higher under Alternative 3 by
29 5 to 6 percent.

30 The average September through December X2 position in km was used to
31 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.
32 X2 values simulated in the CalSim II model for each alternative were averaged
33 over September through December, and compared. Results indicate that under
34 the No Action Alternative, the X2 position would range from 75.9 km to 92.4 km,
35 depending on the water year type, with a long term average X2 position of 84 km.
36 The most eastward location of X2 is predicted under Critical water year
37 conditions. The X2 positions predicted under Alternative 3 would be similar to
38 results under the No Action Alternative in drier water year types. In wetter years,
39 the X2 location would be further east under Alternative 3 than under the No
40 Action Alternative, by 6.0 to 9.7 km. This difference is largely due to
41 implementation of 2008 USFWS BO RPA Component 3 (Action 4), under the No
42 Action Alternative, which requires Reclamation and DWR to provide sufficient
43 Delta outflow to maintain a monthly average X2 no more eastward than 74 km in
44 Above Normal and Wet years. Under Alternative 3, the long term average X2

1 position would be 88.1 km, a location that does not provide for the advantageous
2 overlap of the low salinity zone with Suisun Bay/Marsh.

3 Overall, Alternative 3 likely would have adverse effects on Delta Smelt, as
4 compared to the No Action Alternative, primarily due to increased percentage
5 entrainment during larval and juvenile life stages, and less favorable location of
6 Fall X2 in wetter years, and on average. Given the current condition of the Delta
7 Smelt population, even small differences between alternatives may be important.

8 *Longfin Smelt*

9 The effects of the Alternative 3 as compared to the No Action Alternative were
10 analyzed based on the direction and magnitude of OMR flows during the period
11 (December through June) when adult, larvae, and young juvenile Longfin Smelt
12 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The
13 analysis was augmented with calculated Longfin Smelt abundance index values
14 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions
15 that lower X2 values reflect higher flows and that transporting Longfin Smelt
16 farther downstream leads to greater Longfin Smelt survival. The index value
17 indicates the relative abundance of Longfin Smelt and not the calculated
18 population.

19 As described in Appendix 5A, OMR flows would generally be negative in all
20 months, except April and May where OMR flows would be positive, under the No
21 Action Alternative and the long-term average negative flow ranges from -2,700 to
22 -6,200 cfs from December through June. Because there would be no restrictions
23 on export pumping from December 1 to June 15 due to OMR flow criteria under
24 Alternative 3, OMR flows would generally be more negative during this time
25 period under Alternative 3 as compared to the No Action Alternative. The
26 greatest differences between alternatives would be in April and May, where long-
27 term average OMR flows would be negative under Alternative 3 instead of
28 positive as under the No Action Alternative. The increase in the magnitude of
29 negative flows, particularly the negative flows in April and May, under
30 Alternative 3 as compared to the No Action Alternative could increase the
31 potential for entrainment of Longfin Smelt at the export facilities.

32 Under Alternative 3, Longfin Smelt abundance index values range from
33 1,147 under critical water year conditions to a high of 16,635 under wet water
34 year conditions, with a long-term average value of 7951 (Appendix 9G). Under
35 the No Action Alternative, Longfin Smelt abundance index values range from
36 947 under critical water year conditions to a high of 15,822 under wet water year
37 conditions, with a long-term average value of 7,257.

38 Results indicate that the Longfin Smelt abundance index values would be lower in
39 every water year type under Alternative 3 than under the No Action Alternative,
40 with a long-term average index for Alternative 3 that is 7.6 percent lower than the
41 long-term average index under the No Action Alternative. The greatest decrease
42 in the Longfin Smelt abundance index occurs in above normal years where the
43 index value is 12.3 percent less under Alternative 3 than under the No Action
44 Alternative. For below normal, dry, and critical water years, the Longfin Smelt

1 abundance index values would be 4.6 to 9.9 percent lower under Alternative 3
2 than under the No Action Alternative.

3 Overall, based on the increase in frequency and magnitude of negative OMR
4 flows and the lower Longfin Smelt abundance index values, potential adverse
5 effects on the Longfin Smelt population under Alternative 3 likely would be
6 greater than under the No Action Alternative. Given the current condition of the
7 Longfin Smelt population, even small differences between alternatives may be
8 important.

9 *Sacramento Splittail*

10 Under Alternative 3, flows entering the Yolo Bypass generally would be
11 somewhat higher than under the No Action Alternative from December through
12 March, especially during wetter years (Appendix 5A, Table C-26-2), providing
13 similar value to Sacramento Splittail because of the similar area of potential
14 habitat (inundation). Given the relatively minor changes in flows into the Yolo
15 Bypass, and the inherent uncertainty associated with the resolution of the
16 CalSim II model (average monthly outputs), it is concluded that there would be no
17 definitive difference in effects on Sacramento Splittail between Alternative 3 and
18 the No Action Alternative.

19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes
21 relied on evaluation of changes in available habitat (reservoir storage) and
22 anticipated changes in black bass nesting success.

23 Changes in CVP and SWP water supplies and operations under Alternative 3 as
24 compared to the No Action Alternative generally would result in higher reservoir
25 storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels
26 in Shasta Lake, Lake Oroville, and Folsom Lake would be higher under
27 Alternative 3 as compared to the No Action Alternative (Appendix 9F).

28 The greatest increases in Shasta Lake storage could be as high as 15 percent.
29 Storage in Lake Oroville could be increased by up to 30 percent in some months
30 under Alternative 3 as compared to the No Action Alternative. Storage in Folsom
31 Lake could be increased up to around 20 percent in some months of some water
32 year types and could be reduced by up to 10 percent in July, August, and
33 September. Additional information related to monthly reservoir elevations is
34 provided in Appendix 5A, CalSim II and DSM2 Modeling. Although aquatic
35 habitat within the CVP and SWP water supply reservoirs is not limiting, storage
36 volume, as an indicator of how much habitat is available to fish species inhabiting
37 these reservoirs, suggests that the amount of habitat for reservoir fishes could be
38 higher under Alternative 3 as compared to the No Action Alternative.

39 Results of the bass nesting success analysis are presented in Appendix 9F,
40 Reservoir Fish Analysis Documentation. Black bass nest survival in CVP and
41 SWP reservoirs is anticipated to be near 100 percent in March and April due to
42 increasing reservoir elevations. For May, the likelihood of nest survival for
43 Largemouth and Smallmouth Bass in Shasta Lake being in the 40 to 100 percent

1 range is similar under Alternative 3 and the No Action Alternative. For June, the
2 likelihood of nest survival being greater than 40 percent for Largemouth and
3 Smallmouth Bass is the same under Alternative 3 and the No Action Alternative;
4 however, nest survival of greater than 40 percent is likely only in about 20 percent
5 of the years evaluated. For Spotted Bass, the likelihood of nest survival being
6 greater than 40 percent is high (nearly 100 percent) in May under both
7 Alternative 3 and the No Action Alternative. For June, Spotted Bass nest survival
8 would be less than for May due to greater daily reductions in water surface
9 elevation as Shasta Lake is drawn down. The likelihood of survival being greater
10 than 40 percent is about 10 percent less under Alternative 3 as compared to the
11 No Action Alternative.

12 For May and June, the likelihood of nest survival for Largemouth Bass in Lake
13 Oroville being in the 40 to 100 percent range is somewhat (4 to 10 percent) lower
14 under Alternative 3 as compared to the No Action Alternative. However, June
15 nest survival of greater than 40 percent is likely only in about 30 percent of the
16 years evaluated under Alternative 3. The likelihood of nest survival for
17 Smallmouth Bass in Lake Oroville exhibits nearly the same pattern. For Spotted
18 Bass, the likelihood of nest survival being greater than 40 percent is high (over
19 90 percent) in May under both Alternative 3 and the No Action Alternative with
20 the likelihood of greater than 40 percent survival being similar under
21 Alternative 3 as compared to the No Action Alternative. For June, Spotted Bass
22 survival would be less than for May due to greater daily reductions in water
23 surface elevation as Lake Oroville is drawn down. The likelihood of survival
24 being greater than 40 percent is substantially lower (nearly 20 percent) under
25 Alternative 3 as compared to the No Action Alternative.

26 Black bass nest survival in Folsom Lake is anticipated to be near 100 percent in
27 March, April, and May due to increasing reservoir elevations. For June, the
28 likelihood of nest survival for Largemouth Bass and Smallmouth Bass in Folsom
29 Lake being in the 40 to 100 percent range would be about 5 percent lower under
30 Alternative 3 than the No Action Alternative. For Spotted Bass, nest survival for
31 June would be less than for May due to greater daily reductions in water surface
32 elevation. However, the likelihood of survival being greater than 40 percent is
33 around 7 percent lower under Alternative 3 as compared to the No Action
34 Alternative. Most black bass spawning likely occurs prior to June, such that
35 drawdowns during June would likely affect only a small proportion of the
36 spawning population. Thus, it is concluded that effects on black bass nesting
37 success would be similar under Alternative 3 and the No Action Alternative.

38 *Summary of Effects on Reservoir Fishes*

39 The analysis of the effects of Alternative 3 and the No Action Alternative for
40 reservoir fish relied on CalSim II output for reservoir storage levels and water
41 surface elevation changes as described in Appendix 9F. As described above,
42 reservoir storage is anticipated to be increased under Alternative 3 relative to the
43 No Action Alternative and this increase could affect the amount of warm and cold
44 water habitat available within the reservoirs. However, it is unlikely that aquatic
45 habitat within the CVP and SWP water supply reservoirs is limiting.

1 The analysis of black bass nest survival based on changes in water surface
2 elevation during the spawning period indicated that the likelihood of high
3 (>40 percent) nest survival in most of the reservoirs would be similar in March,
4 April, and May under Alternative 3 and the No Action Alternative, but somewhat
5 lower in June. Most black bass spawning likely occurs prior to June, such that
6 drawdowns during June would likely affect only a small proportion of the
7 spawning population. Overall, the results of the habitat and nest survival analysis
8 suggest that conditions in the reservoirs likely to support self-sustaining
9 populations of black bass would be similar under Alternative 3 and the No Action
10 Alternative.

11 *Other Species*

12 Several other fish species could be affected by changes in operations that
13 influence temperature and flow. The following describes the extent of these
14 changes and the potential effects on these species.

15 *Pacific Lamprey*

16 Little information is available on factors that influence populations of Pacific
17 Lamprey in the Sacramento River, but they are likely affected by many of the
18 same factors as salmon and steelhead because of the parallels in their life cycles.

19 Pacific Lamprey would be subjected to the same temperature conditions described
20 above for salmonids. Average monthly water temperatures under Alternative 3
21 and the No Action Alternative would generally be similar. Pacific Lamprey can
22 tolerate higher temperatures than salmonids, up to around 72°F during their entire
23 life history. Given the somewhat increased flows and similar temperatures under
24 Alternative 3 and the No Action Alternative from January through the summer,
25 there would be little difference in potential effects on Pacific Lamprey in the
26 Sacramento, Feather, and American rivers under Alternative 3 and the No Action
27 Alternative. This conclusion likely applies to other species of lamprey that
28 inhabit these rivers (e.g., River Lamprey).

29 *Striped Bass, American Shad, and Hardhead*

30 Average monthly water temperatures under Alternative 3 and the No Action
31 Alternative would generally be similar. Striped Bass, American Shad, and
32 Hardhead can generally tolerate higher temperatures than salmonids. Based on
33 the similar water temperatures during their spawning and incubation period under
34 Alternative 3, it is likely that thermal conditions for and effects on Striped Bass,
35 American Shad, and Hardhead in the Sacramento, Feather, and American rivers
36 would be similar under Alternative 1 and the No Action Alternative.

37 Alternative 3 would result in a more eastward X2 position as compared to the No
38 Action Alternative during April and May, with similar values in June
39 (Appendix 5A, Section C Table C-16-2). Based on Kimmerer (2002) and
40 Kimmerer et al. (2009), this change in X2 would likely reduce the survival index
41 and the habitat index as measured by salinity for Striped Bass and abundance and
42 habitat index for American Shad. In addition, the increased bag limits and ability
43 of anglers to retain Striped Bass that are 12 inches in length versus 18 inches

1 under Alternative 3 could reduce the ability to meet the doubling goals for Striped
2 Bass populations under the requirements of Section 3406(b)(1) of CVPIA.

3 Overall, Alternative 3 likely would have similar effects on Hardhead, but slightly
4 greater potential for adverse effects on Striped Bass and American Shad as
5 compared to the No Action Alternative, primarily due to the potential for reduced
6 survival during larval and juvenile life stages, and less favorable location of
7 Spring X2 on average.

8 *Stanislaus River/Lower San Joaquin River*

9 *Fall-Run Chinook Salmon*

10 Changes in operations influence temperature and flow conditions that could affect
11 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam
12 and in the San Joaquin River below Vernalis. The following describes those
13 changes and their potential effects.

14 *Changes in Water Temperature (Stanislaus River)*

15 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
16 under Alternative 3 and the No Action Alternative generally would be similar
17 (differences less than 0.5°F), except from May through October of drier years
18 when average monthly water temperatures could be up to 2.9°F cooler
19 (September) under Alternative 3 as compared to the No Action
20 Alternative (Appendix 6B, Table B-17-2).

21 Downstream at Orange Blossom Bridge, average monthly water temperatures
22 would be similar (less than 0.5°F differences) under Alternative 3 and the No
23 Action Alternative, except in October when water temperatures under
24 Alternative 3 could be higher than water temperatures under the No Action
25 Alternative by up to 1.5°F in some water year types. Water temperatures in June
26 under Alternative 3 would be substantially higher (2.3°F on average) and up to
27 3.7°F warmer in wetter years. In September of drier years, water temperatures
28 under Alternative 3 could be cooler (by up to 2.1°F in critical years) than under
29 the No Action Alternative (Appendix 6B, Table B-18-2).

30 This temperature pattern would continue downstream to the confluence with the
31 San Joaquin River, although temperatures and magnitude of temperature
32 differences under Alternative 3 compared to the No Action Alternative would
33 progressively increase in a downstream direction except for in September when
34 temperature differences would diminish at this location (Appendix 6B,
35 Table B-19-2).

36 Overall, the temperature differences between Alternative 3 and the No Action
37 Alternative would be relatively minor (less than 0.5°F) and likely would have
38 little effect on fall-run Chinook Salmon in the Stanislaus River. Based on the life
39 history timing for fall-run Chinook Salmon, the lower water temperatures in
40 September and October below Goodwin Dam under Alternative 3 likely would
41 have little effect on fall-run Chinook Salmon spawning as the majority of
42 spawning occurs later, in November. The higher water temperatures in June at
43 Orange Blossom Bridge and the mouth under Alternative 3 may increase the

1 likelihood of adverse effects on fall-run Chinook Salmon rearing in the Stanislaus
2 River, if they are present, as compared to the No action Alternative.

3 *Changes in Exceedance of Water Temperature Thresholds*
4 *(Stanislaus River)*

5 While specific water temperature thresholds for fall-run Chinook Salmon in the
6 Stanislaus River are not established, temperatures generally suitable for fall-run
7 Chinook Salmon spawning (56°F) would be exceeded in October (over 30 percent
8 of the time) and November over 20 percent of the time in the Stanislaus River at
9 Goodwin Dam under Alternative 3 (Appendix 6B, Table B-17-2). Similar
10 exceedances would occur under the No Action Alternative, although average
11 monthly water temperatures under Alternative 3 would remain lower than under
12 the No Action Alternative during the periods when the threshold is exceeded.
13 Water temperatures under Alternative 3 also would exceed the threshold about
14 5 percent less frequently in November than under the No Action Alternative.
15 Water temperatures for rearing generally would be below 56°F, except in May
16 and June when average monthly water temperatures would reach about 60°F
17 under the No Action Alternative (Appendix 6B, Figures B-17-8 and B-17-9).

18 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run
19 Chinook Salmon spawning would be exceeded frequently under both
20 Alternative 3 and the No Action Alternative during October and November.
21 Under Alternative 3, average monthly water temperatures would exceed 56°F
22 about 87 percent of the time in October. This would be about 31 percent more
23 frequently than under the No Action Alternative. In November, average monthly
24 water temperatures would exceed 56°F about 24 percent of the time under
25 Alternative 3, which would be about 9 percent less frequent than under the No
26 Action Alternative (Appendix 6B, Figure B-18-1 and B-18-2).

27 During January through May, rearing fall-run Chinook Salmon under
28 Alternative 3 would occasionally encounter average monthly water temperatures
29 that exceed 56°F at Orange Blossom Bridge under both Alternative 3 and the No
30 Action Alternative (Appendix 6B, Table B-18-2).

31 *Changes in Egg Mortality (Stanislaus River)*

32 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg
33 mortality rate is predicted to be around 6 percent, with higher mortality rates (in
34 excess of 13 percent) occurring in critical dry years under Alternative 3. Overall,
35 egg mortality would be similar under Alternative 3 and the No Action
36 Alternative in all water year types (Appendix 9C, Table B-1).

37 *Changes in Delta Hydrodynamics*

38 San Joaquin River-origin Chinook Salmon smolts are most abundant in the Delta
39 from April through June. Near the confluence of the San Joaquin River and the
40 Mokelumne River, the median proportion of positive velocities would be slightly
41 lower under Alternative 3 relative to the No Action Alternative in April and May,
42 and similar in June (Appendix 9K). On Old River downstream of the facilities,
43 the median proportion of positive velocities would be substantially lower in April

1 and May under Alternative 3 relative to the No Action Alternative, but would be
2 only moderately lower in June. In Old River upstream of the facilities, the
3 median proportion of positive velocities would be similar for Alternative 3
4 relative to the No Action Alternative in June. In April and May, values for
5 Alternative 3 would be slightly higher under Alternative 3 relative to the No
6 Action Alternative. On the San Joaquin River downstream of the Head of Old
7 River, the median proportion of positive velocities would be similar under
8 Alternative 3 relative to the No action Alternative in April, May and June.

9 *Changes in Junction Entrainment*

10 At the Head of Old River junction, entrainment under Alternative 3 would be
11 slightly higher in April, May, and June (Appendix 9L). Median entrainment into
12 Turner Cut would be slightly greater under Alternative 3 during April and May,
13 and similar in June. At the Columbia Cut junction, entrainment would be
14 moderately higher under Alternative 3 during April and May, whereas
15 entrainment would be slightly higher in June. Entrainment probabilities at the
16 Middle River junction from April through June would be moderately greater
17 under Alternative 3 relative to the No action Alternative. A similar pattern would
18 be observed at the Old River junction.

19 *Changes in Juvenile Salmonid Passage through the Delta (Trap and Haul)*

20 Poor survival of juvenile salmonids in the Sacramento-San Joaquin Delta has
21 been hypothesized as a major contributor to declines in the number of returning
22 adults and may be a significant impediment to the recovery of threatened or
23 endangered populations (NOAA 2009). Under Alternative 3, fish would be
24 trapped in the San Joaquin River between the mouth of the Stanislaus River and
25 the Head of Old River to capture juveniles migrating from natal rearing habitat in
26 the San Joaquin River, Merced River, Tuolumne River and Stanislaus River.
27 Captured fish would be transported by barge through the Delta and released at
28 locations within San Francisco Bay. Although trucks are currently used to
29 transport hatchery reared salmonids and salvaged fishes (including salmonids),
30 barging results in greater survival benefits (Ward et al. 1997) and may reduce
31 straying of returning adults.

32 In response to low survival in the Columbia River hydro system, a transportation
33 program was initiated where migrating salmonids (Chinook salmon and
34 steelhead) are captured at dams and transported by barge to the lowest dam in the
35 system before being released (Williams et al. 2004). The effectiveness of the
36 Columbia River transportation program has been questioned because although
37 survival of transported Chinook (≈ 98 percent; McMichael et al. 2011) is greater
38 than in-river migrants (≈ 50 percent; Faulkner et al. 2010), SAR rates have not
39 been proportional to the increase in hydro system survival. The most recent
40 evidence suggests that that differences in ocean entry timing that occur due to the
41 rapid rate of barge transport and the long distances transported are likely
42 responsible for the lower post-hydro system survival of transported fish (Muir
43 et al 2006; Rechisky et al 2012). To assess the potential benefits and risks of a
44 transportation program for salmonids in the San Joaquin River, an analysis of
45 CWT recovery rates for Chinook Salmon reared at the Feather River Hatchery

1 and the Mokelumne River Hatchery was performed (Appendix 9O). Based on
2 this analysis, Alternative 3 is expected to improve the survival of juvenile fall-run
3 Chinook Salmon and steelhead smolts originating from the San Joaquin River
4 basin in comparison to the No Action Alternative. Previous work on the
5 Columbia River suggests that benefits may be greater than demonstrated in
6 Appendix 9O if juveniles were transported by barge instead of truck (Ward et al.
7 1997). The program would also improve the survival of spring-run Chinook
8 Salmon if these fish become established as part of the San Joaquin River
9 Restoration Program, or as part of the New Melones fish passage project. As
10 indicated in Chapter 3, Description of Alternatives, this action will include
11 measures to quantify the benefit.

12 While a trap and haul program may increase survival, it also may result in
13 unintended consequences or population impacts. For example, a study of
14 returning adult Chinook Salmon and steelhead on the Columbia River following
15 transport as juveniles found that the proportion of adults successfully homing was
16 significantly lower and that the unaccounted loss and permanent straying into
17 non-natal rivers was higher for barged fish of both species (Keefer et al. 2008).
18 Increased straying could have consequences for populations in their natal streams,
19 but also could adversely influence populations in other streams if those fish breed
20 with other wild populations. The conditions and transport distances in the Delta
21 differ from those studied on the Columbia River system, thus the overall influence
22 on straying is uncertain.

23 However, as indicated in Appendix 9O, straying rates of transported fish are
24 anticipated to be greater than fish allowed to migrate within the river system. An
25 important consideration for this analysis of straying is that all releases into the bay
26 were transported by truck to bypass the Delta. Barge transport where water is
27 recirculated may reduce straying by allowing fish to “sample” water along the
28 migration route. Additionally, the location of collection on the San Joaquin River
29 would be downstream of natal rearing locations allowing fish to experience
30 portions of the migration route during rearing. In addition, trapping and hauling
31 is inconsistent with CDFW’s goal of achieving volitional fish passage.

32 *Summary of Effects on Fall-Run Chinook Salmon*

33 The analysis of temperatures indicates lower temperatures and a lesser likelihood
34 of exceedance of suitable temperatures for spawning and rearing of fall-run
35 Chinook Salmon under Alternative 3 as compared to the No Action Alternative in
36 the Stanislaus River downstream of Goodwin Dam and in the San Joaquin River
37 at Vernalis. The effect of lower temperatures is not reflected in the overall
38 mortality of fall-run Chinook Salmon eggs predicted by Reclamation’s salmon
39 mortality model for fall-run in the Stanislaus River.

40 Implementation of a fish passage project under the No Action Alternative,
41 although intended to address the limited availability of suitable habitat for spring-
42 run Chinook Salmon and steelhead in the Stanislaus River reaches downstream of
43 Goodwin Dam, likely would provide some benefit to fall-run Chinook Salmon if
44 passage for fall-run Chinook Salmon was provided and additional habitat could be
45 accessed. Any potential benefit to fall-run Chinook Salmon under the No Action

1 Alternative relative to Alternative 3 is uncertain. The potential benefits of actions
2 under the No Action Alternative intended to increase the efficiency of the Tracy
3 and Skinner Fish Collection Facilities could improve the overall salvage survival
4 of fall-run Chinook Salmon relative to Alternative 3.

5 Overall, Alternative 3 likely would have similar effects on the fall-run Chinook
6 Salmon population in the San Joaquin River watershed as compared to the No
7 Action Alternative. Alternative 3 could also provide beneficial effects to juvenile
8 fall-run Chinook Salmon as a result of trap and haul passage through the Delta
9 and ocean harvest restrictions. It remains uncertain, however, if predator
10 management actions under Alternative 3 and fish passage under the No Action
11 Alternative would benefit fall-run Chinook Salmon.

12 *Steelhead*

13 Changes in operations that influence temperature and flow conditions in the
14 Stanislaus River downstream of Goodwin Dam and the San Joaquin River
15 downstream of the Stanislaus River confluence, as measured at Vernalis could
16 affect steelhead. The following describes those changes and their potential
17 effects.

18 *Changes in Water Temperature (Stanislaus River)*

19 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
20 under Alternative 3 and the No Action Alternative generally would be similar
21 (differences less than 0.5°F), except from May through October of drier years
22 when average monthly water temperatures could be up to 2.9°F cooler
23 (September) under Alternative 3 than under the No Action Alternative.

24 Downstream at Orange Blossom Bridge, average monthly water temperatures
25 would be similar (less than 0.5°F differences) under Alternative 3 and the No
26 Action Alternative, except in October when water temperatures under
27 Alternative 3 could be higher than water temperatures under the No Action
28 Alternative by up to 1.5°F in some water year types. Water temperatures in June
29 under Alternative 3 would be substantially higher (2.3°F on average) and up to
30 3.7°F warmer in wetter years. In September of drier years, water temperatures
31 under Alternative 3 could be cooler (by up to 2.1°F in critical years) than under
32 the No Action Alternative.

33 This temperature pattern would continue downstream to the confluence with the
34 San Joaquin River, although temperatures and magnitude of temperature
35 differences under Alternative 3 compared to the No Action Alternative would
36 progressively increase in a downstream direction except for in September when
37 temperature differences would diminish at this location (Appendix 6B,
38 Table B-19-2).

39 Overall, the temperature differences between Alternative 3 and the No Action
40 Alternative would be relatively minor (less than 0.5°F) and likely would have
41 little effect on steelhead in the Stanislaus River. The higher water temperatures in
42 June at Orange Blossom Bridge and the mouth under Alternative 3 may increase
43 the likelihood of adverse effects on steelhead rearing in the Stanislaus River as

1 compared to the No action Alternative. The lower water temperatures in
 2 September of drier years under Alternative 3 may decrease the likelihood of
 3 adverse effects to steelhead rearing in the Stanislaus River during this month.

4 *Changes in Exceedance of Water Temperature Thresholds*
 5 *(Stanislaus River)*

6 Average monthly water temperatures in the Stanislaus River at Orange Blossom
 7 Bridge would frequently exceed the temperature threshold (56°F) established for
 8 adult steelhead migration under both Alternative 3 and the No Action
 9 Alternative during October and November. Under Alternative 3, average monthly
 10 water temperatures would exceed 56°F about 87 percent of the time in October
 11 and about 57 percent of the time under the No Action Alternative. In November,
 12 average monthly water temperatures would exceed 56°F about 24 percent of the
 13 time under Alternative 3, which would be about 9 percent less frequent than under
 14 the No Action Alternative.

15 From January through May, the temperature threshold at Orange Blossom Bridge
 16 is 55°F, which is intended to support steelhead spawning. This threshold could be
 17 exceeded about 1 percent of the time under Alternative 3 in February. In March
 18 through May, exceedances would occur under both alternatives in each month,
 19 with the threshold most frequently exceeded (nearly half the time) in May.
 20 Compared to the No Action Alternative, water temperatures under Alternative 3
 21 would exceed the threshold 3 percent more frequently in March, 1 percent more
 22 frequently in April, and 4 percent more frequently in May. From June through
 23 November, the temperature threshold of 65°F established to support steelhead
 24 rearing would be exceeded by both Alternative 3 and No Action Alternative in all
 25 months but November, with the highest frequency of exceedance in July
 26 (19 percent under Alternative 3). The differences between Alternative 3 and No
 27 Action Alternative, however, would be variable depending on the month, with
 28 Alternative 3 exceeding the threshold up to about 6 percent less frequently than
 29 under the No Action Alternative in June and from August through October.
 30 Under Alternative 3, water temperatures would exceed the rearing temperature
 31 threshold up to 4 percent more frequently in April, May, and July.

32 Average monthly water temperatures also would exceed the threshold (52°F)
 33 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles
 34 upstream of Knights Ferry, average monthly water temperatures under
 35 Alternative 3 would exceed 52°F in March, April, and May about 12 percent,
 36 30 percent, and 63 percent of the time, respectively and 2 percent of the time in
 37 January and February. By comparison to the No Action Alternative, Alternative 3
 38 would result in exceedances occurring about 2 to 4 percent more frequently
 39 during the January through March period. Farther downstream at Orange
 40 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and
 41 would be exceeded less frequently. The magnitude of the exceedance also would
 42 be less. Average monthly water temperatures under Alternative 3 and the No
 43 Action Alternative would not exceed the threshold during January through March.
 44 In April and May, exceedances of 3 percent and 17 percent would occur under

1 Alternative 3, which would be nearly the same as under the No Action
2 Alternative.

3 Overall, the differences in exceedance frequency between Alternative 3 and the
4 No Action Alternative would be relatively small, with the exception of substantial
5 differences in the frequency of exceedances in October when the average monthly
6 water temperatures under Alternative 3 would exceed the threshold for adult
7 steelhead migration about 28 percent less frequently and in April during the
8 spawning period when the frequency would be about 17 percent less. Given the
9 frequency of exceedance under both Alternative 3 and the No Action
10 Alternative and the generally stressful temperature conditions in the river, the
11 substantial differences (improvements) in October and April under Alternative 3
12 suggest that there would be less potential to result in adverse effects on steelhead
13 under Alternative 3 than under the No Action Alternative. Even during months
14 when the differences would be relatively small, the lower frequency of
15 exceedances under Alternative 3 suggest that there would be less potential to
16 result in adverse effects on steelhead under Alternative 3 than under the No
17 Action Alternative.

18 *Changes in Delta Hydrodynamics*

19 San Joaquin River-origin steelhead generally move through the Delta during
20 spring; however, there is less information on their timing relative to Chinook
21 Salmon. Thus, hydrodynamics in the entire January through June period have the
22 potential to affect juvenile steelhead. For a description of potential hydrodynamic
23 effects on steelhead, see the descriptions for winter-run Chinook Salmon in the
24 Sacramento Basin and fall-run Chinook Salmon in the San Joaquin River basin
25 above.

26 *Summary of Effects on Steelhead*

27 Given the frequency of exceedance under both Alternative 3 and the No Action
28 Alternative, water temperature conditions for steelhead in the Stanislaus River
29 would be generally stressful in the fall, late spring, and summer months. The
30 differences in temperature exceedance (both positive and negative) between
31 Alternative 3 and the No Action Alternative would be relatively small, with no
32 clear benefit associated with either alternative. However, because Alternative 3
33 generally would exceed thresholds less frequently during the warmest months, it
34 may have slightly less impact than the No Action Alternative. Alternative 3 also
35 could provide additional beneficial effects to juvenile steelhead as a result of trap
36 and haul passage through the Delta. It remains uncertain, however, if predator
37 management actions under Alternative 3 would benefit steelhead.

38 Implementation of the fish passage program under the No Action
39 Alternative intended to address the limited availability of suitable habitat for
40 steelhead in the Stanislaus River reaches downstream of Goodwin Dam could
41 provide a benefit to Central Valley steelhead in the Stanislaus River. This is
42 particularly important in light of anticipated increases in water temperature
43 associated with climate change in 2030. In addition, RPA actions intended to
44 increase the efficiency of the Tracy and Skinner Fish Collection Facilities could

1 improve the overall salvage survival of steelhead under the No Action
2 Alternative. Thus, it is concluded that the potential for adverse effects on
3 steelhead under Alternative 3 would be greater, principally because Alternative 3
4 does not include a strategy to address water temperatures critical to steelhead
5 sustainability over the long term with climate change by 2030.

6 *White Sturgeon*

7 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River
8 upstream of the confluence with the Stanislaus River. While flows in the San
9 Joaquin River upstream of the Stanislaus River are expected to be similar under all
10 alternatives, flow contributions from the Stanislaus River could influence water
11 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may
12 occur during the spring and early summer. The magnitude of influence on water
13 temperature would depend on the proportional flow contribution of the Stanislaus
14 River and the temperatures in both the Stanislaus and San Joaquin rivers. The
15 potential for an effect on White Sturgeon eggs and larvae would be influenced by
16 the proportion of the population occurring in the San Joaquin River. In
17 consideration of this uncertainty, it is not possible to distinguish potential effects
18 on White Sturgeon between alternatives.

19 *Reservoir Fishes*

20 The analysis of effects associated with changes in operation on reservoir fishes
21 relied on evaluation of changes in available habitat (reservoir storage) and
22 anticipated changes in black bass nesting success.

23 Under Alternative 3, storage in New Melones could be increased up to around
24 20 percent in some months of some water year types (Appendix 5A). Additional
25 information related to monthly reservoir elevations is provided in Appendix 5A,
26 CalSim II and DSM2 Modeling. It is anticipated that aquatic habitat within New
27 Melones is not limiting; however, storage volume is an indicator of how much
28 habitat is available to fish species inhabiting these reservoirs. Therefore, the
29 amount of habitat for reservoir fishes could be increased under Alternative 3 as
30 compared to the No Action Alternative.

31 Results of the bass nesting success analysis are presented in Appendix 9F. For
32 March, the likelihood of Largemouth Bass and Smallmouth Bass nest survival in
33 New Melones being above 40 percent is 100 percent under Alternative 3 and the
34 No Action Alternative. For April, the likelihood that nest survival of Largemouth
35 Bass and Smallmouth Bass is between 40 and 100 percent is reasonably high
36 (around 80 percent) but is substantially (about 10 percent) higher under
37 Alternative 3 than under the No Action Alternative. For May, the pattern is
38 similar with the likelihood of high nest survival being about 6 percent greater
39 under Alternative 3. For June, the likelihood of survival being greater than
40 40 percent for Largemouth Bass and Smallmouth Bass in New Melones is similar
41 under Alternative 3 and the No Action Alternative. For Spotted Bass, nest
42 survival from March through June is anticipated to be near 100 percent in every
43 year under both Alternative 3 and the No Action Alternative. Most black bass
44 spawning likely occurs prior to June, such that drawdowns during June would

1 likely affect only a small proportion of the spawning population. Thus, it is
2 concluded that effects on black bass nesting success would be similar under
3 Alternative 3 and the No Action Alternative.

4 *Other Species*

5 Changes in operations that influence temperature and flow conditions in the
6 Stanislaus River downstream of Keswick Dam and the San Joaquin River at
7 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

8 As described above, average monthly water temperatures in the Stanislaus River
9 at Goodwin Dam under Alternative 3 and the No Action Alternative generally
10 would be similar. Downstream at Orange Blossom Bridge, average monthly
11 water temperatures under Alternative 3 generally would be similar to water
12 temperatures under the No Action Alternative except in September when they
13 could be cooler and October when they could be warmer than under the No
14 Action Alternative. This temperature pattern would continue downstream to the
15 confluence with the San Joaquin River, although temperatures would
16 progressively increase. Water temperatures from May to July may also be
17 warmer under Alternative 3 compared to the No Action
18 Alternative (Appendix 6B, Table B-19-2).

19 In general, lamprey species can tolerate higher temperatures than salmonids, up to
20 around 72°F during their entire life history. Because lamprey ammocoetes remain
21 in the river for several years, any substantial flow reductions or water temperature
22 increases could result in adverse effects on larval lamprey. Given the slightly
23 lower flows and increased water temperatures during portions of their spawning
24 and incubation period, it is likely that the potential to affect lamprey species in the
25 Stanislaus and San Joaquin rivers would be somewhat greater under Alternative 3
26 and the No Action Alternative.

27 In general, Striped Bass and Hardhead also can tolerate higher temperatures than
28 salmonids. Thus, thermal conditions for these species are expected to be similar
29 under Alternative 3 and the No Action Alternative. However, implementation of
30 a predator control program under Alternative 3 could result in adverse effects on
31 Striped Bass.

32 *San Francisco Bay Area Region*

33 *Killer Whale*

34 As described above for the comparison of Alternative 1 to the No Action
35 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
36 supported heavily by hatchery production of fall-run Chinook Salmon, would be
37 appreciably affected by any of the alternatives.

38 **9.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

39 As described in Chapter 3, Description of Alternatives, the CVP and SWP
40 operations and ongoing operational management policies of the CVP and SWP
41 under Alternative 3 would be similar to the operational assumptions under the
42 Second Basis of Comparison except for changes to water demand assumptions,

1 OMR flow criteria, and operations of New Melones Reservoir to meet SWRCB
2 D-1641 flow requirements on the San Joaquin River at Vernalis. As a
3 consequence, conditions for fish and aquatic resources would be relatively
4 unchanged in most of the system under Alternative 3. The following briefly
5 summarizes these minor changes, but focuses on portions of the CVP and SWP
6 where changes would occur under Alternative 3 relative to the Second Basis of
7 Comparison.

8 *Trinity River Region*

9 *Coho Salmon*

10 The analysis of effects associated with changes in operation on Coho Salmon was
11 conducted using temperature model outputs for Lewiston Dam to anticipate the
12 likely effects on conditions in the Trinity River downstream of Lewiston Dam for
13 Coho Salmon.

14 Long-term average monthly water temperature in the Trinity River at Lewiston
15 Dam under Alternative 3 would be similar (less than 0.5°F) to long-term average
16 water temperatures under the Second Basis of Comparison in all months. The
17 greatest differences would occur in critical years when average monthly
18 temperatures would be 0.6°F lower in September and October and 0.8°F higher in
19 November under Alternative 3 (Appendix 6B, Table B-1-5). The differences in
20 the frequency with which Alternative 3 and the Second Basis of Comparison
21 would exceed established temperature thresholds also would be small, with water
22 temperatures under Alternative 3 exceeding thresholds about 0-2 percent less
23 frequently than under the Second Basis of Comparison.

24 Given the similarity of the results and the inherent uncertainty associated with the
25 resolution of the water temperature model (average monthly outputs), it is
26 concluded that Alternative 3 and the Second Basis of Comparison are likely to
27 have similar effects on the Coho Salmon population in the Trinity River.

28 *Spring-run Chinook Salmon*

29 As described above for Coho Salmon, water temperatures would generally be
30 similar (less than 0.5°F difference) under Alternative 3 and the Second Basis of
31 Comparison. Similarly, the differences in the frequency with which water
32 temperatures under Alternative 3 and the Second Basis of Comparison would
33 exceed established temperature thresholds also would be small, with Alternative 3
34 exceeding water temperature thresholds about 1 to 2 percent less frequently than
35 the Second Basis of Comparison.

36 Given the similarity of the results and the inherent uncertainty associated with the
37 resolution of the temperature model (average monthly outputs), it is concluded
38 that Alternative 3 and Second Basis of Comparison are likely to have similar
39 effects on the spring-run Chinook Salmon population in the Trinity River.

40 *Fall-Run Chinook Salmon*

41 As described above for Coho Salmon, water temperatures under Alternative 3 and
42 the Second Basis of Comparison generally would be similar (Appendix 6B,
43 Table B-1-5. This is reflected in the egg mortality results, which indicate similar

1 levels of mortality, under Alternative 3 and the Second Basis of Comparison
2 (Appendix 9C, Table 5-5).

3 Given the similarity of the results and the inherent uncertainty associated with the
4 resolution of the temperature model (average monthly outputs), it is concluded
5 that Alternative 3 and Second Basis of Comparison are likely to have similar
6 effects on the fall-run Chinook Salmon population in the Trinity River.

7 *Steelhead*

8 Differences in water temperature conditions for steelhead in the Trinity River
9 between Alternative 3 and the Second Basis of Comparison would be minor as
10 described above for salmon. These results suggest that conditions for steelhead in
11 the Trinity River generally would be similar under Alternative 3 and the Second
12 Basis of Comparison.

13 *Green Sturgeon*

14 Green Sturgeon would be subjected to the same water temperature conditions
15 described above for salmonids. The similarity in temperatures between
16 Alternative 3 and the Second Basis of Comparison suggest that conditions for
17 Green Sturgeon in the Trinity River generally would be similar under
18 Alternative 3 and the Second Basis of Comparison.

19 *Reservoir Fishes*

20 Reservoir fishes in Trinity Lake would be exposed to relatively minor differences
21 in storage under Alternative 3 as compared to the Second Basis of Comparison
22 and these relatively small differences would have little effect on the amount of
23 habitat available for these species. Black bass nesting survival would be similar
24 under Alternative 3 and the Second Basis of Comparison. Overall, effects on
25 reservoir fishes in Trinity Lake would be similar under both Alternative 3 and the
26 Second Basis of Comparison.

27 *Pacific Lamprey and Eulachon*

28 As described above for Coho Salmon, there would be only minor differences in
29 water temperatures between Alternative 3 and the Second Basis of Comparison.
30 This suggests that water temperature conditions for Pacific Lamprey and
31 Eulachon in the Trinity River and Klamath River downstream of the confluence
32 generally would be similar under Alternative 3 and the Second Basis of
33 Comparison.

34 *Sacramento River System*

35 *Winter-run Chinook Salmon*

36 Changes in operations that influence temperature and flow conditions in the
37 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
38 Salmon. The following describes those changes and their potential effects.

39 *Changes in Water Temperature*

40 Long-term average monthly water temperature in the Sacramento River at
41 Keswick Dam under Alternative 3 and the Second Basis would be similar
42 (Appendix 6B, Table B-5-5). There would be slight differences in the frequency

1 of exceeding temperature thresholds under Alternative 3 and the Second Basis of
 2 Comparison with the frequency of exceedance being up to 4 percent less under
 3 Alternative 3 at Balls Ferry and up to 4 percent more at Bend Bridge. Egg
 4 mortality would be similar under Alternative 3 and the Second Basis of
 5 Comparison (Appendix 9C, Table B-4).

6 *Changes in Weighted Usable Area*

7 The WUA results for winter-run Chinook Salmon spawning habitat between
 8 Keswick Dam and Battle Creek indicated that the amount of spawning habitat
 9 would be similar under Alternative 3 and the Second Basis of Comparison
 10 (Appendix 9E, Table C-17-5). Results were similar for fry rearing,
 11 (Appendix 9E, Table C-18-5). Results for juvenile rearing also were similar
 12 under both Alternative 3 and the Second Basis of Comparison (Appendix 9E,
 13 Table C-19-5).

14 *Changes in SALMOD Output*

15 SALMOD results indicate that potential production of winter-run Chinook
 16 Salmon under Alternative 3 would be essentially the same as under the Second
 17 Basis of Comparison. (Appendix 9D, Table B-4-21).

18 *Changes in Delta Passage Model Output*

19 The Delta Passage Model predicted similar estimates of annual Delta survival
 20 across the 81-year time period for winter-run Chinook Salmon between
 21 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta
 22 survival was 0.354 for Alternative 3 and 0.352 for the Second Basis of
 23 Comparison.

24 *Changes in Delta Hydrodynamics*

25 Winter-run Chinook Salmon smolts are most abundant in the Delta during
 26 January, February, and March. On the Sacramento River near the confluence of
 27 Georgiana Slough, the median proportion of positive velocities under
 28 Alternative 3 was indistinguishable from the Second Basis of Comparison
 29 (Appendix 9K). On the San Joaquin River near the Mokelumne River confluence,
 30 the median proportion of positive velocities would be slightly higher under
 31 Alternative 3 than under the Second Basis of Comparison. In Old River
 32 downstream of the facilities, the median proportion of positive velocities would
 33 be similar under Alternative 3 and the Second Basis of Comparison in March, but
 34 would be moderately to slightly higher January and February, respectively under
 35 Alternative 3. In Old River upstream of the facilities, the median proportion of
 36 positive velocities would be slightly to moderately lower under Alternative 3 and
 37 the Second Basis of Comparison in these months. On the San Joaquin River
 38 downstream of Head of Old River, the percent of positive velocities would be
 39 similar under both alternative in January, February and March.

40 *Changes in Junction Entrainment*

41 Entrainment at the Georgiana Slough Junction under Alternative 3 would be
 42 almost indistinguishable from the Second Basis of Comparison (Appendix 9L).
 43 At the Head of Old River junction, median entrainment probability would be

1 slightly lower under Alternative 3 in January and February and similar in March.
2 At Turner Cut, median entrainment probabilities would be slightly lower under
3 Alternative 3 relative to the Second Basis of Comparison in January and
4 February; however, median entrainment probability would be similar in March.
5 The median entrainment probability under Alternative 3 at Columbia Cut, Middle
6 River, and Old River would be slightly lower from January to March relative to
7 the Second Basis of Comparison.

8 *Changes in Salvage*

9 Salvage of Sacramento River-origin Chinook salmon is predicted to be
10 substantially lower under Alternative 3 relative to the Second Basis of
11 Comparison in January (Appendix 9M). In February salvage would be only
12 moderately lower and slightly lower in March.

13 *Changes in Oncorhynchus Bayesian Analysis Output*

14 Escapement of winter-run Chinook Salmon and Delta survival was modeled by
15 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook
16 salmon. Differences in escapement between Alternative 3 and the Second Basis
17 scenarios were moderately small (Appendix 9I). Escapement was generally
18 greater under Alternative 3 relative to Second Basis of Comparison, and it was
19 consistently greater over the 1986 to 1988 simulation period (dark gray and light
20 gray areas above the dashed line). In most other years the difference in
21 escapement estimates included 0 (i.e., dashed line located in the dark gray, central
22 0.50 probability region) (see Appendix 9I). The median delta survival was
23 slightly higher under Alternative 3 relative to the Second Basis scenario
24 (6 percent), although the probability of no difference between alternatives was
25 generally high throughout the simulation time period.

26 *Changes in Interactive Object-Oriented Simulation Output*

27 The IOS model predicted similar adult escapement trajectories for winter-run
28 Chinook Salmon between Alternative 3 and the Second Basis of Comparison
29 across the 81 years (Appendix 9H). Median adult escapement under Alternative 3
30 was 4,025 and under the Second Basis of Comparison median escapement
31 was 4,042.

32 Similar to adult escapement, the IOS model predicted similar egg survival for
33 winter-run Chinook Salmon between Alternative 3 and the Second Basis of
34 Comparison across the 81 water years. Median egg survival was 0.987 for both
35 scenarios.

36 *Summary of Effects on Winter-Run Chinook Salmon*

37 The multiple model and analysis outputs described above characterize the
38 anticipated conditions for winter-run Chinook Salmon and their response to
39 change under Alternative 3 as compared to the Second Basis of Comparison. For
40 the purpose of analyzing effects on winter-run Chinook Salmon and developing
41 conclusions, greater reliance was placed on the outputs from the two life cycle
42 models, IOS and OBAN because they each integrate the available information to
43 produce single estimates of winter-run Chinook Salmon escapement. The output

1 from IOS indicated that winter-run Chinook Salmon escapement would be similar
 2 under both scenarios, whereas the OBAN results indicated that escapement under
 3 Alternative 3 could be higher than under the Second Basis of Comparison.

4 These model results suggest that effects on winter-run Chinook Salmon would be
 5 similar under both scenarios, with a small likelihood that winter-run Chinook
 6 Salmon escapement would be higher under Alternative 3 than under the Second
 7 Basis of Comparison. The ocean harvest restrictions under Alternative 3 could
 8 provide additional benefit, although the effects of the predator management
 9 program are uncertain. Overall, given the small differences, distinguishing a clear
 10 difference between alternatives is difficult. The non-operational components
 11 associated with Alternative 3 could benefit winter-run Chinook Salmon relative to
 12 the Second Basis of Comparison over the short term if successful. Thus, it is
 13 concluded that the potential for adverse effects on winter-run Chinook Salmon
 14 would be slightly less under Alternative 3 than under the Second Basis of
 15 Comparison.

16 *Spring-run Chinook Salmon*

17 Operations under Alternative 3 generally would be similar to those for the Second
 18 Basis of Comparison. The following describes those changes and their potential
 19 effects.

20 *Changes in Water Temperature*

21 Long-term average monthly water temperature in the Sacramento River under
 22 Alternative 3 and the Second Basis of Comparison would be similar
 23 (Appendix 6B). Differences in the frequency of exceeding temperature thresholds
 24 under Alternative 3 and the Second Basis of Comparison also would be minor
 25 (differences of about 1 percent), as would egg mortality, which would be similar
 26 under Alternative 3 and the Second Basis of Comparison (Appendix 9C,
 27 Table B-3).

28 In Clear Creek, average monthly water temperature at Igo under Alternative 3
 29 relative to the Second Basis of Comparison would be similar (Appendix 6B,
 30 Table B-3-5). The frequency of exceeding temperature thresholds for spring-run
 31 Chinook Salmon rearing also would be minor (differences of 1 percent).

32 In the Feather River, average monthly water temperature at the low flow channel
 33 under Alternative 3 relative to the Second Basis of Comparison also would be
 34 similar (differences less than 0.5°F), with a slight reduction in temperature (0.7°F)
 35 in August of below normal years (Appendix 6B, Table B-20-5). Water
 36 temperatures at the downstream location also would be similar, with temperatures
 37 under Alternative 3 at Robinson Riffle and Gridley up to 2°F percent cooler in
 38 July and August of some water year types (Appendix 6B, Table B-21-5).
 39 Changes in the frequency of temperature thresholds would be minor (differences
 40 of 1 percent or less), except in May when the temperature threshold for rearing
 41 would be exceeded about 4 percent more frequently than under the Second Basis
 42 of Comparison.

1 *Changes in Weighted Usable Area*

2 Weighted usable area curves are available for spring-run Chinook Salmon in
3 Clear Creek. Flows in Clear Creek downstream of Whiskeytown Dam are not
4 anticipated to differ under Alternative 3 relative to the Second Basis of
5 Comparison. Therefore, there would be no change in the amount of potentially
6 suitable spawning and rearing habitat for spring-run Chinook Salmon (as indexed
7 by WUA) available under the Alternative 3 as compared to the Second Basis of
8 Comparison.

9 *Changes in SALMOD Output*

10 SALMOD results indicate that potential production of spring-run Chinook
11 Salmon would be essentially the same under Alternative 3 relative to the Second
12 Basis of Comparison, but could be up to 8 percent less than under the Second
13 Basis of Comparison in critical dry years (Appendix 9D, Table B-3-21).

14 *Changes in Delta Passage Model Output*

15 The Delta Passage Model predicted similar estimates of annual Delta survival
16 across the 81-year time period for spring-run Chinook Salmon between
17 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta
18 survival would be 0.286 for both scenarios.

19 *Changes in Delta Hydrodynamics*

20 Spring-run Chinook Salmon are most abundant in the Delta from March through
21 May. Near the junction of Georgiana Slough, the median proportion of time that
22 velocity would be positive was similar for both Alternative 3 and the Second
23 Basis of Comparison in March, April and May (Appendix 9K). Near the
24 confluence of the San Joaquin River and the Mokelumne River, the median
25 proportion with positive velocity was similar during these months under
26 Alternative 3 and the Second Basis of Comparison. In the San Joaquin River
27 downstream of the Head of Old River, the median proportion of positive
28 velocities was similar between scenarios in March, whereas values were slightly
29 to moderately lower under Alternative 3 relative to the Second Basis of
30 Comparison in April and May, respectively. In Old River upstream of the
31 facilities, the median proportion with positive velocities was similar between
32 scenarios in March and moderately higher in April and May under Alternative 3
33 relative to the Second Basis of Comparison. In Old River downstream of the
34 facilities, the median proportion with positive velocities was similar between
35 scenarios in March and slightly higher in April and May under Alternative 3
36 relative to the Second Basis of Comparison.

37 *Changes in Junction Entrainment*

38 Entrainment at the Georgiana Slough Junction under Alternative 3 would be
39 almost indistinguishable from the Second Basis of Comparison during March
40 April and May (Appendix 9L). At the Head of Old River junction, entrainment
41 would be similar under Alternative 3 and the Second Basis of Comparison in
42 March, whereas entrainment would be much greater under Alternative 3 relative
43 to the Second Basis of Comparison in April and May. At Turner Cut, entrainment
44 would be similar under Alternative 3 relative to the Second Basis of Comparison

1 in March and slightly to moderately lower in April and May, respectively under
2 Alternative 3. Entrainment at Columbia Cut, Middle River, and Old River would
3 yield similar patterns as those observed at Turner Cut.

4 *Changes in Salvage*

5 Spring-run Chinook Salmon smolts migrating through the Delta would be most
6 susceptible in the months of March, April, and May. Salvage of Sacramento
7 River-origin Chinook salmon is predicted to be similar under Alternative 3 and
8 the Second Basis of Comparison in March, April, and May (Appendix 9M).

9 *Summary of Effects on Spring-Run Chinook Salmon*

10 The multiple model and analysis outputs described above characterize the
11 anticipated conditions for spring-run Chinook Salmon and their response to
12 change under Alternative 3 and the Second Basis of Comparison. For the purpose
13 of analyzing effects on spring-run Chinook Salmon in the Sacramento River,
14 greater reliance was placed on the outputs from the SALMOD model because it
15 integrates the available information on temperature and flows to produce
16 estimates of mortality for each life stage and an overall, integrated estimate of
17 potential spring-run Chinook Salmon juvenile production. The output from
18 SALMOD indicated that spring-run Chinook Salmon production in the
19 Sacramento River would be similar under Alternative 3 and the Second Basis of
20 Comparison, although production under Alternative 3 could be up to 8 percent
21 less than under the Second Basis of Comparison in critical dry years.

22 The analyses attempting to assess the effects on routing, entrainment, and salvage
23 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
24 potential losses of juvenile salmon at the export facilities) of Sacramento
25 River-origin Chinook Salmon generally would be similar under Alternative 3 and
26 the Second Basis of Comparison.

27 In Clear Creek and the Feather River, the analysis of the effects of Alternative 3
28 and the Second Basis of Comparison for spring-run Chinook Salmon relied on
29 output from the WUA analysis and water temperature output for Clear Creek at
30 Igo, and in the Feather River low flow channel and downstream of the Thermalito
31 complex. The WUA analysis suggests that there would be little difference in the
32 availability of spawning and rearing habitat in Clear Creek. The temperature
33 model outputs suggest that thermal conditions and effects on each of the
34 spring-run Chinook Salmon life stages generally cannot be fully characterized in
35 Clear Creek and the Feather River. This conclusion is supported by the water
36 temperature threshold exceedance analysis that indicated that water temperature
37 thresholds for spawning and egg incubation in Clear Creek and the Feather River
38 would be exceeded less frequently in some months and more frequently in others
39 under Alternative 3 than under the Second Basis of Comparison. The water
40 temperature threshold for rearing spring-run Chinook Salmon in the Feather River
41 would also be exceeded less frequently in some months and more frequently in
42 others under Alternative 3. Because of the inherent uncertainty associated with
43 the resolution of the temperature model (average monthly outputs), and the
44 differences in the magnitude and direction of the temperature exceedances under

1 Alternative 3, the extent of temperature-related effects on spring-run Chinook
2 Salmon in Clear Creek and the Feather River is uncertain.

3 These model results suggest that overall, effects on spring-run Chinook Salmon
4 could be slightly more adverse under Alternative 3 than the Second Basis of
5 Comparison, with a small likelihood that spring-run Chinook Salmon production
6 would be lower under the Second Basis of Comparison. Although the operational
7 components associated with Alternative 3 could have greater adverse effects on
8 spring-run Chinook Salmon than the Second Basis of Comparison, the non-
9 operational components associated with Alternative 3 could benefit spring-run
10 Chinook Salmon relative to the Second Basis of Comparison over the short term
11 if successful. The ocean harvest restriction component of Alternative 3 could
12 increase spring-run Chinook Salmon numbers by reducing ocean harvest and the
13 trap and haul program and predator control measures under Alternative 3 could
14 reduce predation on juvenile spring-run Chinook Salmon and thereby increase
15 survival. The effects of the trap and haul and predator management programs
16 under Alternative 3 are uncertain. Thus, it is concluded that the potential for
17 adverse effects on spring-run Chinook Salmon would be slightly less under
18 Alternative 3 than under the Second Basis of Comparison.

19 *Fall-Run Chinook Salmon*

20 Changes in operations that influence temperature and flow conditions in the
21 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
22 Whiskeytown Dam, Feather River downstream of Oroville Dam and American
23 River below Nimbus could affect fall-run Chinook Salmon. The following
24 describes those changes and their potential effects.

25 *Changes in Water Temperature*

26 Water temperature conditions in the Sacramento River, Clear Creek, and Feather
27 River under Alternative 3 and the Second Basis of Comparison would be same as
28 those described above for spring-run Chinook Salmon. Temperature conditions in
29 the Sacramento River, Clear Creek, Feather River, and American River would
30 generally be similar (differences less than 0.5°F) under Alternative 3 and the
31 Second Basis of Comparison (Appendix 6B).

32 The frequency of exceeding established temperature thresholds in the Sacramento
33 and Feather rivers for fall-run Chinook Salmon would be the same or nearly so
34 (differences of up to 2 percent) for both Alternative 3 and the Second Basis of
35 Comparison. Similarly, in the American River (Appendix 9C, Table B-6),
36 differences in the frequency of temperature threshold exceedance would be minor
37 (up to about 1 percent).

38 The results from Reclamation's salmon mortality model reflect the similarities in
39 temperature described above. For fall-run Chinook Salmon in the Sacramento
40 River, egg mortality would be similar under Alternative 3 and the Second Basis of
41 Comparison (Appendix 9C, Table B-1). Differences in the Feather and American
42 rivers would also be similar under Alternative 3 and the Second Basis of
43 Comparison.

1 *Changes in Weighted Usable Area*

2 Modeling results indicate that, in general, there would be similar amounts (less
3 than 5 percent differences) of fall-run Chinook Salmon spawning habitat available
4 in the Sacramento, Feather, and American rivers under Alternative 3 as compared
5 to the Second Basis of Comparison; fall-run fry and juvenile rearing WUA would
6 also be similar under Alternative 3 and the Second Basis of Comparison in the
7 Sacramento River. Overall, spawning and rearing habitat availability for fall-run
8 Chinook Salmon would be similar under Alternative 3 and the Second Basis of
9 Comparison.

10 *Changes in SALMOD Output*

11 SALMOD results indicate that production for fall-run Chinook Salmon would be
12 similar under Alternative 3 and the Second Basis of Comparison (Appendix 9D,
13 Table B-1-21).

14 *Changes in Delta Passage Model Output*

15 The Delta Passage Model predicted similar estimates of annual Delta survival
16 across the 8-year time period for fall-run Chinook Salmon between Alternative 3
17 and the Second Basis of Comparison (Appendix 9J). Median Delta survival was
18 0.246 for Alternative 3 and 0.245 for the Second Basis of Comparison.

19 *Changes in Delta Hydrodynamics*

20 Fall-run Chinook Salmon smolts are most abundant in the Delta during the
21 months of April, May and June. At the junction of Georgiana Slough and the
22 Sacramento River, the median proportion of positive velocities would be similar
23 in April, May, and June under Alternative 3 and the Second Basis of Comparison
24 (Appendix 9K). Near the confluence of the San Joaquin River and the
25 Mokelumne River, the median proportion of positive velocities would be similar
26 to or slightly lower under Alternative 3 relative to the Second Basis of
27 Comparison in the months when fall-run Chinook Salmon are most abundant. On
28 Old River downstream of the facilities, the median proportion of positive
29 velocities would be slightly higher in April and May, and similar in June under
30 Alternative 3 relative to the Second Basis of Comparison. In Old River upstream
31 of the facilities, the median proportion of positive velocities would be moderately
32 higher under Alternative 3 in April and May and slightly lower in June. On the
33 San Joaquin River downstream of the Head of Old River, the median proportion
34 of positive velocities would be slightly to moderately lower under Alternative 3
35 relative to the Second Basis of Comparison in April and May, respectively, and
36 slightly lower in June.

37 *Changes in Junction Entrainment*

38 Entrainment at the Georgiana Slough Junction under Alternative 3 would be
39 almost indistinguishable from the Second Basis of Comparison in April, May, and
40 June (Appendix 9L). At the Head of Old River junction in April and May,
41 entrainment would be much greater under Alternative 3 relative to the Second
42 Basis of Comparison. In June, entrainment would be similar under each scenario.
43 Patterns of entrainment would be similar at Turner Cut, Columbia Cut, Middle
44 River, and Old River. At these junctions, median entrainment under Alternative 3

1 would be slightly to moderately lower in April and May, and almost
2 indistinguishable in June.

3 *Changes in Salvage*

4 Salvage of Sacramento River-origin Chinook Salmon is predicted to be lower
5 under Alternative 3 relative to the Second Basis of Comparison in every month
6 except April, May, and June (Appendix 9M). Fall-run Chinook Salmon smolts
7 migrating through the Delta would be most susceptible in the months of April,
8 May, and June. Predicted values in April and May indicated a similar fraction of
9 fish salvaged under Alternative 3 and the Second Basis of Comparison and a
10 slightly reduce fraction salvaged in June under Alternative 3.

11 *Summary of Effects on Fall-Run Chinook Salmon*

12 The multiple model and analysis outputs described above characterize the
13 anticipated conditions for fall-run Chinook Salmon and their response to change
14 under Alternative 3 and the Second Basis of Comparison. For the purpose of
15 analyzing effects on fall-run Chinook Salmon in the Sacramento River, greater
16 reliance was placed on the outputs from the SALMOD model because it integrates
17 the available information on temperature and flows to produce estimates of
18 mortality for each life stage and an overall, integrated estimate of potential fall-
19 run Chinook Salmon juvenile production. The output from SALMOD indicated
20 that fall-run Chinook Salmon production would be similar in all water year types
21 under Alternative 3 and the Second Basis of Comparison.

22 The analyses attempting to assess the effects on routing, entrainment, and salvage
23 of juvenile salmonids in the Delta suggest that salvage (as an indicator of
24 potential losses of juvenile salmon at the export facilities) of Sacramento
25 River-origin Chinook Salmon generally would be similar under Alternative 3 and
26 the Second Basis of Comparison.

27 In Clear Creek and the Feather and American rivers, the analysis of the effects of
28 Alternative 3 and the Second Basis of Comparison for fall-run Chinook Salmon
29 relied on the WUA analysis for habitat and water temperature model output for
30 the rivers at various locations downstream of the CVP and SWP facilities. The
31 WUA analysis indicated that the availability of spawning and rearing habitat in
32 Clear Creek and spawning habitat in the Feather and American rivers would be
33 similar under Alternative 3 and the Second Basis of Comparison. The
34 temperature model outputs for each of the fall-run Chinook Salmon life stages
35 suggest that thermal conditions and effects on fall-run Chinook Salmon in all of
36 these streams generally would be similar under both scenarios. The water
37 temperature threshold exceedance analysis that indicated that the water
38 temperature thresholds for fall-run Chinook Salmon spawning and egg incubation
39 would be exceeded slightly less frequently in the Feather River and Clear Creek
40 under Alternative 3 and could reduce the potential for adverse effects on the fall-
41 run Chinook Salmon populations in Clear Creek and the Feather River. Results of
42 the analysis using Reclamation's salmon mortality model indicate that there
43 would be little difference in fall-run Chinook Salmon egg mortality under
44 Alternative 3 and the Second Basis of Comparison.

1 Overall, the results of the numerical models suggest the potential for less adverse
2 effects on fall-run Chinook Salmon under Alternative 3 as compared to the
3 Second Basis of Comparison. However, discerning a meaningful difference
4 between these two scenarios based on the quantitative results is not possible
5 because of the similarity in results (generally differences less than 5 percent) and
6 the inherent uncertainty of the models. In addition, adverse effects of
7 Alternative 3 could be offset by the potentially beneficial effects of the predator
8 control program and ocean harvest restrictions. Thus, it is concluded that the
9 potential for adverse effects on fall-run Chinook Salmon would be slightly less
10 under Alternative 3 than under the Second Basis of Comparison.

11 *Late Fall-Run Chinook Salmon*

12 *Changes in Water Temperature*

13 Temperature conditions in the Sacramento River downstream of Keswick Dam
14 for late fall-run Chinook Salmon under Alternative 3 and the Second Basis of
15 Comparison generally would be similar, as described above for fall-run Chinook
16 Salmon. The results from Reclamation's salmon mortality model reflect the
17 similarities in temperature described above. For late fall-run Chinook Salmon in
18 the Sacramento River, egg mortality would be similar under Alternative 3 and the
19 Second Basis of Comparison (Appendix 9C, Table B-1).

20 *Changes in Weighted Usable Area*

21 Modeling results indicate that there would be similar amounts of spawning habitat
22 available for late fall-run Chinook Salmon in the Sacramento River from January
23 through April under Alternative 3 as compared to the Second Basis of
24 Comparison (Appendix 9E, Table C-14-5). There also would be similar amounts
25 of suitable late fall-run Chinook Salmon fry rearing habitat available during April
26 and May under Alternative 3 and the Second Basis of Comparison (Appendix 9E,
27 Table C-15-5). Modeling results indicate that, there would generally be similar
28 amounts of suitable juvenile rearing habitat available all year long under
29 Alternative 3 and the Second Basis of Comparison (Appendix 9E, Table C-16-5).

30 *Changes in SALMOD Output*

31 Results from the SALMOD model indicate that potential production under
32 Alternative 3 would be similar under Alternative 3 and the Second Basis of
33 Comparison in all water year types (Appendix 9D, Table B-2-21).

34 *Changes in Delta Passage Model Output*

35 The Delta Passage Model predicted similar estimates of annual Delta survival
36 across the 81-year time period for late fall-run Chinook Salmon between
37 Alternative 3 and the Second Basis of Comparison (Appendix 9J). Median Delta
38 survival would be 0.199 for both scenarios.

39 *Changes in Delta Hydrodynamics*

40 The late fall-run Chinook Salmon migration period overlaps with the winter-run.
41 See the section on hydrodynamic analysis for winter-run Chinook Salmon for
42 potential effects on late fall-run Chinook Salmon.

1 *Changes in Junction Entrainment*

2 Entrainment probabilities for late fall-run Chinook Salmon are assumed to mimic
3 that of winter-run Chinook Salmon due to the overlap in timing. See the section
4 on winter-run Chinook Salmon entrainment for potential effects on late fall-run
5 Chinook Salmon.

6 *Changes in Salvage*

7 Salvage of late fall-run Chinook Salmon is assumed to mimic that of winter-run
8 Chinook Salmon due to overlap in timing. See the section on winter-run Chinook
9 Salmon entrainment for potential effects on the late fall-run Chinook Salmon.

10 *Summary of Effects on Late Fall-Run Chinook Salmon*

11 The multiple model and analysis outputs described above characterize the
12 anticipated conditions for late fall-run Chinook Salmon and their response to
13 change under Alternative 3 and the Second Basis of Comparison. For the purpose
14 of analyzing effects on late fall-run Chinook Salmon and developing conclusions,
15 greater reliance was placed on the outputs from the SALMOD model because it
16 integrates the available information on temperature and flows to produce
17 estimates of mortality for each life stage and an overall, integrated estimate of
18 potential fall-run Chinook Salmon juvenile production. The output from
19 SALMOD suggested that late fall-run Chinook Salmon production would be
20 similar under Alternative 3 and the Second Basis of Comparison.

21 Although, potential losses of juvenile salmon at the export facilities could be
22 higher under Alternative 3, as suggested by the analysis of salvage, it is likely that
23 effects on the late fall-run Chinook Salmon population would be similar under
24 Alternative 3 and the Second Basis of Comparison.

25 Overall, the results of the numerical models suggest the potential for less adverse
26 effects on late fall-run Chinook Salmon under Alternative 3 as compared to the
27 Second Basis of Comparison. However, discerning a meaningful difference
28 between these two scenarios based on the quantitative results is not possible
29 because of the similarity in results (generally differences less than 5 percent) and
30 the inherent uncertainty of the models. In addition, any adverse effects of
31 Alternative 3 could be offset by the potentially beneficial effects resulting from
32 predator control and ocean harvest restrictions. Thus, it is concluded that the
33 effects on late fall-run Chinook Salmon would be similar under Alternative 3 and
34 the Second Basis of Comparison.

35 *Steelhead*

36 *Changes in Water Temperature*

37 Water temperature conditions in the Sacramento River, Clear Creek, Feather
38 River and American River under Alternative 3 and the Second Basis of
39 Comparison would be same as those described above for fall-run Chinook
40 Salmon. Temperature conditions in the Sacramento River, Clear Creek, Feather
41 River, and American River would generally be similar (differences less than
42 0.5°F) under Alternative 3 and the Second Basis of Comparison (Appendix 6B).

1 The frequency of exceeding temperature thresholds in the Sacramento, Feather,
2 and American rivers for steelhead would be the same or nearly so (differences of
3 up to 2 percent) for both Alternative 3 and the Second Basis of Comparison
4 Exceedances.

5 *Changes in Weighted Usable Area*

6 Modeling results indicate that, in general, there would be similar amounts (less
7 than 5 percent differences) of steelhead spawning habitat available in Clear Creek,
8 and the Sacramento, Feather, and American rivers under Alternative 3 as
9 compared to the Second Basis of Comparison.

10 *Summary of Effects on Steelhead*

11 The multiple model and analysis outputs described above characterize the
12 anticipated conditions for steelhead and their response to change under
13 Alternative 3 and the Second Basis of Comparison. The analysis of the effects of
14 Alternative 3 and the Second Basis of Comparison for steelhead relied on the
15 WUA analysis for habitat and water temperature model output for the rivers at
16 various locations downstream of the CVP and SWP facilities. The WUA analysis
17 indicated that the availability of steelhead spawning and rearing habitat in Clear
18 Creek and steelhead spawning habitat in the Sacramento, Feather and American
19 rivers would be similar under Alternative 3 and the Second Basis of Comparison.
20 The temperature model outputs for each of the steelhead life stages indicated that
21 the water temperature thresholds for steelhead spawning and egg incubation
22 would be exceeded less frequently in the Feather River under Alternative 3.
23 However, the water temperature threshold for steelhead rearing in the Feather
24 River would be exceeded less frequently in some months and more frequently in
25 others under Alternative 3. The water temperature threshold for steelhead rearing
26 in the American River would also be exceeded more frequently in most months
27 under Alternative 3. Because of the inherent uncertainty associated with the
28 resolution of the temperature model (average monthly outputs), and the
29 differences in the magnitude and direction of the temperature exceedances under
30 Alternative 3, the extent of temperature-related effects on steelhead in the Feather
31 and American rivers is uncertain.

32 Overall, the results of the numerical models suggest a slightly greater potential to
33 result in adverse effects on steelhead under Alternative 3 as compared to the
34 Second Basis of Comparison. However, discerning a meaningful difference
35 between these two scenarios based on the quantitative results is not possible
36 because of the similarity in results (generally differences less than 5 percent) and
37 the inherent uncertainty of the models. In addition, any adverse effects of
38 Alternative 3 could be offset by the potentially beneficial effects resulting from
39 predator control and ocean harvest restrictions. Thus, it is concluded that the
40 effects on steelhead would be similar under Alternative 3 and the Second Basis of
41 Comparison.

1 *Sturgeon (green and white)*

2 Changes in operations that influence temperature and flow conditions could affect
3 Green Sturgeon. The following describes those changes and their potential
4 effects.

5 *Changes in Water Temperature*

6 The analysis of the effects of Alternative 3 and Second Basis of Comparison for
7 sturgeon relied on water temperature model output for the Sacramento and
8 Feather rivers at various locations downstream of Shasta Dam and the Thermalito
9 complex. The temperature model outputs for each of these rivers suggest that
10 thermal conditions and effects on sturgeon in the Sacramento and Feather rivers
11 generally would be similar under both scenarios. This conclusion is supported by
12 the water temperature threshold exceedance analysis that indicated that the water
13 temperature thresholds for sturgeon spawning, incubation, and rearing would be
14 exceeded slightly less frequently under Alternative 3 in the Sacramento River.
15 The water temperature threshold for sturgeon spawning, incubation, and rearing
16 also would be exceeded slightly less frequently in the Feather River.

17 *Changes in Delta Outflow*

18 As described in Appendix 9P, mean (March to July) Delta outflow was used an
19 indicator of potential year class strength and the likelihood of producing a strong
20 year class of sturgeon. The median value over the 82-year CalSim II modeling
21 period of mean (March to July) Delta outflow was predicted to similar under the
22 Alternative 3 and the Second Basis of Comparison. In addition, the likelihood of
23 mean (March to July) Delta outflow exceeding the threshold of 50,000 cfs was the
24 same under both alternatives.

25 *Summary of Effects on Sturgeon*

26 The slightly reduced frequency of exceedance of temperature thresholds under
27 Alternative 3 could reduce the potential for adverse effects on sturgeon in the
28 Sacramento and Feather rivers relative to the Second Basis of Comparison. The
29 analysis based on Delta outflows suggests that Alternative 3 provides similar
30 mean (March to July) outflows which would have similar effects on year class
31 strength of juvenile sturgeon relative to the Second Basis of Comparison.
32 Therefore, based primarily on the analysis of water temperatures, Alternative 3
33 could be less likely to result in adverse effects on White Sturgeon than the Second
34 Basis of Comparison.

35 *Delta Smelt*

36 *Changes in Proportional Entrainment*

37 As described in Appendix 9G, a proportional entrainment regression model
38 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt
39 entrainment, as influenced by OMR flow in December through March. Results
40 indicate that the percentage of entrainment of migrating and spawning adult Delta
41 Smelt under Alternative 3 would be 7.3 to 8.5 percent, depending on the water
42 year type, with a long term average percent entrainment of 7.9 percent. Percent

1 entrainment of adult Delta Smelt under Alternative 3 would be similar to results
2 under the Second Basis of Comparison.

3 As described in Appendix 9G, a proportional entrainment regression model
4 (based on Kimmerer 2008) was used to simulate larval and early juvenile Delta
5 Smelt entrainment, as influenced by OMR flow and location of X2 in March
6 through June. Results indicate that the percentage of entrainment of larval and
7 early juvenile Delta Smelt under Alternative 3 would be 5.6 to 20.5 percent,
8 depending on the water year type, with a long term average percent entrainment
9 of 12.7 percent, and highest entrainment under Critical water year conditions.
10 Percent entrainment of larval and early juvenile Delta Smelt under Alternative 3
11 would be similar to results under the Second Basis of Comparison.

12 *Changes in Fall Abiotic Habitat Index*

13 The average September through December X2 position in km was used to
14 evaluate the fall abiotic habitat availability for delta smelt under the Alternatives.
15 X2 values simulated in the CalSim II model for each alternative were averaged
16 over September through December, and compared. Results indicate that under
17 the Second Basis of Comparison, the X2 position would range from 85.6 km to
18 92.3 km, depending on the water year type, with a long term average X2 position
19 of 88.1 km. The most eastward location of X2 is predicted under Critical water
20 year conditions. The X2 positions predicted under Alternative 3 would be similar
21 to predictions under the Second Basis of Comparison (only 0.1 to 0.3 km
22 difference). Under Alternative 3, the long term average X2 position would be
23 88.1 km, a location that does not provide for the advantageous overlap of the low
24 salinity zone with Suisun Bay/Marsh.

25 *Summary of Effects on Delta Smelt*

26 Overall, Alternative 3 likely would have similar effects on Delta Smelt, as
27 compared to the Second Basis of Comparison with regard to estimated
28 entrainment and predicted location of Fall X2. However, given the current
29 condition of the Delta Smelt population, even small differences between
30 alternatives may be important.

31 *Longfin Smelt*

32 The effects of the Alternative 3 as compared to the Second Basis of Comparison
33 were analyzed based on the direction and magnitude of OMR flows during the
34 period (December through June) when adult, larvae, and young juvenile Longfin
35 Smelt are present in the Delta in the vicinity of the export facilities
36 (Appendix 5A). The analysis was augmented with calculated Longfin Smelt
37 abundance index values (Appendix 9G) per Kimmerer et al. (2009), which is
38 based on the assumptions that lower X2 values reflect higher flows and that
39 transporting Longfin Smelt farther downstream leads to greater Longfin Smelt
40 survival. The index value indicates the relative abundance of Longfin Smelt and
41 not the calculated population.

42 As described in Appendix 5A, OMR flows would be negative in all months under
43 both Alternative 3 and the Second Basis of Comparison. Flows under
44 Alternative 3 generally would be less negative than under the Second Basis of

1 Comparison, except in June, July, and August, when OMR flows under
2 Alternative 3 would be more negative by greater 25 percent in some months and
3 year types. The increase in the magnitude of negative flows in June, July, and
4 August under Alternative 3 could increase the likelihood of entrainment of
5 Longfin Smelt at the export facilities.

6 Under Alternative 3, Longfin Smelt abundance index values range from 1,094
7 under critical water year conditions to a high of 15,638 under wet water year
8 conditions, with a long-term average value of 7,345 (see Appendix 9G). Under
9 the Second Basis of Comparison, Longfin Smelt abundance index values range
10 from 947 under critical water year conditions to a high of 15,822 under wet water
11 year conditions, with a long-term average value of 7,257.

12 Results indicate that the Longfin Smelt abundance index values would be similar
13 in wetter years and higher in drier water year types under Alternative 3 than they
14 would be under the Second Basis of Comparison, with a long-term average index
15 for Alternative 3 that is 1 similar to the long-term average index under the Second
16 Basis of Comparison. The greatest increase in the Longfin Smelt abundance
17 index occurs in critical years where it is 15.5 percent greater under Alternative 3
18 than under the Second Basis of Comparison. For below normal, and dry water
19 years, the Longfin Smelt abundance index values would be 9.7 and 13.8 percent
20 higher, respectively, under Alternative 3 than under the Second Basis of
21 Comparison. Based on the Longfin Smelt abundance indices, Alternative 3 likely
22 would have a lower potential for adverse effects on Longfin Smelt, as compared
23 to the Second Basis of Comparison. Given the current condition of the Longfin
24 Smelt population, even these small differences between alternatives may be
25 important.

26 *Sacramento Splittail*

27 Under Alternative 3, flows entering the Yolo Bypass generally would similar to
28 flows under the Second Basis of Comparison from December through March
29 (Appendix 5A, Table C-26-5). Any differences likely would be insufficient to
30 reduce potential Sacramento Splittail spawning habitat in the bypass. Given the
31 relatively minor changes in flows into the Yolo Bypass, and the inherent
32 uncertainty associated with the resolution of the CalSim II model (average
33 monthly outputs), it is concluded that there would be no definitive difference in
34 effects on Sacramento Splittail between Alternative 3 and the Second Basis of
35 Comparison.

36 *Reservoir Fishes*

37 The analysis of effects associated with changes in operation on reservoir fishes
38 relied on evaluation of changes in available habitat (reservoir storage) and
39 anticipated changes in black bass nesting success.

40 Alternative 3 as compared to the Second Basis of Comparison generally would
41 result in similar (differences less than 5 percent) storage levels in CVP and SWP
42 reservoirs during the March through June period (Appendix 5A).

1 In general, black bass nesting success also would be similar under Alternative 3
2 and the Second Basis of Comparison. Nesting success of black bass would be
3 high in March and April due to increasing water surface elevations. During May,
4 the likelihood of high (>40 percent) nesting success would be similar in most of
5 the reservoirs under Alternative 3 as compared to the Second Basis of
6 Comparison. This pattern is reversed in June, with the likelihood of high nesting
7 success being somewhat (5 to 7 percent) lower under Alternative 3
8 (Appendix 9F). Most black bass spawning likely occurs prior to June, such that
9 drawdowns during June would likely affect only a small proportion of the
10 spawning population. Thus, it is concluded that effects on black bass nesting
11 success would be similar under Alternative 3 and the Second Basis of
12 Comparison.

13 *Other Species*

14 Several other fish species could be affected by changes in operations that
15 influence temperature and flow. In general, lampreys, Striped Bass, American
16 Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on
17 the similar water temperatures during their spawning and incubation period under
18 Alternative 3, it is likely that thermal conditions for and effects on these other
19 species in the Sacramento, Feather, and American rivers would be similar under
20 Alternative 3 and the Second Basis of Comparison. Alternative 3 would result in
21 a similar X2 position as compared to the Second Basis of Comparison during
22 April, May, and June (Appendix 5A, Section C Table C-16-5). This similarity in
23 the position of X2 would likely result in a similar survival index and habitat index
24 as measured by salinity for Striped Bass and a similar abundance and habitat
25 index for American Shad. Alternative 3 likely would have a similar potential for
26 adverse effects on lampreys, American Shad, and Hardhead as the Second Basis
27 of Comparison. However, the increased bag limits and ability of anglers to retain
28 Striped Bass that are 12 inches in length versus 18 inches under Alternative 3
29 could reduce the ability to meet the doubling goals for Striped Bass populations
30 under the requirements of Section 3406(b)(1) of CVPIA. Overall, Alternative 3
31 likely would have slightly greater potential for adverse effects on Striped Bass as
32 compared to the Second Basis of Comparison, primarily due to the potential for
33 adverse effects of changing the bag and size limits for Striped Bass under the
34 predator control program.

35 *Stanislaus River/Lower San Joaquin River*

36 *Fall-Run Chinook Salmon*

37 Changes in operations influence temperature and flow conditions that could affect
38 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam
39 and in the San Joaquin River below Vernalis. The following describes those
40 changes and their potential effects.

41 *Changes in Water Temperature (Stanislaus River)*

42 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
43 under Alternative 3 generally would be similar to the Second Basis of Comparison
44 but could be lower (up to 1.5°F) than under the Second Basis of Comparison in

1 September, October, and November of drier years (Appendix 6B, Table B-17-5).
2 Downstream at Orange Blossom Bridge, average monthly water temperatures
3 under Alternative 3 and the Second Basis of Comparison would generally be
4 similar except from August through November of drier years when water
5 temperatures could be up to up to 1.6°F cooler under Alternative 3 and in June
6 when the average monthly water temperature could be 2.8°F warmer and up to
7 4.3°F warmer in wet years under Alternative 3 as compared to the Second Basis
8 of Comparison (Appendix 6B, Table B-18-5). This temperature pattern would
9 continue downstream to the confluence with the San Joaquin River, although the
10 magnitude of temperature differences under Alternative 3 (Appendix 6B,
11 Table B-19-5) would be larger in June and water temperatures could be up to
12 1.6°F cooler in April under Alternative 3 as compared to the Second Basis of
13 Comparison. Lower fall water temperatures in drier years would reduce the
14 likelihood of adverse effects on spawning fall-run Chinook Salmon.

15 *Changes in Exceedance of Water Temperature Thresholds*
16 *(Stanislaus River)*

17 While specific water temperature thresholds for fall-run Chinook Salmon in the
18 Stanislaus River are not established, temperatures generally suitable for fall-run
19 Chinook Salmon spawning (56°F) would be exceeded in October (over 30 percent
20 of the time) and November over 20 percent of the time in the Stanislaus River at
21 Goodwin Dam under Alternative 3 (Appendix 6B, Table B-17-1). Similar
22 exceedances would occur under the Second Basis of Comparison. Water
23 temperatures for rearing generally would be below 56°F, except in May.

24 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run
25 Chinook Salmon spawning would be exceeded frequently under both
26 Alternative 3 and the Second Basis of Comparison during October and November,
27 but the 56°F threshold would be exceeded 2 percent more frequently in October
28 and 4 percent less frequently in November percent.

29 During January through May, rearing fall-run Chinook Salmon under
30 Alternative 3 and the Second Basis of Comparison would be subjected to average
31 monthly water temperatures that exceed 56°F, with water temperatures under
32 Alternative 3 exceeding the threshold in April about 4 percent less frequently and
33 about 7 percent more frequently in May than under the Second Basis of
34 Comparison (Appendix 6B, Figure B-18-5).

35 *Changes in Egg Mortality (Stanislaus River)*

36 For fall-run Chinook Salmon in the Stanislaus River, egg mortality rates would be
37 similar under both scenarios (Appendix 9C, Table B-8).

38 *Changes in Delta Hydrodynamics*

39 San Joaquin River-origin fall-run Chinook Salmon smolts are most abundant in
40 the Delta during the months of April, May and June. Near the confluence of the
41 San Joaquin River and the Mokelumne River, the median proportion of positive
42 velocities would be similar to or slightly lower under Alternative 3 relative to the
43 Second Basis of Comparison in the months when fall-run would be most abundant

1 (Appendix 9K). On Old River downstream of the facilities, the median
 2 proportion of positive velocities would be slightly higher in April and May, and
 3 similar in June under Alternative 3 relative to the Second Basis of Comparison.
 4 In Old River upstream of the facilities, the median proportion of positive
 5 velocities would be moderately higher under Alternative 3 in April and May, and
 6 slightly lower in June. On the San Joaquin River downstream of the Head of Old
 7 River, the median proportion of positive velocities would be slightly to
 8 moderately lower under Alternative 3 relative to the Second Basis of Comparison
 9 in April and May, respectively, and slightly lower in June.

10 *Changes in Junction Entrainment*

11 Entrainment at the Georgiana Slough Junction under Alternative 3 would be
 12 almost indistinguishable from the Second Basis of Comparison in April, May, and
 13 June (Appendix 9L). At the Head of Old River junction in April and May,
 14 entrainment would be much greater under Alternative 3 relative to the Second
 15 Basis of Comparison (Appendix 9L). In June, entrainment would be similar
 16 under each scenario. Patterns of entrainment would be similar at Turner Cut,
 17 Columbia Cut, Middle River, and Old River. At these junctions, median
 18 entrainment under Alternative 3 would be slightly to moderately lower in April
 19 and May, and almost indistinguishable in June.

20 *Summary of Effects on Fall-Run Chinook Salmon*

21 The analysis of temperatures indicates somewhat similar temperatures and a
 22 similar likelihood of exceedance of suitable temperatures for spawning and
 23 rearing of fall-run Chinook Salmon under Alternative 3 as compared to the
 24 Second Basis of Comparison in the Stanislaus River below Goodwin Dam and in
 25 the San Joaquin River at Vernalis. The effect of lower temperatures is reflected in
 26 the similar overall mortality of fall-run Chinook Salmon eggs predicted by
 27 Reclamation's salmon mortality model for fall-run in the Stanislaus River.

28 Overall, Alternative 3 likely would have similar effects on the fall-run Chinook
 29 Salmon population in the San Joaquin River watershed as compared to the Second
 30 Basis of Comparison. Alternative 3 could also provide beneficial effects to
 31 juvenile fall-run Chinook Salmon as a result of trap and haul passage through the
 32 Delta and ocean harvest restrictions. It remains uncertain, however, if predator
 33 management actions under Alternative 3 would benefit fall-run Chinook Salmon.

34 *Steelhead*

35 Changes in operations that influence temperature and flow conditions in the
 36 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below
 37 Vernalis could affect steelhead. The following describes those changes and their
 38 potential effects.

39 *Changes in Water Temperature (Stanislaus River)*

40 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
 41 under Alternative 3 generally would be similar to the Second Basis of Comparison
 42 but could be lower (up to 1.5°F) than under the Second Basis of Comparison in
 43 September, October, and November of drier years. Downstream at Orange

1 Blossom Bridge, average monthly water temperatures under Alternative 3 and the
2 Second Basis of Comparison would generally be similar except from August
3 through November of drier years when water temperatures could be up to up to
4 1.6°F cooler under Alternative 3 and in June when the average monthly water
5 temperature could be 2.8°F warmer and up to 4.3°F warmer in drier years under
6 Alternative 3 as compared to the Second Basis of Comparison. This temperature
7 pattern would continue downstream to the confluence with the San Joaquin River,
8 although the magnitude of temperature differences under Alternative 3 would be
9 larger in June and water temperatures could be up to 1.6°F cooler in April under
10 Alternative 3 as compared to the Second Basis of Comparison.

11 *Changes in Exceedance of Water Temperature Thresholds*
12 *(Stanislaus River)*

13 Average monthly water temperatures in the Stanislaus River at Orange Blossom
14 Bridge would frequently exceed the temperature threshold (56°F) established for
15 adult steelhead migration under both Alternative 3 and the Second Basis of
16 Comparison during October and November, with the threshold being exceeded
17 2 percent more frequently in October and 4 percent less frequently in
18 November percent. In January through May, the temperature threshold at Orange
19 Blossom Bridge is 55°F, which is intended to support steelhead spawning. Under
20 Alternative 3, this threshold would be exceeded under Alternative 3 about
21 8 percent and 10 percent more frequently in March and May, respectively, than
22 under the Second Basis of Comparison. However, the threshold would be
23 exceeded 16 percent less frequently under Alternative 3 in April.

24 During June through November, the temperature threshold of 65°F established to
25 support steelhead rearing would be exceeded under both Alternative 3 and the
26 Second Basis of Comparison in all months but November, with the highest
27 frequency of exceedance in July (19 percent under Alternative 3). The
28 differences between Alternative 3 and the Second Basis of Comparison, however,
29 would be variable depending on the month, with water temperatures under
30 Alternative 3 exceeding the threshold 2 percent to 4 percent more frequently than
31 under the Second Basis of Comparison in June and July and up to 4 percent less
32 frequently from August to October.

33 Average monthly water temperatures also would exceed the threshold (52°F)
34 established for smoltification at Knights Ferry from January through May under
35 both Alternative 3 and the Second Basis of Comparison. Differences in the
36 likelihood of threshold exceedance between scenarios would be small (up to
37 3 percent) with the threshold being more likely to be exceeded in March and less
38 likely to be exceeded in April and May. Farther downstream at Orange Blossom
39 Bridge, the temperature threshold for smoltification is higher (57°F). Under
40 Alternative 3, water temperatures would exceed the 57°F threshold about
41 4 percent less frequently in April and about 7 percent more frequently than under
42 the Second Basis of Comparison in May.

1 *Changes in Delta Hydrodynamics*

2 San Joaquin River-origin steelhead generally move through the Delta during
3 spring; however, there is less information on their timing than there is for
4 Chinook salmon. Thus, hydrodynamics in the entire January through June period
5 could have the potential to affect juvenile steelhead. For a description of potential
6 hydrodynamic effects on steelhead, see the descriptions for winter-run Chinook
7 Salmon in the Sacramento Basin and fall-run Chinook Salmon in the San Joaquin
8 River basin, above.

9 *Summary of Effects on Steelhead*

10 Given the frequency of exceedance under both Alternative 3 and the Second Basis
11 of Comparison, water temperature conditions for steelhead in the Stanislaus River
12 would likely be similar. The differences in temperature exceedance would be
13 variable (both positive and negative) between Alternative 3 and the Second Basis
14 of Comparison, with no clear benefit associated with either alternative.
15 Discerning a meaningful difference between these two scenarios based on the
16 quantitative results is not possible because of the similarity in results (generally
17 differences less than 5 percent) and the inherent uncertainty of the models. Thus,
18 it is concluded that the effects on steelhead would be similar under Alternative 3
19 and the Second Basis of Comparison.

20 *White Sturgeon*

21 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River
22 upstream of the confluence with the Stanislaus River. While flows in the San
23 Joaquin River upstream of the Stanislaus River are expected to be similar under all
24 alternatives, flow contributions from the Stanislaus River could influence water
25 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may
26 occur during the spring and early summer. The magnitude of influence on water
27 temperature would depend on the proportional flow contribution of the Stanislaus
28 River and the temperatures in both the Stanislaus and San Joaquin rivers. The
29 potential for an effect on White Sturgeon eggs and larvae would be influenced by
30 the proportion of the population occurring in the San Joaquin River. In
31 consideration of this uncertainty, it is not possible to distinguish potential effects
32 on White Sturgeon between alternatives.

33 *Reservoir Fishes*

34 *Changes in Available Habitat (Storage)*

35 As described in Chapter 5, Surface Water Resources and Water Supplies, storage
36 levels in New Melones Reservoir would be higher under Alternative 3 as
37 compared to the Second Basis of Comparison, as summarized in Table 5.38, due
38 to higher allocations of water supplies to CVP water service contractors, less
39 fisheries flows, no water quality releases under SWRCB D-1641, and no
40 Bay-Delta flow releases under SWRCB D-1641.

41 Storage in New Melones could be increased up to around 20 percent in some
42 months of some water year types. Additional information related to monthly
43 reservoir elevations is provided in Appendix 5A, CalSim II and DSM2 Modeling.
44 It is anticipated that aquatic habitat within New Melones is not limiting; however,

1 storage volume is an indicator of how much habitat is available to fish species
2 inhabiting these reservoirs. Therefore, the amount of habitat for reservoir fishes
3 could be increased under Alternative 3 as compared to the Second Basis of
4 Comparison.

5 *Changes in Black Bass Nesting Success*

6 Results of the bass nesting success analysis are presented in Appendix 9F,
7 Reservoir Fish Analysis Documentation. For March, the likelihood of
8 Largemouth Bass and Smallmouth Bass nest survival in New Melones being
9 above 40 percent is similar under Alternative 3 and the Second Basis of
10 Comparison. For April, the likelihood that nest survival of Largemouth Bass and
11 Smallmouth Bass is between 40 and 100 percent is reasonably high (around
12 80 percent) but is about 5 percent lower under Alternative 3 as compared to the
13 Second Basis of Comparison. For May, the pattern is reversed with the likelihood
14 of high nest survival being about 7 percent greater under Alternative 3. For June,
15 the likelihood of survival being greater than 40 percent for Largemouth Bass and
16 Smallmouth Bass in New Melones is about 38 percent greater under Alternative 3
17 as compared to the Second Basis of Comparison. For Spotted Bass, nest survival
18 from March through June is anticipated to be near 100 percent in every year under
19 both Alternative 3 and the Second Basis of Comparison. Most black bass
20 spawning likely occurs prior to June, such that drawdowns during June would
21 likely affect only a small proportion of the spawning population. Thus, it is
22 concluded that effects on black bass nesting success would be similar under
23 Alternative 3 and the Second Basis of Comparison.

24 The analysis of black bass nest survival based on changes in water surface
25 elevation during the spawning period indicated that the likelihood of high
26 (>40 percent) nest survival in New Melones under Alternative 3 would be similar
27 to or higher than under the Second Basis of Comparison. This suggests that
28 conditions in New Melones could be more likely to support self-sustaining
29 populations of black bass under Alternative 3 than under the Second Basis of
30 Comparison.

31 *Other Species*

32 Changes in operations that influence temperature and flow conditions in the
33 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at
34 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.
35 As described above, water temperatures would generally be similar under
36 Alternative 3 and the Second Basis of Comparison. In general, lampreys, Striped
37 Bass and Hardhead can tolerate higher temperatures than salmonids. Given the
38 similar flows and temperatures during their spawning and incubation period, it is
39 likely that the potential to affect these species in the Stanislaus and San Joaquin
40 rivers would be similar under Alternative 3 and the Second Basis of Comparison.
41 However, the increased bag limits and ability of anglers to retain Striped Bass that
42 are 12 inches in length versus 18 inches under Alternative 3 could reduce the
43 ability to meet the doubling goals for Striped Bass populations under the
44 requirements of Section 3406(b)(1) of CVPIA.

1 *San Francisco Bay Area Region*

2 *Killer Whale*

3 As described above for the comparison of Alternative 1 to the No Action
4 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
5 supported heavily by hatchery production of fall-run Chinook Salmon, would be
6 appreciably affected by any of the alternatives.

7 **9.4.3.5 Alternative 4**

8 The CVP and SWP operations under Alternative 4 are identical to the CVP and
9 SWP operations under the Second Basis of Comparison and Alternative 1, as
10 described in Chapter 3, Description of Alternatives. Alternative 4 also includes
11 the following items that are not included in the No Action Alternative or the
12 Second Basis of Comparison and would affect fish and aquatic resources.

- 13 • Implement predator control programs for black bass, Striped Bass, and
14 Pikeminnow to protect salmonids and Delta Smelt as follows:
 - 15 – Black bass catch limit changed to allow catch of 12-inch fish with a bag
16 limit of 10
 - 17 – Striped Bass catch limit changed to allow catch of 12-inch fish with a bag
18 limit of 5
 - 19 – Establish a Pikeminnow sport-fishing reward program with a 8-inch limit
20 at \$2/fish
- 21 • Establish a trap and haul program for juvenile salmonids entering the Delta
22 from the San Joaquin River in March through June as follows:
 - 23 – Begin operation of downstream migrant fish traps upstream of the Head of
24 Old River on the San Joaquin River
 - 25 – “Barge” all captured juvenile salmonids through the Delta, release at
26 Chipps Island.
 - 27 – Tag subset of fish in order to quantify effectiveness of the program
 - 28 – Attempt to capture 10 percent to 20 percent of outmigrating juvenile
29 salmonids
- 30 • Work with Pacific Fisheries Management Council, CDFW, and NMFS to
31 impose salmon harvest restrictions to reduce by-catch of winter-run and
32 spring-run Chinook Salmon to less than 10 percent of age-3 cohort in all years

33 As described in Chapter 4, Approach to Environmental Analysis, Alternative 4 is
34 compared to the No Action Alternative and the Second Basis of Comparison.

35 **9.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

36 *Trinity River Region*

37 The CVP and SWP operations under Alternative 4 are identical to the CVP and
38 SWP operations under the Second Basis of Comparison and Alternative 1.
39 Therefore, changes in aquatic resources at Trinity Lake and along the Trinity

1 River and lower Klamath River under Alternative 4 as compared to the No Action
2 Alternative would be the same as the impacts described in Section 10.4.4.2.1,
3 Alternative 1 Compared to the No Action Alternative.

4 *Central Valley Region and Stanislaus River*

5 The CVP and SWP operations under Alternative 4 are identical to the CVP and
6 SWP operations under the Second Basis of Comparison and Alternative 1.
7 Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in
8 the rivers downstream of the reservoirs, and in the Delta under Alternative 4 as
9 compared to the No Action Alternative would be the same as the impacts
10 described in Section 9.4.3.2.1, Alternative 1 Compared to the No Action
11 Alternative.

12 Conditions related to salmonid survival could be improved under Alternative 4 as
13 compared to the No Action Alternative due to implementation of changes in
14 Striped Bass bag limits for predator control and changes in PMFC/NMFS harvest
15 limits. However, these benefits would not likely exceed those described for the
16 No Action Alternative, particularly in consideration of the provision of fish
17 passage upstream of Shasta and Folsom dams to address long-term temperature
18 challenges on listed salmonids caused by climate change.

19 Conditions for Striped Bass under Alternative 4 could be influenced by
20 implementation of a predator control program that reduces the size restrictions
21 and increases the catch limit for Striped Bass taken in the sport fishery. This also
22 could reduce the ability to meet the doubling goals for Striped Bass populations
23 under the requirements of Section 3406(b)(1) of CVPIA.

24 *San Francisco Bay Area Region*

25 *Killer Whale*

26 As described above the comparison of Alternative 1 to the No Action Alternative,
27 it is unlikely that the Chinook Salmon prey base of killer whales, supported
28 heavily by hatchery production of fall-run Chinook Salmon, would be appreciably
29 affected by any of the alternatives.

30 **9.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

31 *Trinity River Region*

32 The CVP and SWP operations under Alternative 4 are identical to the CVP and
33 SWP operations under the Second Basis of Comparison and Alternative 1.
34 Therefore, aquatic resources conditions at Trinity Lake and along the Trinity
35 River and lower Klamath River under Alternative 4 be the same as under the
36 Second Basis of Comparison.

37 *Central Valley Region and Stanislaus River*

38 The CVP and SWP operations under Alternative 4 are identical to the CVP and
39 SWP operations under the Second Basis of Comparison and Alternative 1.
40 Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in
41 the rivers downstream of the reservoirs, and in the Delta due to operations under

1 Alternative 4 would be the same as described for the Second Basis of
2 Comparison.

3 Conditions related to salmonid survival could be improved under Alternative 4 as
4 compared to the Second Basis of Comparison due to implementation of the Trap
5 and Haul Program, changes in bag limits, and changes in PMFC/NMFS harvest
6 limits. Conditions related to year class strength of juvenile sturgeon would be the
7 same under the Alternative 4 relative to the Second Basis of Comparison due to
8 similar reductions in mean (March to July) Delta outflow. Conditions for Striped
9 Bass under Alternative 4 would be the same as those described above for the
10 comparison to the No Action Alternative.

11 However, it should be noted that the changes in ocean harvest limits under
12 Alternative 4 could be inconsistent with NMFS' fisheries management framework
13 for reducing the impact of ocean salmon fishery on winter-run Chinook Salmon
14 for the Pacific Coast Salmon Fishery Management Plan (National Marine
15 Fisheries Service 2012). The framework consists of two components. The first
16 component specifies that the previous standards for winter-run Chinook Salmon
17 regarding minimum size limits and seasonal windows south of Point Arena for
18 both the commercial and recreational fisheries will continue to remain in effect at
19 all times regardless of abundance estimates or impact rate limit. The second
20 component is based on the population status of winter-run Chinook Salmon
21 where, during periods of relatively low abundance, the proposed structure of
22 fishing management measures each year for winter-run Chinook Salmon south of
23 Point Arena must be equal to or less than the maximum allowable impact rate
24 (MAIR) specified annually. The fishery control rule and tiered approach for
25 managing impacts to winter-run Chinook Salmon in the ocean salmon fishery
26 include: (1) if the geometric mean of the most recent 3 years of spawning return
27 estimates is less than 500, the MAIR is zero percent; and (2) if the geometric
28 mean of the most recent 3 years of spawning return estimates is between 500 and
29 4,000, the MAIR is between 10 percent and 20 percent, increasing linearly.

30 If Alternative 4 were selected, Reclamation would be required to re-consult with
31 NMFS regarding all aspects of the alternative that could result in the take of listed
32 salmonids before implementation, including the provisions of the proposed
33 changes in harvest limits.

34 *Killer Whale*

35 As described above for the comparison of Alternative 1 to the No Action
36 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
37 supported heavily by hatchery production of fall-run Chinook Salmon, would be
38 appreciably affected by any of the alternatives.

39 **9.4.3.6 Alternative 5**

40 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
41 under Alternative 5 are similar to the No Action Alternative with modified OMR
42 flow criteria and New Melones Reservoir operations. As described in Chapter 4,
43 Approach to Environmental Analysis, Alternative 5 is compared to the No Action
44 Alternative and the Second Basis of Comparison.

1 Alternative 5 also includes the Delta Cross Channel Temporary Closure Multi-
2 year Study. As noted in the Finding of No Significant Impact (FONSI) document
3 from Reclamation (Reclamation, 2012), this study proposes closing the DCC for
4 up to 10 days during the first half of October from 2012 through 2016. The
5 FONSI also notes that the DCC closure would not cause any adverse effects to the
6 native aquatic and fisheries. Therefore, the effects of this study are not
7 considered any further in the impact analyses for Alternative 5 below.

8 **9.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

9 Because of the considerable similarities between Alternative 5 and the No Action
10 Alternative, the analysis below combines species within some regions where to
11 reduce repetition.

12 *Trinity River Region*

13 *Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon,*
14 *Steelhead, and Green Sturgeon*

15 Average monthly water temperature in the Trinity River at Lewiston Dam under
16 Alternative 5 would be similar to water temperatures under the No Action
17 Alternative (less than 0.5°F differences) in all months (Appendix 6B,
18 Table B-1-3). Similarly, the differences in the frequency with which
19 Alternative 5 and the No Action Alternative would exceed established
20 temperature thresholds also would be small (up to 1 or 2 percent) (Appendix 9N).
21 These temperature results are reflected in the egg mortality results for fall-run
22 Chinook Salmon in the Trinity River, which indicate similar mortality under
23 Alternative 5 and the No Action Alternative (Appendix 9C, Table B-5).

24 The minor differences in temperature and mortality results suggest that conditions
25 for Coho Salmon, spring-run Chinook Salmon, fall-run Chinook Salmon,
26 steelhead and Green Sturgeon in the Trinity River generally would be similar
27 under Alternative 5 and the No Action Alternative. Given the similarity of the
28 results and the inherent uncertainty associated with the resolution of the
29 temperature model (average monthly outputs), it is concluded that Alternative 5
30 and the No Action Alternative are likely to have similar effects on salmonids and
31 sturgeon in the Trinity River.

32 *Reservoir Fishes*

33 Reservoir fishes in Trinity Lake would be exposed to relatively minor differences
34 in storage (less than 5 percent) under Alternative 5 (Appendix 5A) as compared to
35 the No Action Alternative and these relatively small differences likely would have
36 little effect on the amount of habitat available for these species. Black bass
37 nesting survival would be similar under Alternative 5 and the No Action
38 Alternative (Appendix 9F). The minor differences in storage and similar nesting
39 success suggest that effects on reservoir fishes in Trinity Lake would be similar
40 under Alternative 5 and the No Action Alternative.

1 *Other Species*

2 The minor differences in average monthly water temperatures described above for
3 salmonids apply to Pacific Lamprey and Eulachon. These minor differences
4 suggest that conditions for aquatic species in the Trinity River and Klamath River
5 downstream of the confluence generally would be similar under Alternative 5 and
6 the No Action Alternative. Given the similarity of the results and the inherent
7 uncertainty associated with the resolution of the temperature model (average
8 monthly outputs), it is concluded that Alternative 5 and the No Action
9 Alternative are likely to have similar effects on the lamprey and Eulachon in the
10 Trinity River.

11 *Sacramento River System*

12 *Winter-run Chinook Salmon*

13 Changes in operations that influence temperature and flow conditions in the
14 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
15 Salmon. The following describes those changes and their potential effects.

16 *Changes in Water Temperature*

17 Monthly water temperature in the Sacramento River at Keswick Dam under
18 Alternative 5 and the No Action Alternative would be similar (differences of less
19 than 0.5°F) (Appendix 6B, Table B-5-3). Differences in the frequency of
20 exceeding temperature thresholds under Alternative 5 and the No Action
21 Alternative also would be small (less than 3 percent) (Appendix 9N). The
22 differences in water temperatures and temperature threshold exceedances
23 predicted at locations in the downstream reaches are similar to those predicted at
24 Keswick Dam. Egg mortality is anticipated to be similar under Alternative 5 and
25 the No Action Alternative (Appendix 9C, Table B-4).

26 *Changes in Weighted Usable Area*

27 The WUA results for winter-run Chinook Salmon spawning habitat between
28 Keswick Dam and Battle Creek indicated that available spawning habitat under
29 Alternative 5 and the No Action Alternative would be similar (less than 5 percent
30 difference) (Appendix 9E, Table C-17-3). The results were similar for fry and
31 juvenile rearing (Appendix 9E, Table C-18-3 and Table C-19-3).

32 *Changes in SALMOD Output*

33 SALMOD results indicated that potential juvenile production under Alternative 5
34 would be the similar to the No Action Alternative in all water year types
35 (Appendix 9D, Table B-4-11).

36 *Changes in Delta Passage Model Output*

37 The Delta Passage Model predicted similar estimates of annual Delta survival
38 across the 81-year time period for winter-run Chinook Salmon between
39 Alternative 5 and the No Action Alternative (Appendix 9J). Median Delta
40 survival was 0.35 for Alternative 5 and 0.349 for the No Action Alternative.

1 *Changes in Delta Hydrodynamics*

2 Winter-run Chinook Salmon smolts are most abundant in the Delta during
3 January, February and March. On the Sacramento River near the confluence of
4 Georgiana Slough, the median proportion of positive velocities under
5 Alternative 5 were indistinguishable from the No Action Alternative in January,
6 February and March (Appendix 9K). On the San Joaquin River near the
7 Mokelumne River confluence, the median proportion of positive velocities also
8 was indistinguishable between these two scenarios. In Old River, both upstream
9 and downstream of the facilities, the median proportion of positive velocities was
10 indistinguishable in the months when winter run Chinook Salmon are present. On
11 the San Joaquin River downstream of the Head of Old River, there was no
12 discernable difference in the median proportion of positive velocities between
13 these two scenarios.

14 *Changes in Junction Entrainment*

15 For all junctions examined, the median entrainment probabilities under both
16 Alternative 5 and the No Action Alternative were almost indistinguishable
17 (Appendix 9L).

18 *Changes in Salvage*

19 There were no discernable differences in predicted salvage between Alternative 5
20 and No Action Alternative (Appendix 9M).

21 *Changes in Oncorhynchus Bayesian Analysis Output*

22 Escapement and Delta survival was modeled by the OBAN model for winter-run
23 Chinook salmon. Escapement was similar under Alternative 5 as compared to the
24 No Action Alternative (Appendix 9I) as was through-Delta survival.

25 *Changes in Interactive Object-Oriented Simulation Output*

26 The IOS model predicted similar adult escapement trajectories for winter-run
27 Chinook Salmon between Alternative 5 and the No Action Alternative across the
28 81 water years (Appendix 9H). Alternative 5 median adult escapement was
29 3,545 and No Action Alternative median escapement was 3,935.

30 Similar to adult escapement, the IOS model predicted similar egg survival for
31 winter-run Chinook Salmon between Alternative 5 and the No Action
32 Alternative across the 81 water years (Appendix 9H). Median egg survival was
33 0.989 for Alternative 5 and 0.990 for the No Action Alternative.

34 *Summary of Effects on Winter-Run Chinook Salmon*

35 The analysis of temperatures suggested that the frequency of temperature
36 threshold exceedance under Alternative 5 would be similar to the No Action
37 Alternative. This was reflected in Reclamation's salmon mortality model results,
38 which predicted egg mortality would be similar under Alternative 5 and the No
39 Action Alternative. The analysis of flow changes under Alternative 5 suggested
40 that availability of spawning habitat for winter-run Chinook Salmon would
41 similar under Alternative 5 and the No Action Alternative; SALMOD also
42 indicated that there would be similar juvenile production under these two
43 alternatives. Through Delta survival of juvenile winter-run Chinook Salmon

1 would be the same under both Alternative 5 and the No Action Alternative as
 2 indicated by the DPM and the OBAN results. Median adult escapement to the
 3 Sacramento River would be similar under Alternative 5 and the No Action
 4 Alternative as indicated by the IOS and OBAN model results. Additional
 5 analyses attempting to assess the effects on routing, entrainment and salvage of
 6 juvenile salmonids in the Delta all indicate the effects would be similar between
 7 Alternative 5 and the No Action Alternative.

8 Given the similarity of the results and the inherent uncertainty associated with the
 9 resolution of the models, it is concluded that Alternative 5 and the No Action
 10 Alternative are likely to have similar effects on the winter-run Chinook Salmon in
 11 the Sacramento River and Delta.

12 *Spring-run Chinook Salmon, Fall-run Chinook Salmon, Late Fall-run*
 13 *Chinook Salmon, Steelhead, Green Sturgeon and White Sturgeon*
 14 *Changes in Water Temperature*

15 Average monthly water temperatures in the Sacramento River under Alternative 5
 16 and the No Action Alternative would be similar (differences of less than 0.5°F)
 17 (Appendix 6B, Table B-5-3). Differences in the frequency of exceeding
 18 temperature thresholds under Alternative 5 and the No Action Alternative would
 19 be relatively small (differences less than 2 percent) for the spring-run, fall-run,
 20 and late fall-run Chinook Salmon, steelhead, and sturgeon in the Sacramento
 21 River (Appendix 9N).

22 In Clear Creek, average monthly water temperatures at Igo under Alternative 5
 23 relative to the No Action Alternative would be similar (differences less than
 24 0.5°F) (Appendix 6B, Table B-3-3). The frequency of exceeding temperature
 25 thresholds for spring-run Chinook Salmon rearing also would be small
 26 (differences of up to 1 percent) (Appendix 9N).

27 In the Feather River, average monthly water temperatures in the low flow channel
 28 under Alternative 5 relative to the No Action Alternative would be similar
 29 (differences less than 0.5°F) (Appendix 6B, Table B-20-3). Water temperatures at
 30 the downstream location also would be similar. Changes in the frequency of
 31 exceeding temperature thresholds would be relatively small (differences of
 32 2 percent or less) between the two scenarios for the fall-run Chinook Salmon,
 33 spring-run Chinook Salmon, steelhead, and Green Sturgeon.

34 In the American River at Watt Avenue, average monthly water temperatures
 35 under Alternative 5 and the No Action Alternative would be similar (differences
 36 less than 0.5°F) (Appendix 6B, Table B-13-3). Changes in the frequency of
 37 exceeding temperature thresholds would be small (differences of 1 percent or
 38 less) between the two scenarios for fall-run Chinook Salmon and steelhead.

39 Egg mortality for all races Chinook Salmon within the Sacramento River system
 40 was predicted to be similar under Alternative 5 and the No Action
 41 Alternative (Appendix 9C, Tables B-1, B-6 and B-7).

1 *Changes in SALMOD Output*

2 SALMOD results indicated that potential spring-run Chinook Salmon juvenile
3 production under Alternative 5 would be the similar to the No Action
4 Alternative in all water year types (Appendix 9D, Table B-3-11).

5 *Changes in Delta Passage Model Output*

6 The Delta Passage Model predicted similar estimates of annual Delta survival
7 across the 81-year time period for spring-run, fall-run and late fall-run Chinook
8 Salmon between Alternative 5 and the No Action Alternative (Appendix 9J).

9 *Changes in Delta Hydrodynamics*

10 As described in Appendix 9K, the median proportion of time that velocity was
11 positive at various junctions in the Delta were projected to be similar under
12 Alternative 5 compared to the No Action Alternative.

13 *Changes in Junction Entrainment*

14 As described in Appendix 9L, median entrainment at various junctions is
15 indistinguishable or lower under Alternative 5 compared to the No Action
16 Alternative for fall-run, late fall-run, and spring-run Chinook Salmon.

17 *Changes in Salvage*

18 As described in Appendix 9M, salvage of migrating spring-run, late-fall run and
19 fall-run smolts is similar or lower under Alternative 5 compared to the No Action
20 Alternative.

21 *Changes in Delta Outflow*

22 As described in Appendix 9P, mean (March to July) Delta outflow was used an
23 indicator of potential year class strength and the likelihood of producing a strong
24 year class of sturgeon. The median value over the 82-year CalSim II modeling
25 period of mean (March to July) Delta outflow was predicted to be similar under
26 the Alternative 5 and the No Action Alternative. In addition, the likelihood of
27 mean (March to July) Delta outflow exceeding the threshold of 50,000 cfs was the
28 same under both alternatives.

29 *Summary of Effects on Spring-run Chinook Salmon, Fall-run Chinook*
30 *Salmon, Late Fall-run Chinook Salmon, Steelhead, Green Sturgeon and*
31 *White Sturgeon*

32 The analysis of temperatures indicates similar temperatures and likelihood of
33 exceedance of temperature thresholds under Alternative 5 as compared to the No
34 Action Alternative in the Clear Creek, and the Sacramento, Feather, and
35 American rivers. This was reflected in Reclamation's salmon mortality model
36 results for the fall-run on the Sacramento, Feather and American rivers which
37 predicted similar Chinook Salmon mortalities under Alternative 5 and the No
38 Action Alternative. There would be no change in flows in Clear Creek and
39 Feather River low flow channel. Flows are expected to be similar in Sacramento
40 River and American River. Flows in May in the Feather River are reduced
41 (Appendix 5A). However, most of the spawning habitat in the Feather River is in
42 the low flow channel; therefore, this reduction in May flow would only have

1 minor effect on the availability of the habitat. SALMOD results indicate that the
2 potential production for the fall-run, late fall-run and spring-run Chinook Salmon
3 on the Sacramento River would be similar. Delta survival is expected to be
4 similar as indicated by the Delta Passage Model and OBAN results, and the
5 entrainment risk would be lower based on the expected changes in OMR flows
6 under Alternative 5. Additional analyses attempting to assess the effects on
7 routing, entrainment and salvage of juvenile salmonids in the Delta all indicate
8 the effects would be similar under Alternative 5 and the No Action Alternative.
9 The analysis based on Delta outflows suggests that Alternative 5 provides similar
10 mean (March to July) outflows which would have similar effects on year class
11 strength of juvenile sturgeon relative to the No Action Alternative.

12 Given the similarity of the results and the inherent uncertainty associated with the
13 resolution of the models, it is concluded that Alternative 5 and the No Action
14 Alternative are likely to have similar effects on salmonids and sturgeon in the
15 Sacramento River and Delta.

16 *Delta Smelt*

17 A proportional entrainment regression model (based on Kimmerer 2008, 2011)
18 was used to simulate adult Delta Smelt entrainment, as influenced by OMR flow
19 in December through March. Results indicate that the percentage of entrainment
20 of migrating and spawning adult Delta Smelt under Alternative 5 will be nearly
21 identical to the results estimated for the No Action Alternative in all water
22 year types.

23 A proportional entrainment regression model (based on Kimmerer 2008) also was
24 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced
25 by OMR flow and location of X2 in March through June. Results indicate that
26 the percentage of entrainment of larval and early juvenile Delta Smelt under
27 Alternative 5 would be similar to that estimated for the No Action Alternative.

28 The average September through December X2 position in km was used to
29 evaluate the fall abiotic habitat availability for delta smelt under the Alternatives.
30 X2 values simulated in the CalSim II model for each alternative were averaged
31 over September through December, and compared. Results indicate that fall X2
32 values under Alternative 5 would be nearly identical to the No Action Alternative.

33 Given the similarity of the results and the inherent uncertainty associated with the
34 resolution of the models, it is concluded that Alternative 5 and the No Action
35 Alternative are likely to have similar effects on Delta Smelt.

36 *Longfin Smelt*

37 The effects of the Alternative 5 as compared to the No Action Alternative were
38 analyzed based on the direction and magnitude of OMR flows during the period
39 (December through June) when adult, larvae, and young juvenile Longfin Smelt
40 are present in the Delta in the vicinity of the export facilities (Appendix 5A). The
41 analysis was augmented with calculated Longfin Smelt abundance index values
42 (Appendix 9G) per Kimmerer et al. (2009), which is based on the assumptions
43 that lower X2 values reflect higher flows and that transporting Longfin Smelt

1 farther downstream leads to greater Longfin Smelt survival. The index value
2 indicates the relative abundance of Longfin Smelt and not the calculated
3 population.

4 OMR flows generally would be negative in all months under both scenarios,
5 except in April and May when the long-term average would positive. Flows
6 under Alternative 5 during these two months would be more positive than under
7 the No Action Alternative, especially in dry and critical years when OMR flows
8 under Alternative 5 would be positive and flows under the No Action
9 Alternative would be negative. Differences in OMR flow during April and May
10 under Alternative 5 would up to about 1,350 cfs more positive than under the No
11 Action Alternative.

12 Longfin Smelt abundance index values were calculated for long-term average
13 conditions and for each water year type for the different alternatives (see
14 Appendix 9G). Under Alternative 5, Longfin Smelt abundance index values
15 range from 1,204 under critical water year conditions to a high of 16,683 under
16 wet water year conditions, with a long-term average value of 8,015
17 (Appendix 9G). Under the No Action Alternative, Longfin Smelt abundance
18 index values range from 1,147 under critical water year conditions to a high of
19 16,635 under wet water year conditions, with a long-term average value of 7,951.

20 Results indicate that the Longfin Smelt abundance index values would be similar
21 in all but critical years under Alternative 5 than they would be under the No
22 Action Alternative. In critical water years, the Longfin Smelt abundance index
23 value would be about 5 percent higher under Alternative 5 than it would be under
24 the No Action Alternative.

25 Given the similarity of the results and the inherent uncertainty associated with the
26 resolution of the models, it is concluded that Alternative 5 and the No Action
27 Alternative are likely to have similar effects on Longfin Smelt.

28 *Sacramento Splittail*

29 Under Alternative 5, flows entering the Yolo Bypass over the Fremont Weir
30 generally would be similar to the No Action Alternative (Appendix 5A,
31 Table C-26-3), thus providing similar value to Sacramento Splittail because of the
32 similar area of potential habitat (inundation) and the similar frequency of
33 inundation. Given the relatively minor changes in flows into the Yolo Bypass,
34 and the inherent uncertainty associated with the resolution of the CalSim II model
35 (average monthly outputs), it is concluded that there would be no definitive
36 difference in effects on Sacramento Splittail between Alternative 5 and the No
37 Action Alternative.

38 *Reservoir Fishes*

39 The analysis of effects associated with changes in operation on reservoir fishes
40 relied on evaluation of changes in available habitat (reservoir storage) and
41 anticipated changes in black bass nesting success.

1 Changes in CVP and SWP water supplies and operations under Alternative 5 as
 2 compared to the No Action Alternative generally would result in similar reservoir
 3 storage in CVP and SWP reservoirs in the Central Valley Region (Appendix 5A).
 4 Storage levels in Shasta Lake, Lake Oroville, and Folsom Lake would be similar
 5 under Alternative 5 as compared to the No Action Alternative. Additional
 6 information related to monthly reservoir elevations is provided in Appendix 5A,
 7 CalSim II and DSM2 Modeling.

8 In general, black bass nesting success would be similar under Alternative 5 and
 9 the No Action Alternative (Appendix 9F). Nesting success of black bass would
 10 be high in March and April due to increasing water surface elevations. During
 11 May and June, the likelihood of high (>40 percent) nesting success would be
 12 similar in most of the reservoirs under Alternative 5 as compared to the No Action
 13 Alternative (Appendix 9F). Therefore, it is concluded that the effects on black
 14 bass species would be similar under both Alternative 5 and the No Action
 15 Alternative.

16 *Other Species*

17 Several other fish species could be affected by changes in operations that
 18 influence temperature and flow. In general, lampreys, Striped Bass, American
 19 Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on
 20 the generally similar water temperatures during their spawning and incubation
 21 period under Alternative 5, it is likely that thermal conditions for and effects on
 22 these other species in the Sacramento, Feather, and American rivers would be
 23 similar under Alternative 5 and the No Action Alternative. Alternative 5 would
 24 result in a similar X2 position as compared to the No Action Alternative during
 25 April, May, and June (Appendix 5A, Section C Table C-16-3). This similarity in
 26 the position of X2 would likely result in a similar survival index and habitat index
 27 as measured by salinity for Striped Bass and a similar abundance and habitat
 28 index for American Shad. Alternative 5 likely would have a similar potential for
 29 adverse effects on lampreys, American Shad, and Hardhead as the Second Basis
 30 of Comparison. Overall, the potential for effects on lamprey, Striped Bass,
 31 American Shad, and Hardhead would be similar under Alternative 5 and the No
 32 Action Alternative.

33 *Stanislaus River/Lower San Joaquin River*

34 *Fall-Run Chinook Salmon and Steelhead*

35 *Changes in Water Temperature*

36 Monthly average temperatures in the Stanislaus River at Goodwin under
 37 Alternative 5 would be similar (less than 0.5°F differences) to the No Action
 38 Alternative in most of the months and water years. From August through
 39 November, water temperatures under Alternative 5 could be somewhat (0.6°F to
 40 1.6°F) warmer, particularly in drier water years. This pattern in temperature
 41 changes under Alternative 5 was also predicted downstream at Orange Blossom
 42 Bridge. However, the differences are smaller at the San Joaquin River confluence
 43 and water temperatures in April and May could be up to 2.1°F cooler under
 44 Alternative 5.

1 The frequency of exceedance of temperature thresholds for steelhead adult
2 migration in the fall months, steelhead smoltification thresholds in April and May
3 at Knights Ferry, and steelhead rearing in summer and fall months are higher
4 under (by up to 8 percent) under Alternative 5 as compared to the No Action
5 Alternative. Frequency of exceedance of thresholds for steelhead spawning and
6 smoltification at Orange Blossom Bridge in March through May are lower by up
7 to 11 percent under Alternative 5 compared to the No Action Alternative.

8 While specific water temperature thresholds for fall-run Chinook Salmon in the
9 Stanislaus River are not established, temperatures generally suitable for fall-run
10 Chinook Salmon spawning (56°F) would be exceeded in October and November
11 up to 3 percent more frequently under Alternative 5 compared to the No Action
12 Alternative, in the Stanislaus River at Orange Blossom Bridge. During May and
13 June, the 56°F threshold for fall-run rearing is exceeded less frequently (by up to
14 10 percent) under Alternative 5 compared to the No Action Alternative.

15 These changes in temperatures are not reflected in Reclamation's salmon
16 mortality model results for the fall-run Chinook Salmon in the Stanislaus River.
17 As shown in Appendix 9C, the long-term average egg mortality rate is predicted
18 to be around 8.5 percent, with higher mortality rates (in excess of 16 percent)
19 occurring in critical dry years under Alternative 5. Overall, egg mortality is
20 predicted to be similar under Alternative 5 and the No Action Alternative.

21 *Changes in Delta Hydrodynamics*

22 San Joaquin River-origin fall run Chinook salmon smolts are most abundant in the
23 Delta during the months of April, May and June. San Joaquin River-origin
24 steelhead generally move through the Delta during spring however there is less
25 information on their timing relative to Chinook salmon. Thus, hydrodynamics in
26 the entire January through June period could have the potential to affect juvenile
27 steelhead. Near the confluence of the San Joaquin River and the Mokelumne
28 River, the proportion of positive velocities was slightly higher under Alternative 5
29 relative to the No Action Alternative in January and February and almost
30 indistinguishable from March through June (Appendix 9K). On Old River
31 upstream and downstream of the facilities, the median proportion of positive
32 velocities was similar under Alternative 5 and the No Action Alternative in all
33 months. On the San Joaquin River downstream of the Head of Old River, the
34 median proportion of positive velocities was similar under Alternative 5 and the
35 No Action Alternative in all months.

36 *Changes in Entrainment at Junctions*

37 As described in Appendix 9L, median entrainment at various junctions is
38 indistinguishable or lower under Alternative 5 compared to the No Action
39 Alternative for fall-run Chinook Salmon.

40 *Summary of Effects on Fall-Run Chinook Salmon and Steelhead*

41 The analysis of temperatures indicates somewhat higher temperatures in some
42 water year types and a higher likelihood of exceedance of suitable temperatures
43 for spawning, and lower likelihood of exceeding suitable temperature for rearing
44 of fall-run Chinook Salmon under Alternative 5 as compared to the No Action

1 Alternative in the Stanislaus River below Goodwin Dam. The effect of higher
2 temperatures is not reflected in overall mortality of fall-run Chinook Salmon eggs
3 predicted by Reclamation's salmon mortality model for fall-run Chinook Salmon
4 in the Stanislaus River. The frequency of exceedance of temperature thresholds
5 for steelhead smoltification and rearing could be more stressful under
6 Alternative 5 compared to the No Action Alternative. However, the higher flows
7 in April and May and lower temperatures in April and May under Alternative 5
8 may benefit steelhead spawning.

9 Given the variability in the results and the inherent uncertainty associated with the
10 resolution of the models, it is concluded that Alternative 5 and the No Action
11 Alternative are likely to have similar effects on fall-run Chinook Salmon and
12 steelhead in the Stanislaus and lower San Joaquin rivers.

13 *White Sturgeon*

14 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River
15 upstream of the confluence with the Stanislaus River. While flows in the San
16 Joaquin River upstream of the Stanislaus River are expected to be similar under all
17 alternatives, flow contributions from the Stanislaus River could influence water
18 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may
19 occur during the spring and early summer. The magnitude of influence on water
20 temperature would depend on the proportional flow contribution of the Stanislaus
21 River and the temperatures in both the Stanislaus and San Joaquin rivers. The
22 potential for an effect on White Sturgeon eggs and larvae would be influenced by
23 the proportion of the population occurring in the San Joaquin River. In
24 consideration of this uncertainty, it is not possible to distinguish potential effects
25 on White Sturgeon between alternatives.

26 *Reservoir Fishes*

27 Storage levels in New Melones Reservoir would be similar (within 5 percent) for
28 Alternative 5 as compared to the No Action Alternative (Appendix 5A).

29 Results of the bass nesting success analysis indicate that for March, the likelihood
30 of Largemouth Bass and Smallmouth Bass nest survival in New Melones being
31 above 40 percent is 100 percent under both Alternative 5 and the No Action
32 Alternative. For April, the likelihood that nest survival of Largemouth Bass and
33 Smallmouth Bass is between 40 and 100 percent is predicted to be reasonably
34 high but is somewhat (about 13 percent) lower under Alternative 5 as compared to
35 the No Action Alternative. For May, the difference between alternatives is less
36 with the likelihood of high nest survival being about 5 percent less under
37 Alternative 5. For June, the likelihood of survival being greater than 40 percent
38 for Largemouth Bass and Smallmouth Bass in New Melones is similar under
39 Alternative 5 and the No Action Alternative. For Spotted Bass, nest survival in
40 March is anticipated to be near 100 percent in every year under both Alternative 5
41 and the No Action Alternative. The likelihood of Spotted Bass nest survival
42 being greater than 40 percent is about 7 percent less under Alternative 5 than
43 under the No Action Alternative in April, but is still reasonably high (greater than
44 90 percent). During May, the likelihood of high (>40 percent) Spotted Bass nest

1 survival is about 5 percent lower under Alternative 5 as compared to the No
2 Action Alternative. During June, Spotted Bass nest survival would be greater
3 than 40 percent in every year under Alternative 5 as compared to approximately
4 98 percent of the years under the No Action Alternative.

5 Overall, the analysis suggests that conditions under Alternative 5 have the
6 potential to negatively influence black bass nesting success, especially in April
7 and May, by comparison to the No Action Alternative. However, nesting success
8 under Alternative 5 would still exceed 40 percent most of the time under both
9 alternatives. Therefore, it is concluded that there would be no definitive
10 difference in effects on reservoir fish between Alternative 5 and the No Action
11 Alternative.

12 *Other Species*

13 Changes in operations that influence temperature and flow conditions in the
14 Stanislaus River downstream of Goodwin Dam and the San Joaquin River at
15 Vernalis could affect other fishes such as lampreys, Hardhead, and Striped Bass.

16 Monthly average temperatures in the Stanislaus River at Goodwin under
17 Alternative 5 would be similar (less than 0.5°F differences) to the No Action
18 Alternative in most of the months and water years. From August through
19 November, water temperatures under Alternative 5 could be somewhat (0.6°F to
20 1.6°F) warmer, particularly in drier water years. This pattern in temperature
21 changes under Alternative 5 was also predicted downstream at Orange Blossom
22 Bridge. However, the differences are smaller at the San Joaquin River confluence
23 and water temperatures in April and May could be up to 2.1°F cooler under
24 Alternative 5.

25 In general, lamprey species can tolerate higher temperatures than salmonids, up to
26 around 72°F during their entire life history. Because lamprey ammocoetes remain
27 in the river for several years, any substantial flow reductions or temperature
28 increases could result in adverse effects on larval lamprey.

29 In general, Striped Bass and Hardhead also can tolerate higher temperatures than
30 salmonids. Given the similar flows and generally similar temperatures during
31 their spawning and incubation period, it is likely that the potential to affect
32 Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be
33 similar under Alternative 5 and the No Action Alternative.

34 Given the similarity of the results and the inherent uncertainty associated with the
35 resolution of the models, it is concluded that Alternative 5 and the No Action
36 Alternative are likely to have similar effects on lampreys, Hardhead, and Striped
37 Bass in the Stanislaus and lower San Joaquin rivers. No definitive difference
38 between Alternative 5 and the No Action Alternative could be discerned.

1 *San Francisco Bay Area Region*

2 *Killer Whale*

3 As described above for the comparison of Alternative 1 to the No Action
4 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
5 supported heavily by hatchery production of fall-run Chinook Salmon, would be
6 appreciably affected by any of the alternatives.

7 **9.4.3.6.1 Alternative 5 Compared to the Second Basis of Comparison**

8 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
9 under Alternative 5 are similar to the No Action Alternative with modified OMR
10 flow criteria and New Melones Reservoir operations. Therefore, the comparison
11 of Alternative 5 to the Second Basis of Comparison would be similar to the
12 comparison of No Action Alternative to Second Basis of Comparison described
13 above in Section 9.4.4.1, No Action Alternative.

14 *Trinity River Region*

15 *Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, and*
16 *Steelhead*

17 Monthly water temperature in the Trinity River at Lewiston Dam under
18 Alternative 5 generally would be similar (less than 0.5°F differences) to the
19 temperatures that would occur under the Second Basis of Comparison
20 (Appendix 6B, Table B-1-6), with the exception of drier years when temperatures
21 under Alternative 5 could be as much as 2.2°F cooler in November and 1.5°F
22 warmer in December. Average monthly water temperatures could be slightly (up
23 to 0.6°F) higher under Alternative 5 during July and August and lower (up to
24 0.7°F) in September in some water year types. The slightly lower September
25 temperatures under Alternative 5 may result in slightly better conditions than
26 under the Second Basis of Comparison for spring-run Chinook Salmon spawning.
27 Similarly, temperature conditions under Alternative 5 could be slightly better than
28 the Second Basis of Comparison for fall-run Chinook Salmon spawning because
29 of the reduced temperatures in November during critical dry years.

30 Under Alternative 5, water temperature thresholds for Coho Salmon, fall-run
31 Chinook Salmon, and steelhead would be exceeded slightly more frequently (less
32 than 1 percent), whereas thresholds for spring-run Chinook Salmon would be
33 exceeded less frequently (up to 4 percent) in August in September
34 (Appendix 9N).

35 These temperature results are not entirely reflected in the egg mortality results for
36 fall-run Chinook Salmon, which indicate similar levels of egg mortality under
37 Alternative 5 compared to the Second Basis of Comparison (Appendix 9C,
38 Table B-5).

39 The minor changes in water temperatures and mortality suggest that conditions
40 for Coho Salmon, fall-run Chinook Salmon, and steelhead in the Trinity River
41 would be similar under both Alternative 5 and the Second Basis of Comparison.
42 However, the slight reduction in threshold exceedances for spring-run Chinook

1 Salmon spawning under Alternative 5, although small, could reduce the potential
2 for adverse impacts in the Trinity River under Alternative 5.

3 In addition, implementation of a Hatchery Management Plan under Alternative 5
4 could reduce the impacts of hatchery Chinook Salmon on natural Chinook
5 Salmon in the Trinity River and increase the genetic diversity and diversity of
6 run-timing for these stocks relative to the Second Basis of Comparison, but the
7 potential magnitude of these benefits is uncertain. Thus, given these relatively
8 minor changes in temperature and temperature threshold exceedance, the inherent
9 uncertainty associated with the resolution of the temperature model (average
10 monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that
11 Alternative 5 and Second Basis of Comparison are likely to have similar effects
12 on Chinook Salmon and steelhead in the Trinity River.

13 *Reservoir Fishes*

14 The analysis of effects associated with changes in operation on reservoir fishes
15 relied on evaluation of changes in available habitat (reservoir storage) and
16 anticipated changes in black bass nesting success.

17 Black bass species in Trinity Lake would be exposed to minor differences in
18 storage under both Alternative 5 and the Second Basis of Comparison, and these
19 relatively small differences would have negligible effect on nest survival. The
20 nest survival under Alternative 5 would be generally similar to Second Basis of
21 Comparison for Largemouth Bass, Smallmouth Bass, and Spotted Bass
22 (Appendix 9F). These negligible differences in nest survival suggest that
23 conditions for reservoir species in Trinity Lake would be similar under
24 Alternative 5 and the Second Basis of Comparison.

25 *Other Species*

26 The minor differences in average monthly water temperatures described above for
27 salmonids apply to Pacific Lamprey, Eulachon, and other aquatic species in the
28 Trinity River. These minor differences suggest that conditions for aquatic species
29 in the Trinity River and Klamath River downstream of the confluence generally
30 would be similar under Alternative 5 and the Second Basis of Comparison.

31 *Sacramento River System*

32 *Winter-run Chinook Salmon*

33 Changes in operations that influence temperature and flow conditions in the
34 Sacramento River downstream of Keswick Dam could affect winter-run Chinook
35 Salmon. The following describes those changes and their potential effects.

36 *Changes in Water Temperature*

37 Monthly water temperature in the Sacramento River at Keswick Dam under
38 Alternative 5 and the Second Basis of Comparison generally would be similar
39 (differences less than 0.5°F). Average monthly water temperatures in September
40 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
41 1.2°F) in drier years (Appendix 6B). Similarly, water temperatures in October of
42 critical years could be 0.9°F warmer under Alternative 5. A similar temperature
43 pattern generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry,

1 and Bend Bridge, with average monthly temperature differences in September
2 increasing (up to 2.8°F cooler at Bend Bridge) in September during the wetter
3 years and up to 0.8°F warmer in critical years (Appendix 6B).

4 *Changes in Exceedances of Water Temperature Thresholds*

5 With the exception of April, average monthly water temperatures under both
6 Alternative 5 and Second Basis of Comparison would show exceedances of the
7 water temperature threshold of 56°F established in the Sacramento River at Ball's
8 Ferry for winter-run Chinook Salmon spawning and egg incubation in every
9 month, with exceedances under both as high as about 41 percent and 54 percent,
10 respectively, in some months (Appendix 9N). Under Alternative 5, the
11 temperature threshold generally would be exceeded more frequently than under
12 the Second Basis of Comparison (by about 1 percent to 3 percent) in the April
13 through August period, with the temperature threshold in September exceeded
14 about 11 percent less frequently under Alternative 5 than under the Second Basis
15 of Comparison. Farther downstream at Bend Bridge, the frequency of
16 exceedances would increase, with exceedances under both Alternative 5 and the
17 Second Basis of Comparison as high as about 90 percent in some months. Under
18 Alternative 5, temperature exceedances generally would be more frequent (by up
19 to 10 percent) than under the Second Basis of Comparison, with the exception of
20 September, when exceedances under Alternative 5 would be about 30 percent less
21 frequent under Alternative 5.

22 *Changes in Egg Mortality*

23 The temperatures described above for the Sacramento River below Keswick Dam
24 are reflected in the analysis of egg mortality using the Reclamation Salmon
25 Survival Model (Appendix 9C). For winter-run Chinook Salmon in the
26 Sacramento River, the long-term average egg mortality rate is predicted to be
27 relatively low (around 5 percent), with higher mortality rates (exceeding
28 20 percent) occurring in critical dry years under Alternative 5. Overall, egg
29 mortality would be similar under Alternative 5 and the Second Basis of
30 Comparison (Appendix 9C, Table B-4).

31 *Changes in Weighted Usable Area*

32 As an indicator of the amount of suitable spawning habitat for winter-run Chinook
33 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
34 in general, there would be similar amounts of spawning habitat available from
35 May through September under Alternative 5 as compared to the Second Basis of
36 Comparison (Appendix 9E, Table C-17-6). Modeling results indicate that, in
37 general, there would be similar amounts of suitable fry rearing habitat available
38 from June through October under Alternative 5 and the Second Basis of
39 Comparison (Appendix 9E, Table C-18-6). Similar to the results for fry rearing
40 WUA, modeling results indicate that there would be similar amounts of suitable
41 juvenile rearing habitat available during the juvenile rearing period under
42 Alternative 5 and the Second Basis of Comparison (Appendix 9E, Table C-19-6).

1 *Changes in SALMOD Output*

2 SALMOD results indicate that potential juvenile production would be the same
3 under Alternative 5 and the Second Basis of Comparison (Appendix 9D,
4 Table B-4-26).

5 *Changes in Delta Passage Model Output*

6 The Delta Passage Model predicted similar estimates of annual Delta survival
7 across the 81 water year time period for winter-run Chinook Salmon between
8 Alternative 5 and the Second Basis of Comparison Alternative (Appendix 9J).
9 Median Delta survival was 0.350 for Alternative 5 and 0.352 for the Second Basis
10 of Comparison Alternative. Overall, there would be little change in through-Delta
11 survival for emigrating juvenile winter-run Chinook Salmon under Alternative 5
12 as compared to the Second Basis of Comparison.

13 *Changes in Delta Hydrodynamics*

14 Winter run smolts are most abundant in the Delta during the months of January
15 February and March. On the Sacramento River near the confluence of Georgiana
16 Slough, the median proportion of positive velocities under Alternative 5 was
17 indistinguishable from the Second Basis of Comparison in January, February, and
18 March (Appendix 9K). On the San Joaquin River near the Mokelumne River
19 confluence, the median proportion of positive velocities was slightly greater under
20 Alternative 5 relative to Second Basis of Comparison in January and February and
21 similar in March. In Old River downstream of the facilities, the median
22 proportion of positive velocities was substantially higher under Alternative 5
23 during January and moderately higher in February. Values in March were almost
24 indistinguishable between scenarios. On Old River upstream of the facilities, the
25 median proportion of positive velocities was moderately lower in January and
26 February and slightly lower in March under Alternative 5 relative to Second Basis
27 of Comparison. On the San Joaquin River downstream of Head of Old River, the
28 median proportion of positive velocities was similar for both scenarios in January,
29 February and March.

30 *Changes in Junction Entrainment*

31 At the junction of Georgiana Slough and the Sacramento River, median
32 entrainment under Alternative 5 and the Second Basis of Comparison was
33 essentially indistinguishable in January, February and March (Appendix 9L).
34 Entrainment at the Head of Old River junction was similar to slightly lower under
35 Alternative 5 relative to Second Basis of Comparison during the period of winter
36 run Chinook Salmon migration through the Delta (January, February, and March).
37 For the Turner Cut junction, median entrainment under Alternative 5 was slightly
38 lower in January and February relative to Second Basis of Comparison. In
39 March, the difference in entrainment between scenarios was similar. At the
40 Columbia Cut, Middle River and Old River junctions, patterns in entrainment
41 between Alternative 5 and Second Basis of Comparison were similar. At these
42 junctions, median entrainment was slightly to moderately lower under
43 Alternative 5 during January and February and values were more similar in
44 March.

1 *Changes in Salvage*

2 Salvage of winter-run Chinook salmon is predicted to be substantially lower
3 under Alternative 5 relative to the Second Basis of Comparison in January and
4 February (Appendix 9M). In March, predicted salvage was only moderately
5 lower under Alternative 5 relative to Second Basis of Comparison.

6 *Changes in Oncorhynchus Bayesian Analysis Output*

7 Escapement of winter-run Chinook Salmon and Delta survival was modeled by
8 the Oncorhynchus Bayesian Analysis (OBAN) model for winter-run Chinook
9 salmon. Escapement was generally higher under Alternative 5 as compared to the
10 Second Basis alternative (Appendix 9I). The median abundance under
11 Alternative 5 was higher the Second Basis of Comparison. Median delta survival
12 was approximately 15 percent higher under Alternative 5 as compared to the
13 Second Basis of Comparison.

14 *Changes in Interactive Object-Oriented Simulation Output*

15 The IOS model predicted similar adult escapement trajectories for Winter-Run
16 Chinook salmon between Alternative 5 and the Second Basis of Comparison
17 Alternative across the 81 water years (Appendix 9H). Alternative 5 median adult
18 escapement was 3,545 and Second Basis of Comparison Alternative median
19 escapement was 4,042).

20 Similar to adult escapement, the IOS model predicted similar egg survival for
21 Winter-Run Chinook salmon between Alternative 5 and the Second Basis of
22 Comparison Alternative across the 81 water years (Appendix 9H). Median egg
23 survival was 0.989 for Alternative 5 and 0.987 for the Second Basis of
24 Comparison Alternative).

25 *Summary of Effects on Winter-Run Chinook Salmon*

26 The analysis of temperatures indicates somewhat higher temperatures and greater
27 likelihood of exceedance of thresholds under Alternative 5 as compared to the
28 Second Basis of Comparison. This is not reflected in the similar survival of
29 winter-run Chinook Salmon eggs predicted by Reclamation's salmon mortality
30 model. Flow changes under Alternative 5 would have small effects on the
31 availability of spawning and rearing habitat for winter-run Chinook Salmon as
32 indicated by the WUA analysis and the decrease in flow (habitat)-related
33 mortality predicted by SALMOD under Alternative 5. Through Delta survival of
34 juvenile winter-run Chinook Salmon would be the same under both Alternative 5
35 and Second Basis of Comparison as indicated by the DPM results; the OBAN
36 results suggest that Delta survival could be higher under Alternative 5.
37 Entrainment may also be reduced under Alternative 5 as indicated by the salvage
38 analysis based on OMR flows. Median adult escapement to the Sacramento River
39 could be reduced slightly under Alternative 5 as indicated by the IOS model
40 results which incorporate temperature, flow, and mortality effects on each life
41 stage over the entire life cycle of winter-run Chinook Salmon. However, the
42 OBAN model results indicate an increase in escapement over a more limited time
43 period (1971 to 2002).

1 The model results suggest that effects on winter-run Chinook Salmon would be
2 similar under both Alternative 5 and Second Basis of Comparison, with a small
3 likelihood that winter-run Chinook Salmon escapement would be higher under the
4 Alternative 5. Positive effects, however, likely would be greater because of the
5 potential benefits of providing fish passage under Alternative 5 intended to
6 address the limited availability of suitable habitat for winter-run Chinook Salmon
7 in the Sacramento River reaches downstream of Keswick Dam. This potential
8 beneficial effect and its magnitude would depend on the success of the fish
9 passage program. In addition, benefits to winter-run Chinook Salmon may accrue
10 under Alternative 5 as a result actions intended to increase the efficiency of the
11 Tracy and Skinner Fish Collection Facilities to improve the overall salvage
12 survival of listed salmonids, including winter-run Chinook Salmon.

13 Overall, the quantitative results from the numerical models suggest that operation
14 under Alternative 5 would be less likely to result in adverse effects on winter-run
15 Chinook Salmon than would the Second Basis of Comparison. In consideration
16 of the potentially beneficial effects resulting from actions under the Alternative 5
17 that are not included in the numerical models (see Appendix 5A, Section B),
18 however, Alternative 5 has a much greater potential to address the long-term
19 sustainability of winter-run Chinook Salmon than does the Second Basis of
20 Comparison. Alternative 5 includes provisions for fish passage upstream of
21 Shasta Dam to address long-term temperature increases associated with climate
22 change; the Second Basis of Comparison does not. Even though the success of
23 fish passage is uncertain, it is concluded that the potential for adverse effects on
24 winter-run Chinook Salmon under Alternative 5 would clearly be less than those
25 under the Second Basis of Comparison, principally because the Second Basis of
26 Comparison does not include a strategy to address water temperatures critical to
27 winter-run Chinook Salmon sustainability over the long term with climate change
28 by 2030.

29 *Spring-run Chinook Salmon*

30 Changes in operations that influence temperature and flow conditions in the
31 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
32 Whiskeytown Dam, and Feather River downstream of Oroville Dam could affect
33 spring-run Chinook Salmon. The following describes those changes and their
34 potential effects.

35 *Changes in Water Temperature*

36 Changes in water temperature that could affect spring-run Chinook Salmon could
37 occur in the Sacramento River, Clear Creek, and Feather River. The following
38 describes temperature conditions in those water bodies.

39 *Sacramento River*

40 Monthly water temperature in the Sacramento River at Keswick Dam under
41 Alternative 5 and the Second Basis of Comparison generally would be similar
42 (differences less than 0.5°F). Average monthly water temperatures in September
43 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
44 1.2°F) in drier years. Similarly, water temperatures in October of critical years

1 could be 0.9°F warmer under Alternative 5. A similar temperature pattern
 2 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend
 3 Bridge and Red Bluff, with average monthly temperature differences in
 4 September progressively increasing (up to 3.2°F cooler at Red Bluff) during the
 5 wetter years (Appendix 6B, Table B-9-6).

6 *Clear Creek*

7 Average monthly water temperatures in Clear Creek at Igo under
 8 Alternative relative to the Second Basis of Comparison are generally predicted to
 9 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average
 10 monthly water temperatures during May under Alternative 5 would be up to 0.8°F
 11 lower than under the Second Basis of Comparison in all but critical water years.
 12 The lower water temperatures in May associated with Alternative 5 reflect the
 13 effects of additional water discharged from Whiskeytown Dam to meet the spring
 14 attraction flow requirements to promote attraction of spring-run Chinook Salmon
 15 into the creek. While the reduction in May water temperatures indicated by the
 16 modeling could improve thermal conditions for spring-run Chinook Salmon, the
 17 duration of the two pulse flows may not be of sufficient duration (3 days each) to
 18 provide temperature benefits.

19 *Feather River*

20 Long-term average monthly water temperature in the Feather River at the low
 21 flow channel under Alternative 5 relative to the Second Basis of Comparison
 22 generally would be similar (less than 0.5°F differences). Water temperatures
 23 could be up to 1.5°F warmer in November and December of some water year
 24 types and up to 1.2°F cooler in September of wetter years (Appendix 6B,
 25 Table B-20-6) under Alternative 5. Although temperatures in the river would
 26 become progressively higher in the downstream direction, the differences between
 27 Alternative 5 and Second Basis of Comparison exhibit a similar pattern at the
 28 downstream locations (Robinson Riffle and Gridley Bridge), with water
 29 temperature differences under Alternative 5 generally increasing in most water
 30 year types relative to the Second Basis of Comparison at the confluence with
 31 Sacramento River (Appendix 6B, Table B-23-6). Water temperatures under
 32 Alternative 5 could be somewhat (0.8°F to 1.6°F) cooler on average and up to
 33 3.9°F cooler (September) at the confluence with Sacramento River from July to
 34 September in wetter years.

35 *Changes in Exceedances of Water Temperature Thresholds*

36 Changes in water temperature could result in the exceedance of established water
 37 temperature thresholds for spring-run Chinook Salmon in the Sacramento River,
 38 Clear Creek, and Feather River. The following describes the extent of those
 39 exceedance for each of those water bodies.

40 *Sacramento River*

41 Average monthly water temperatures under both Alternative 5 and Second Basis
 42 of Comparison would show exceedances of the water temperature threshold of
 43 56°F established in the Sacramento River at Red Bluff for spring-run Chinook
 44 Salmon (egg incubation) in October, November, and again in April. The

1 exceedances would occur at the greatest frequency in October, with 80 percent
2 and 79 percent for Alternative 5 and Second Basis of Comparison, respectively.
3 Temperature thresholds would be exceeded less frequently in November
4 (7 percent) and not exceeded at all during December through March. As water
5 temperatures warm in the spring, the thresholds would be exceeded in April by
6 14 percent and 13 percent under Alternative 5 and Second Basis of Comparison.
7 In the warmer months when exceedances occur (October, November, and April),
8 temperature thresholds generally would be exceeded more frequently (by up to
9 2 percent in October) under Alternative 5 than under the Second Basis of
10 Comparison (Appendix 9N, Table 9N.B.1).

11 *Clear Creek*

12 Average monthly water temperatures under both Alternative 5 and Second Basis
13 of Comparison would not exceed the water temperature threshold of 60°F
14 established in Clear Creek at Igo for spring-run Chinook Salmon pre-spawning
15 and rearing in June through August. However, Alternative 5 and Second Basis of
16 Comparison would exceed the water temperature threshold of 56°F established
17 for spawning in September and October about 10 percent to 15 percent of the
18 time. The differences between Alternative 5 and Second Basis of Comparison are
19 small, with Alternative 5 exceeding thresholds about 1 percent more frequently
20 than under the Second Basis of Comparison in September and about 2 percent
21 more frequently in October (Appendix 9N).

22 *Feather River*

23 Average monthly water temperatures under both Alternative 5 and Second Basis
24 of Comparison would exceed the water temperature threshold of 56°F established
25 in the Feather River at Robinson Riffle for spring-run Chinook Salmon egg
26 incubation and rearing (Appendix 9N) during some months, particularly in
27 October and November, and March and April, when temperature thresholds could
28 be exceeded frequently. The frequency of exceedance was highest (about
29 98 percent) in October, a month in which average monthly water could get as high
30 as about 68°F. However, water temperatures under Alternative 5 would exceed
31 temperature thresholds less than 2 percent more frequently than the Second Basis
32 of Comparison in October, November, and December, and about 1 percent less
33 frequently in March. The established water temperature threshold of 63°F for
34 rearing during May through August would be exceeded often under both
35 Alternative 5 and Second Basis of Comparison in May (57 percent and
36 51 percent, respectively) and June (97 percent for both), but not at all in July and
37 August.

38 *Changes in Egg Mortality*

39 These temperature differences described above are reflected in the analysis of egg
40 mortality using the Reclamation salmon mortality model (Appendix 9C). For
41 spring-run Chinook Salmon in the Sacramento River, the long-term average egg
42 mortality rate is predicted to be relatively high (exceeding 20 percent), with high
43 mortality rates (exceeding 80 percent) occurring in critical dry years. In critical
44 dry years the average egg mortality rate would be 13.1 percent greater under
45 Alternative 5 than under the Second Basis of Comparison (Appendix 9C,

1 Table B-3). Overall, egg mortality under Alternative 5 and the Second Basis of
2 Comparison would be similar, except in critical dry water years.

3 *Changes in Weighted Usable Area*

4 Weighted usable area curves are available for spring-run Chinook Salmon in
5 Clear Creek. As described above, flows in Clear Creek below Whiskeytown Dam
6 are not anticipated to differ under Alternative 5 relative to the Second Basis of
7 Comparison except in May due to the release of spring attraction flows in
8 accordance with the 2009 NMFS BO. Therefore, there would be no change in the
9 amount of potentially suitable spawning and rearing habitat for spring-run
10 Chinook Salmon (as indexed by WUA) available under Alternative 5 as compared
11 to the Second Basis of Comparison.

12 *Changes in SALMOD Output*

13 SALMOD results indicate that potential spring-run juvenile production would be
14 similar under Alternative 5 and the Second Basis of Comparison, except in critical
15 dry years when production could be 14 percent lower under Alternative 5 than
16 under the Second Basis of Comparison (Appendix 9D).

17 *Changes in Delta Passage Model Output*

18 The Delta Passage Model predicted similar estimates of annual Delta survival
19 across the 81 water year time period for spring-run between Alternative 5 and the
20 Second Basis of Comparison (Appendix 9J). Median Delta survival was 0.296 for
21 Alternative 5 and 0.286 for the Second Basis of Comparison. Overall, there
22 would be little change in through-Delta survival by emigrating juvenile spring-run
23 Chinook Salmon under Alternative 5 as compared to the Second Basis of
24 Comparison.

25 *Changes in Delta Hydrodynamics*

26 Spring run Chinook salmon are most abundant in the Delta from March through
27 May. Near the junction of Georgiana Slough, the median proportion of time that
28 velocity was positive was similar in March and April and slightly lower in May
29 under Alternative 5 relative to the Second Basis of Comparison (Appendix 9K).
30 Near the confluence of the San Joaquin River and the Mokelumne River, the
31 median proportion of positive velocities was similar in March and slightly to
32 moderately higher under Alternative 5 relative to the Second Basis of Comparison
33 in April and May. In the San Joaquin River downstream of the Head of Old River
34 the median proportion of positive velocities was slightly to moderately higher
35 under Alternative 5 relative to Second Basis of Comparison in April and May,
36 respectively, whereas there was little difference between these scenarios in
37 March. In Old River upstream of the facilities the median proportion of positive
38 velocities was slightly higher in April and May under Alternative 5 relative to
39 Second Basis of Comparison and slightly lower in March. In Old River
40 downstream of the facilities, the median proportion of positive velocities was
41 substantially higher under Alternative 5 relative to Second Basis of Comparison
42 in April and May and more similar in March.

1 *Changes in Junction Entrainment*

2 At the junction of Georgiana Slough and the Sacramento River, median
3 entrainment under Alternative 5 was slightly lower than under the Second Basis
4 of Comparison in April and May but essentially indistinguishable in March
5 (Appendix 9L). Median entrainment at the Head of Old River junction was
6 substantially higher under Alternative 5 relative to Second Basis of Comparison
7 during the months of April and May and similar in March. For the Turner Cut
8 junction, median entrainment under Alternative 5 was moderately lower in April
9 and May relative to Second Basis of Comparison and more similar in March. At
10 the Columbia Cut, Middle River and Old River junctions, entrainment under
11 Alternative 5 was slightly lower than Second Basis of Comparison in March and
12 became moderately to substantially lower in April and May.

13 *Changes in Salvage*

14 Salvage of spring run Chinook salmon was predicted to be substantially lower
15 under Alternative 5 relative the Second Basis of Comparison during April and
16 May and only slightly lower in the month of March (Appendix 9M).

17 *Summary of Effects on Spring-Run Chinook Salmon*

18 The multiple model and analysis outputs described above characterize the
19 anticipated conditions for spring-run Chinook Salmon and their response to
20 change under Alternative 5 as compared to the Second Basis of Comparison. For
21 the purpose of analyzing effects on spring-run Chinook Salmon in the Sacramento
22 River, greater reliance was placed on the outputs from the SALMOD model
23 because it integrates the available information on temperature and flows to
24 produce estimates of mortality for each life stage and an overall, integrated
25 estimate of potential spring-run Chinook Salmon juvenile production. The output
26 from SALMOD indicated that spring-run Chinook Salmon production in the
27 Sacramento River would be similar under Alternative 5 and the Second Basis of
28 Comparison, except in critical dry years. The analyses attempting to assess the
29 effects on routing, entrainment, and salvage of juvenile salmonids in the Delta
30 suggest that salvage (as an indicator of potential losses of juvenile salmon at the
31 export facilities) of Sacramento River-origin Chinook Salmon is predicted to be
32 lower under Alternative 5 relative to the Second Basis of Comparison in every
33 month.

34 In Clear Creek and the Feather River, the analysis of the effects of Alternative 5
35 and Second Basis of Comparison for spring-run Chinook Salmon relied on water
36 temperature output for Clear Creek at Igo, and in the Feather River low flow
37 channel and downstream of the Thermalito complex. The analysis of
38 temperatures indicates somewhat higher temperatures and greater likelihood of
39 exceedance of thresholds under Alternative 5 as compared to the Second Basis of
40 Comparison in the Feather River. There would be little change in flows or
41 temperatures in Clear Creek under Alternative 5 relative to the Second Basis of
42 Comparison. The effect of slightly increased temperatures is not reflected in the
43 similar overall survival of spring-run Chinook Salmon eggs predicted by
44 Reclamation's salmon mortality model for spring-run in the Sacramento River. In

1 drier years, the likelihood of adverse temperature effects would be increased
2 under Alternative 5 as compared to the Second Basis of Comparison.

3 Flow changes under Alternative 5 would likely have small effects due to changes
4 in the availability of spawning and rearing habitat for spring-run Chinook Salmon
5 in the Sacramento River as indicated by the decrease in flow (habitat)-related
6 mortality predicted by SALMOD under Alternative 5. Through Delta survival of
7 juvenile spring-run Chinook Salmon would be the same under both Alternative 5
8 and Second Basis of Comparison as indicated by the DPM results and entrainment
9 could be reduced as indicated by the salvage analysis.

10 The numerical model results suggest that, overall, Alternative 5 likely would have
11 similar or somewhat greater adverse effects on the spring-run Chinook Salmon
12 population in the Sacramento River watershed as compared to the Second Basis of
13 Comparison, particularly in drier water year types. This potential distinction
14 between the two scenarios, however, may be offset by the benefits of
15 implementation of fish passage under Alternative 5 intended to address the
16 limited availability of suitable habitat for spring-run Chinook Salmon in the
17 Sacramento River reaches downstream of Keswick Dam. This beneficial effect
18 and its magnitude would depend on the success of the fish passage program. In
19 addition, spring-run Chinook Salmon may benefit from actions under
20 Alternative 5 intended to increase the efficiency of the Tracy and Skinner Fish
21 Collection Facilities to improve the overall salvage survival of listed salmonids,
22 including spring-run Chinook Salmon.

23 Thus, it is concluded that the potential for adverse effects on spring-run Chinook
24 Salmon under Alternative 5 suggested by the results of the numerical models
25 would likely be offset by the potential benefits of the actions that are not included
26 in the numerical models, principally because the Second Basis of Comparison
27 does not include a strategy to address water temperatures critical to spring-run
28 Chinook Salmon sustainability over the long term with climate change by 2030.
29 On balance and over the long term, the adverse effects on spring-run Chinook
30 Salmon under Alternative 5 would be less than those under the Second Basis of
31 Comparison.

32 *Fall-Run Chinook Salmon*

33 Changes in operations that influence temperature and flow conditions in the
34 Sacramento River downstream of Keswick Dam, Clear Creek downstream of
35 Whiskeytown Dam, Feather River downstream of Oroville Dam and American
36 River below Nimbus could affect fall-run Chinook Salmon. The following
37 describes those changes and their potential effects.

38 *Changes in Water Temperature*

39 Changes in water temperature could affect fall-run Chinook Salmon in the
40 Sacramento, Feather, and American rivers, and Clear Creek. The following
41 describes temperature conditions in those water bodies.

1 *Sacramento River*

2 Monthly water temperature in the Sacramento River at Keswick Dam under
3 Alternative 5 and the Second Basis of Comparison generally would be similar
4 (differences less than 0.5°F). Average monthly water temperatures in September
5 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
6 1.2°F) in drier years. Similarly, water temperatures in October of critical years
7 could be 0.9°F warmer under Alternative 5. A similar pattern in temperatures
8 generally would be exhibited at downstream locations along the Sacramento River
9 (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff, Hamilton City, and
10 Knights Landing), with differences in average monthly temperatures at Knights
11 Landing progressively increasing (up to 1.0°F warmer) in June and up to up to
12 4.6°F cooler in September of wetter years under Alternative 5 relative to the
13 Second Basis of Comparison.

14 *Clear Creek*

15 Average monthly water temperatures in Clear Creek at Igo under
16 Alternative relative to the Second Basis of Comparison are generally predicted to
17 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average
18 monthly water temperatures during May under Alternative 5 would be up to 0.8°F
19 lower than under the Second Basis of Comparison in all but critical water years.
20 The lower water temperatures in May associated with Alternative 5 reflect the
21 effects of additional water discharged from Whiskeytown Dam to meet the spring
22 attraction flow requirements to promote attraction of spring-run Chinook Salmon
23 into the creek. While the reduction in May water temperatures indicated by the
24 modeling could improve thermal conditions for fall-run Chinook Salmon, the
25 duration of the two pulse flows may not be of sufficient duration (3 days each) to
26 provide temperature benefits.

27 *Feather River*

28 Long-term average monthly water temperature in the Feather River at the low
29 flow channel under Alternative 5 relative to the Second Basis of Comparison
30 generally would be similar (less than 0.5°F differences). Water temperatures
31 could be up to 1.5°F warmer in November and December of some water year
32 types and up to 1.2°F cooler in September of wetter years. Although temperatures
33 in the river would become progressively higher in the downstream direction, the
34 differences between Alternative 5 and Second Basis of Comparison exhibit a
35 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
36 with water temperature differences under Alternative 5 generally increasing in
37 most water year types relative to the Second Basis of Comparison at the
38 confluence with Sacramento River (Appendix 6B, Table B-23-6). Water
39 temperatures under Alternative 5 could be somewhat (0.8°F to 1.6°F) cooler on
40 average and up to 3.9°F cooler (September) at the confluence with Sacramento
41 River from July to September in wetter years.

1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam
3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the
4 Second Basis of Comparison, with the exception of during June and August of
5 below normal water years, when temperatures under Alternative 5 could be as
6 much as 0.9°F higher. This pattern generally would persist downstream to Watt
7 Avenue and the mouth, although temperatures under Alternative 5 would be up to
8 1.6°F and 2.1°F higher, respectively, than under the Second Basis of Comparison
9 in June. In addition, average monthly water temperatures at the mouth under
10 Alternative 5 generally would be lower than under the Second Basis of
11 Comparison in September, especially in wetter water year types when water
12 temperatures under Alternative 5 could be up to 1.7°F cooler.

13 *Changes in Exceedances of Water Temperature Thresholds*

14 Changes in water temperature could result in the exceedance of water
15 temperatures that are protective of fall-run Chinook Salmon in the Sacramento
16 River, Clear Creek, Feather River, and American River. The following describes
17 the extent of those exceedances for each of those water bodies.

18 *Sacramento River*

19 Average monthly water temperatures under both Alternative 5 and Second Basis
20 of Comparison would exceed the water temperature threshold of 56°F established
21 in the Sacramento River at Red Bluff for fall-run Chinook Salmon spawning and
22 egg incubation (Table temperature targets) during some months, particularly in
23 October, November, and April, when temperature thresholds would be exceeded.
24 The frequency of exceedance would be greatest in October, a month in which
25 average monthly water temperature could get as high as about 64°F. In October,
26 average monthly water temperatures under Alternative 5 and Second Basis of
27 Comparison would exceed the threshold 82 percent and 79 percent of the time,
28 respectively. The differences in the frequency of exceedances between
29 Alternative 5 and Second Basis of Comparison would be small. Water
30 temperatures under Alternative 5 would exceed temperature thresholds about
31 2 percent more frequently than under the Second Basis of Comparison in October,
32 1 percent less frequently in November, and 1 percent more frequently in April.

33 *Clear Creek*

34 Fall-run Chinook Salmon spawning in lower Clear Creek typically occurs during
35 October through December (USFWS 2015). Average monthly water
36 temperatures at Igo during this period generally would be below 56°F, except in
37 October. Under Alternative 5, the 56°F threshold would be exceeded in October
38 about 12 percent of the time as compared to 10 percent under the Second Basis of
39 Comparison. At the confluence with the Sacramento River, average monthly
40 water temperatures in October would be warmer, with 56°F exceeded nearly
41 20 percent of the time under Alternative 5 and somewhat (about 8 percent) less
42 frequently under the Second Basis of Comparison. During November and
43 December, average monthly water temperatures generally would remain below
44 56°F at both locations.

1 For fall-run Chinook Salmon rearing (January through September), the
2 exceedances described previously for spring-run Chinook Salmon would apply,
3 with the average monthly temperatures remaining below the 60°F threshold
4 except in September when temperatures could increase to over 60°F. During
5 September, water temperatures under Alternative 5 would exceed 56°F about
6 3 percent more frequently than under the Second Basis of Comparison.
7 Downstream at the mouth, the average monthly temperatures would exceed 56°F
8 more frequently, especially in July and August, when it always would be
9 exceeded and average monthly temperatures would approach 64°F under both
10 scenarios in September.

11 Under Alternative 5, temperature conditions at Igo would be slightly warmer than
12 under the Second Basis of Comparison. Average monthly water temperatures
13 likely mask daily temperatures excursions that could exceed important thresholds.
14 Therefore, while the differences in threshold exceedance are relatively minor, the
15 likelihood of adverse effects on fall-run Chinook Salmon in Clear Creek under
16 Alternative 5 would likely be greater than under the Second Basis of Comparison.

17 *Feather River*

18 Average monthly water temperatures under both Alternative 5 and Second Basis
19 of Comparison would exceed the water temperature threshold of 56°F established
20 in the Feather River at Gridley Bridge for fall-run Chinook Salmon spawning and
21 egg incubation during some months, particularly in October, November, March,
22 and April, when temperature thresholds would be exceeded frequently
23 (Appendix 9N). The frequency of exceedance would be greatest in October,
24 when average monthly temperatures under both Alternative 5 and Second Basis of
25 Comparison would be above the threshold in nearly every year. The magnitude of
26 the exceedances would be high as well, with average monthly temperatures in
27 October reaching about 68°F. Similarly, the threshold would be exceeded under
28 both Alternative 5 and the Second Basis of Comparison about 85 percent of the
29 time in April. The differences in threshold exceedance between Alternative 5 and
30 Second Basis of Comparison, would be small, with water temperatures under
31 Alternative 5 generally exceeding temperature thresholds about 1-2 percent more
32 frequently than the Second Basis of Comparison during the October through April
33 period. However, average monthly water temperatures likely mask daily
34 temperatures excursions that could exceed important thresholds. Therefore, while
35 the differences in threshold exceedance are relatively minor, the likelihood of
36 adverse effects on fall-run Chinook Salmon in the Feather River under
37 Alternative 5 would likely be greater than under the Second Basis of Comparison.

38 *Changes in Egg Mortality*

39 Water temperatures influence the viability of incubating fall-run Chinook Salmon
40 eggs. The following describes the differences in egg mortality for the
41 Sacramento, Feather, and American rivers.

1 *Sacramento River*

2 For fall-run Chinook Salmon in the Sacramento River, the long-term average egg
3 mortality rate is predicted to be around 17 percent, with higher mortality rates (in
4 excess of 35 percent) occurring in critical dry years under Alternative 5. Overall,
5 egg mortality would be similar under Alternative 5 and the Second Basis of
6 Comparison (Appendix 9C, Table B-1).

7 *Feather River*

8 For fall-run Chinook Salmon in the Feather River, the long-term average egg
9 mortality rate is predicted to be relatively low (around 7 percent), with higher
10 mortality rates (around 14 percent) occurring in critical dry years under
11 Alternative 5. Overall, egg mortality would be similar under Alternative 5 and
12 the Second Basis of Comparison (Appendix 9C, Table B-7).

13 *American River*

14 For fall-run Chinook Salmon in the American River, the long-term average egg
15 mortality rate is predicted to range from approximately 23 to 25 percent in all
16 water year types under Alternative 5. Overall, egg mortality would be similar
17 under Alternative 5 and the Second Basis of Comparison (Appendix 9C,
18 Table B-6).

19 *Changes in Weighted Usable Area*

20 Weighted usable area, which is influenced by flow, is a measure of habitat
21 suitability. The following describes changes in WUA for fall-run Chinook
22 Salmon in the Sacramento, Feather, and American rivers and Clear Creek.

23 *Sacramento River*

24 As an indicator of the amount of suitable spawning habitat for fall-run Chinook
25 Salmon between Keswick Dam and Battle Creek, modeling results indicate that,
26 in general, there would be lesser amounts of spawning habitat available in
27 September and November under Alternative 5 as compared to the Second Basis of
28 Comparison (Appendix 9E, Table C-11-6). The decrease in long-term average
29 spawning WUA during September (prior to the peak spawning period) would be
30 relatively large (more than 20 percent), with a smaller decrease in November
31 (around 6 percent). The latter month is during the peak spawning period for fall-
32 run Chinook Salmon. Results for the reach from Battle Creek to Deer Creek
33 show the same pattern for changes in WUA for spawning fall-run Chinook
34 Salmon between Alternative 5 and the Second Basis of Comparison
35 (Appendix 9E, Table C-10-6). Overall, spawning habitat availability would be
36 slightly lower under Alternative 5 relative to the Second Basis of Comparison.

37 Modeling results indicate that, in general, there would be similar amounts of
38 suitable fry rearing habitat available from December to March under Alternative 5
39 and the Second Basis of Comparison (Appendix 9E, Table C-12-6). Similar to
40 the results for fry rearing WUA, modeling results indicate that, there would be
41 similar amounts of suitable juvenile rearing habitat available during the juvenile
42 rearing period under Alternative 5 and the Second Basis of Comparison
43 (Appendix 9E, Table C-13-6).

1 *Clear Creek*

2 As described above, flows in Clear Creek below Whiskeytown Dam are not
3 anticipated to differ under Alternative 5 relative to the Second Basis of
4 Comparison except in May due to the release of spring attraction flows in
5 accordance with the 2009 NMFS BO. Therefore, there would be no change in the
6 amount of potentially suitable spawning and rearing habitat for fall-run Chinook
7 Salmon (as indexed by WUA) available under Alternative 5 as compared to the
8 Second Basis of Comparison.

9 *Feather River*

10 As described above, Flows in the low flow channel of the Feather River are not
11 anticipated to differ under Alternative 5 relative to the Second Basis of
12 Comparison. Therefore, there would be no change in the amount of potentially
13 suitable spawning habitat for fall-run Chinook Salmon (as indexed by WUA)
14 available under Alternative 5 as compared to the Second Basis of Comparison.
15 The majority of spawning activity by fall-run Chinook Salmon in the Feather
16 River occurs in this reach with a lesser amount of spawning occurring
17 downstream of the Thermalito Complex.

18 Modeling results indicate that, in general, there would be a lesser amount of
19 spawning habitat available in September (20 percent less) and greater amounts of
20 incubation habitat available in February (6 percent more) under Alternative 5 as
21 compared to the Second Basis of Comparison; fall-run spawning WUA may be
22 slightly (around 5 percent) increased in October (the peak spawning month) for
23 fall-run Chinook Salmon in this reach (Appendix 9E, Table C-24-6). The
24 decrease in long-term average spawning WUA during September would occur
25 prior to the peak spawning period. Overall, spawning and incubation habitat
26 availability would be similar under Alternative 5 relative to the Second Basis of
27 Comparison.

28 *American River*

29 Modeling results indicate that, in general, there would be similar amounts of
30 spawning habitat available for fall-run Chinook Salmon in the American River
31 from October through December under Alternative 5 and the Second Basis of
32 Comparison (Appendix 9E, Table C-25-6).

33 *Changes in SALMOD Output*

34 SALMOD results indicate that potential fall-run juvenile production would be
35 similar under Alternative 5 and the Second Basis of Comparison, except in critical
36 dry years when production could be 7 percent lower under Alternative 5 than
37 under the Second Basis of Comparison (Appendix 9D, Table B-1-26).

38 *Changes in Delta Passage Model Output*

39 The Delta Passage Model predicted similar estimates of annual Delta survival
40 across the 81 water year time period for Fall-run between Alternative 5 and the
41 Second Basis of Comparison Alternative (Appendix 9J). Median Delta survival
42 was 0.248 for Alternative 5 and 0.245 for the Second Basis of Comparison.
43 Overall, there would be little change in through-Delta survival by emigrating

1 juvenile fall-run Chinook Salmon under Alternative 5 as compared to the Second
2 Basis of Comparison.

3 *Changes in Delta Hydrodynamics*

4 Fall run Chinook salmon smolts are most abundant in the Delta during the months
5 of April, May and June. At the junction of Georgiana Slough and the Sacramento
6 River, the median proportion of positive velocities was slightly lower under
7 Alternative 5 relative to the Second Basis of Comparison in May and June
8 (Appendix 9K). The median proportion of positive velocities for Alternative 5
9 was similar in April. Near the confluence of the San Joaquin River and the
10 Mokelumne River, the median proportion of positive velocities was slightly to
11 moderately higher under Alternative 5 relative to Second Basis of Comparison in
12 April and May, respectively, whereas values in June were similar. On Old River
13 downstream of the facilities, the median proportion of positive velocities was
14 substantially higher in April and May and slightly higher in June under
15 Alternative 5 relative to Second Basis of Comparison. In Old River upstream of
16 the facilities, the median proportion of positive velocities was slightly higher
17 under Alternative 5 April and May and slightly lower in June. On the San
18 Joaquin River downstream of the Head of Old River, the median proportion of
19 positive velocities was slightly to moderately lower under Alternative 5 relative to
20 Second Basis of Comparison in April and May, respectively, and similar in June.

21 *Changes in Junction Entrainment*

22 At the junction of Georgiana Slough and the Sacramento River, median
23 entrainment under Alternative 5 was slightly lower than the Second Basis of
24 Comparison in June but essentially indistinguishable in all other months
25 (Appendix 9L). Median entrainment at the Head of Old River junction was
26 considerably higher under Alternative 5 relative to Second Basis of Comparison
27 during the months of April and May and slightly lower in June. For the Turner
28 Cut junction, median entrainment under Alternative 5 was moderately lower in
29 April and May relative to Second Basis of Comparison and slightly lower in June.
30 At the Columbia Cut junction, median entrainment under Alternative 5 was
31 slightly lower in June relative to the Second Basis of Comparison. Median
32 entrainment was substantially lower under Alternative 5 relative to Second Basis
33 of Comparison in April and May. A similar pattern of entrainment under
34 Alternative 5 relative to Second Basis of Comparison was observed at the Middle
35 River and Old River junctions.

36 *Changes in Salvage*

37 Salvage of Sacramento River-origin fall run was predicted to be substantially
38 lower under Alternative 5 relative to the Second Basis of Comparison in April and
39 May (Appendix 9M). During the month of June, salvage was moderately lower
40 under Alternative 5.

41 *Summary of Effects on Fall-Run Chinook Salmon*

42 The multiple model and analysis outputs described above characterize the
43 anticipated conditions for fall-run Chinook Salmon and their response to change
44 under Alternative 5 as compared to the Second Basis of Comparison. For the

1 purpose of analyzing effects on fall-run Chinook Salmon in the Sacramento River,
2 greater reliance was placed on the outputs from the SALMOD model because it
3 integrates the available information on water temperature and flows to produce
4 estimates of mortality for each life stage and an overall, integrated estimate of
5 potential fall-run Chinook Salmon juvenile production. The output from
6 SALMOD indicated that fall-run Chinook Salmon production would be similar
7 under Alternative 5 and the Second Basis of Comparison, except in critical
8 dry years.

9 In Clear Creek and the Feather and American rivers, the analysis of the effects of
10 Alternative 5 and Second Basis of Comparison for fall-run Chinook Salmon relied
11 on the water temperature model output for the rivers at various locations
12 downstream of the CVP and SWP facilities. The analysis of temperatures
13 indicates similar temperatures and slightly greater likelihood of exceedance of
14 thresholds under Alternative 5 as compared to the Second Basis of Comparison in
15 the Feather River. There would be little change in flows or temperatures in Clear
16 Creek under Alternative 5 relative to the Second Basis of Comparison. The effect
17 of slightly increased temperatures is not reflected in the similar overall survival of
18 fall-run Chinook Salmon eggs predicted by Reclamation's salmon mortality
19 model for fall-run in the Feather and American rivers. In drier years, the
20 likelihood of adverse temperature effects would be increased under Alternative 5
21 as compared to the Second Basis of Comparison.

22 Flow changes under Alternative 5 would likely have small effects on the
23 availability of spawning and rearing habitat for fall-run Chinook Salmon in the
24 Sacramento River system as indicated by the similarity in spawning WUA in the
25 Sacramento, Feather, and American rivers under Alternative 5 and the Second
26 Basis of Comparison. Fry and juvenile rearing WUA would be similar in the
27 Sacramento River and this is reflected in the similarity in flow (habitat)-related
28 mortality predicted by SALMOD under Alternative 5.

29 Through-Delta survival of juvenile fall-run Chinook Salmon would be similar
30 under both Alternative 5 and Second Basis of Comparison as indicated by the
31 DPM results and entrainment could be reduced as indicated by the OMR flow
32 analysis. Overall, Alternative 5 likely would have similar or slightly greater
33 adverse effects on the fall-run Chinook Salmon population in the Sacramento
34 River watershed as compared to the Second Basis of Comparison, particularly in
35 drier water year types.

36 Additional actions implemented under Alternative 5 could help improve
37 conditions for fall-run Chinook Salmon relative to the Second Basis of
38 Comparison, such as structural improvements for temperature management in the
39 American River and actions intended to increase the efficiency of the Tracy and
40 Skinner Fish Collection Facilities to improve the overall salvage survival of
41 salmonids, including fall-run Chinook Salmon. The implementation of fish
42 passage under Alternative 5 intended to address the limited availability of suitable
43 habitat for winter-run and spring-run Chinook Salmon in the Sacramento River
44 reaches downstream of Shasta Dam is unlikely to benefit fall-run Chinook
45 Salmon unless passage is provided for adult fall-run Chinook Salmon. The

1 effects of providing similar fish passage at Folsom Dam would also be uncertain
2 for the same reason.

3 Overall, the results of the numerical models suggest the potential for greater
4 adverse effects on fall-run Chinook Salmon under Alternative 5 as compared to
5 the Second Basis of Comparison. However, discerning a meaningful difference
6 between these two scenarios based on the quantitative results is difficult because
7 of the similarity in results (generally differences less than 5 percent), the inherent
8 uncertainty of the models, and the potential for offsetting benefits. Thus, it is
9 concluded that the effects on fall-run Chinook Salmon would be similar under
10 Alternative 5 and the Second Basis of Comparison.

11 *Late Fall-Run Chinook Salmon*

12 Changes in operations that influence temperature and flow conditions in the
13 Sacramento River downstream of Keswick Dam could affect late fall-run Chinook
14 Salmon. The following describes those changes and their potential effects.

15 *Changes in Water Temperature*

16 Monthly water temperature in the Sacramento River at Keswick Dam under
17 Alternative and the Second Basis of Comparison generally would be similar
18 (differences less than 0.5°F). Average monthly water temperatures in September
19 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
20 1.2°F) in drier years. Similarly, water temperatures in October of critical years
21 could be 0.9°F warmer under Alternative 5. A similar temperature pattern
22 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend
23 Bridge and Red Bluff, with average monthly temperatures in September
24 progressively increasing (up to 3.2°F cooler at Red Bluff) during the wetter years.

25 *Changes in Exceedances of Water Temperature Thresholds*

26 Average monthly water temperatures under both Alternative 5 and Second Basis
27 of Comparison would exceed the water temperature threshold of 56°F established
28 in the Sacramento River at Red Bluff during some months, particularly in
29 October, November, and April. The frequency of exceedance would be greatest
30 in October, a month in which average monthly water could get as high as about
31 64°F. In October, average monthly water temperatures under Alternative 5 and
32 Second Basis of Comparison would exceed the threshold 80 percent and
33 79 percent of the time, respectively. Water temperatures under Alternative 5
34 would exceed temperature thresholds about 2 percent more frequently than under
35 the Second Basis of Comparison in October, 1 percent less frequently in
36 November, and 1 percent more frequently in April.

37 *Changes in Egg Mortality*

38 For late fall-run Chinook Salmon in the Sacramento River, the long-term average
39 egg mortality rate is predicted to range from approximately 2.4 to nearly 5 percent
40 in all water year types under Alternative 5. Overall, egg mortality would be
41 similar under Alternative 5 and the Second Basis of Comparison (Appendix 9C,
42 Table B-2).

1 *Changes in Weighted Usable Area*

2 Modeling results indicate that there would be similar amounts of spawning habitat
3 available for late fall-run Chinook Salmon in the Sacramento River from January
4 through April under Alternative 5 and the Second Basis of Comparison
5 (Appendix 9E, Table C-14-6). Modeling results indicate that, in general, there
6 would be similar amounts of suitable late fall-run Chinook Salmon fry rearing
7 habitat available under Alternative 5 and the Second Basis of Comparison
8 (Appendix 9E, Table C-15-6).

9 A substantial fraction of late fall run Chinook Salmon juveniles oversummer in
10 the Sacramento River before emigrating, which allows them to avoid predation
11 through both their larger size and greater swimming ability. One implication of
12 this life history strategy is that rearing habitat is most likely the limiting factor for
13 late-fall-run Chinook Salmon, especially if availability of cool water determines
14 the downstream extent of spawning habitat for late-fall-run salmon. Modeling
15 results indicate that, there would be reduced amounts of suitable juvenile rearing
16 habitat available in September (12 percent less) and November (8 percent less
17 under Alternative 5 as compared to the Second Basis of Comparison. In other
18 months the amount the amount of late fall-run Chinook Salmon juvenile rearing
19 WUA would be similar under Alternative 5 and the Second Basis of Comparison
20 (Appendix 9E, Table C-16-6).

21 *Changes in SALMOD Output*

22 SALMOD results indicate that potential juvenile production would be similar
23 under Alternative 5 and the Second Basis of Comparison (Appendix 9D,
24 Table B-2-26).

25 *Changes in Delta Passage Model Output*

26 For Late-Fall-Run, Delta survival was predicted to be slightly higher for
27 Alternative 5 versus the Second Basis of Comparison for all 81 water years
28 simulated by the Delta Passage Model (Appendix 9J). Median Delta survival
29 across all years was 0.243 for Alternative 5 and 0.199 for the Second Basis of
30 Comparison. Overall, there would be a slight increase in through-Delta survival
31 for emigrating juvenile late fall-run Chinook Salmon under Alternative 5 as
32 compared to the Second Basis of Comparison.

33 *Changes in Delta Hydrodynamics*

34 The late fall-run Chinook migration period overlaps with that of winter-run
35 Chinook Salmon and they are most abundant in the Delta during the months of
36 January February and March. On the Sacramento River near the confluence of
37 Georgiana Slough, the median proportion of positive velocities under
38 Alternative 5 was indistinguishable from the Second Basis of Comparison in
39 January, February and March (Appendix 9K). On the San Joaquin River near the
40 Mokelumne River confluence, the median proportion of positive velocities was
41 slightly greater under Alternative 5 relative to Second Basis of Comparison in
42 January and February and similar in March. In Old River downstream of the
43 facilities, the median proportion of positive velocities was substantially higher
44 under Alternative 5 during January and moderately higher in February. Values in

1 March were almost indistinguishable between scenarios. On Old River upstream
2 of the facilities, the median proportion of positive velocities was moderately
3 lower in January and February and slightly lower in March under Alternative 5
4 relative to Second Basis of Comparison. On the San Joaquin River downstream
5 of Head of Old River, the median proportion of positive velocities was similar for
6 both scenarios in January, February and March.

7 *Changes in Junction Entrainment*

8 At the junction of Georgiana Slough and the Sacramento River, median
9 entrainment under Alternative 5 and the Second Basis of Comparison in January
10 was essentially indistinguishable in January, February and March (Appendix 9L).
11 Entrainment at the Head of Old River junction was similar to slightly lower under
12 Alternative 5 relative to Second Basis of Comparison. For the Turner Cut
13 junction, median entrainment under Alternative 5 was slightly lower in January
14 and February relative to Second Basis of Comparison. In March, the difference in
15 entrainment between scenarios was similar. At the Columbia Cut, Middle River
16 and Old River junctions, patterns in entrainment between Alternative 5 and the
17 Second Basis of Comparison were similar. At these junctions, entrainment was
18 moderately lower under Alternative 5 during January and February and values
19 were more similar in March.

20 *Changes in Salvage*

21 Salvage of late fall-run Chinook salmon is predicted to be substantially lower
22 under Alternative 5 relative to the Second Basis of Comparison in January and
23 February (Appendix 9M). In March salvage was only moderately lower under
24 Alternative 5 relative to Second Basis of Comparison.

25 *Summary of Effects on Late Fall-Run Chinook Salmon*

26 The multiple model and analysis outputs described above characterize the
27 anticipated conditions for late fall-run Chinook Salmon and their response to
28 change under Alternative 5 as compared to the Second Basis of Comparison. For
29 the purpose of analyzing effects on late fall-run Chinook Salmon in the
30 Sacramento River, greater reliance was placed on the outputs from the SALMOD
31 model because it integrates the available information on temperature and flows to
32 produce estimates of mortality for each life stage and an overall, integrated
33 estimate of potential late fall-run Chinook Salmon juvenile production. The
34 output from SALMOD indicated that late fall-run Chinook Salmon production
35 would be similar under Alternative 5 and the Second Basis of Comparison. The
36 analyses attempting to assess the effects on routing, entrainment, and salvage of
37 juvenile salmonids in the Delta suggest that salvage (as an indicator of potential
38 losses of juvenile salmon at the export facilities) of Sacramento River-origin
39 Chinook Salmon is predicted to be lower under Alternative 5 relative to the
40 Second Basis of Comparison in every month.

41 These model results suggest that overall, Alternative 5 is likely to have less
42 adverse effect on late fall-run Chinook Salmon in the Sacramento River as
43 compared to the Second Basis of Comparison. Potential benefits may be
44 enhanced under Alternative 5 by actions intended to increase the efficiency of the

1 Tracy and Skinner Fish Collection Facilities to improve the overall salvage
2 survival of salmonids, including late fall-run Chinook Salmon. Thus, it is
3 concluded that the potential for adverse effects on late fall-run Chinook Salmon
4 would be less under Alternative 5 relative to the Second Basis of Comparison.

5 *Steelhead*

6 Changes in operations that influence temperature and flow conditions that could
7 affect steelhead. The following describes those changes and their potential
8 effects.

9 *Changes in Water Temperature*

10 Changes in water temperature could affect steelhead in the Sacramento, Feather,
11 and American rivers, and Clear Creek. The following describes temperature
12 conditions in those water bodies.

13 *Sacramento River*

14 Monthly water temperature in the Sacramento River at Keswick Dam under
15 Alternative 5 and the Second Basis of Comparison generally would be similar
16 (differences less than 0.5°F). Average monthly water temperatures in September
17 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
18 1.2°F) in drier years. Similarly, water temperatures in October of critical years
19 could be 0.9°F warmer under Alternative 5. A similar temperature pattern
20 generally would be exhibited downstream at Ball's Ferry, Jelly's Ferry, Bend
21 Bridge and Red Bluff, with average monthly temperatures in September
22 progressively increasing (up to 3.2°F cooler at Red Bluff) during the wetter years
23 (Appendix 6B, Table B-9-6).

24 *Clear Creek*

25 Average monthly water temperatures in Clear Creek at Igo under
26 Alternative relative to the Second Basis of Comparison are generally predicted to
27 be similar (less than 0.5°F differences) (Appendix 6B, Table B-3-6). Average
28 monthly water temperatures during May under Alternative 5 would be up to 0.8°F
29 lower than under the Second Basis of Comparison in all but critical water years.

30 *Feather River*

31 Long-term average monthly water temperature in the Feather River at the low
32 flow channel under Alternative 5 relative to the Second Basis of Comparison
33 generally would be similar (less than 0.5°F differences). Water temperatures
34 could be up to 1.5°F warmer in November and December of some water year
35 types and up to 1.2°F cooler in September of wetter years. Although temperatures
36 in the river would become progressively higher in the downstream direction, the
37 differences between Alternative 5 and Second Basis of Comparison exhibit a
38 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
39 with water temperature differences under Alternative 5 generally increasing in
40 most water year types relative to the Second Basis of Comparison at the
41 confluence with Sacramento. Water temperatures under Alternative 5 could be
42 somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)
43 at the confluence with Sacramento River from July to September in wetter years.

1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam
 3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the
 4 Second Basis of Comparison, with the exception of during June and August of
 5 below normal years, when temperatures under Alternative 5 could be as much as
 6 0.9°F higher. This pattern generally would persist downstream to Watt Avenue
 7 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F
 8 and 2.1°F higher, respectively, than under the Second Basis of Comparison in
 9 June. In addition, average monthly water temperatures at the mouth generally
 10 would be lower than the Second Basis of Comparison in September, especially in
 11 wetter water year types when Alternative 5 could be up to 1.7°F cooler.

12 *Changes in Exceedances of Water Temperature Thresholds*

13 Changes in water temperature could result in the exceedance of established water
 14 temperature thresholds for steelhead in the Sacramento River, Clear Creek, and
 15 Feather River. The following describes the extent of those exceedance for each of
 16 those streams.

17 *Sacramento River*

18 As described in the life history accounts (Appendix), steelhead spawning in the
 19 mainstem Sacramento River generally occurs in the upper reaches from Keswick
 20 Dam downstream to near Balls Ferry, with most spawning concentrated near
 21 Redding. Most steelhead, however, spawn in tributaries to the Sacramento River.
 22 Spawning generally takes place in the January through March period when water
 23 temperatures in the river generally do not exceed 52°F under either Alternative 5
 24 or Second Basis of Comparison. While there are no established temperature
 25 thresholds for steelhead rearing in the mainstem Sacramento River, average
 26 monthly temperatures when fry and juvenile steelhead are in the river would
 27 generally remain below 56°F at Balls Ferry except in August and September
 28 when this temperature would be exceeded at least 40 percent of the time under
 29 both the No Action Alternative and Second Basis of Comparison. However,
 30 water temperatures in the Sacramento River at Balls Ferry would exceed 56°F
 31 about 10 percent more often in September under the Second Basis of Comparison
 32 compared to Alternative 5. Overall, thermal conditions for steelhead in the
 33 Sacramento River would be similar under Alternative 5 and the Second Basis of
 34 Comparison.

35 *Clear Creek*

36 While there are no established temperature thresholds for steelhead spawning in
 37 Clear Creek, average monthly water temperatures in the river generally would not
 38 exceed 48°F during the spawning period (December to April) under either
 39 Alternative 5 or Second Basis of Comparison. Similarly, while there are no
 40 established temperature thresholds for steelhead rearing in Clear Creek, average
 41 monthly temperatures in throughout the year would not exceed 56°F at Igo.
 42 Overall, thermal conditions for steelhead in Clear Creek would be similar under
 43 Alternative 5 and the Second Basis of Comparison.

1 *Feather River*

2 Average monthly water temperatures under both Alternative 5 and the Second
3 Basis of Comparison would on occasion exceed the water temperature threshold
4 of 56°F established in the Feather River at Robinson Riffle for steelhead
5 spawning and incubation during some months, particularly in October and
6 November, and March and April, when temperature thresholds could be exceeded
7 frequently (Appendix 9N). There would be a 1 percent exceedance of the 56°F
8 threshold in December and no exceedances of the 56°F threshold in January and
9 February under both Alternative 5 and the Second Basis of Comparison.
10 However, the differences in the frequency of exceedance between Alternative 5
11 and Second Basis of Comparison during March and April would be relatively
12 small with water temperatures under Alternative 5 exceeding the threshold about
13 1 percent more frequently in March and the same exceedance frequency
14 (75 percent) as the Second Basis of Comparison in April.

15 The established water temperature threshold of 63°F for rearing from May
16 through August would be exceeded often under both Alternative 5 and Second
17 Basis of Comparison in May and June, but not at all in July and August. Water
18 temperatures under Alternative 5 would exceed the rearing temperature threshold
19 about 6 percent more frequently than under the Second Basis of Comparison in
20 May, but no more frequently in June. Temperature conditions in the Feather
21 River under Alternative 5 could be more likely to result in adverse effects on
22 steelhead spawning and rearing than under the Second Basis of Comparison
23 because of the slightly increased frequency of exceedance of the 56°F spawning
24 threshold in March and the somewhat increased frequency of exceedance of the
25 63°F rearing threshold in May.

26 *American River*

27 In the American River, the water temperature threshold for steelhead rearing
28 (May through October) is 65°F at the Watt Avenue Bridge. Average monthly
29 water temperatures would exceed this threshold often under both Alternative 5
30 and Second Basis of Comparison, especially in the July through September period
31 when the threshold is exceeded nearly all of the time. In addition, the magnitude
32 of the exceedance would be high, with average monthly water temperatures
33 sometimes higher than 76°F. The differences in exceedance frequency between
34 Alternative 5 and Second Basis of Comparison, however, would be relatively
35 small (differences within 1 percent), except in September, when average monthly
36 water temperatures under Alternative 5 would exceed 65°F about 6 percent less
37 frequently than under the Second Basis of Comparison. Temperature conditions
38 in the American River under Alternative 5 could increase the likelihood of
39 adverse effects on steelhead rearing than under the Second Basis of Comparison
40 because of the increased frequency of exceedance of the 65°F rearing threshold in
41 some months.

42 *Changes in Weighted Usable Area*

43 The following describes changes in WUA for steelhead in the Sacramento,
44 Feather, and American rivers and Clear Creek.

1 *Sacramento River*

2 Modeling results indicate that, in general, there would be similar amounts of
3 suitable steelhead spawning habitat available from December through March
4 under Alternative 5 as compared to the Second Basis of Comparison
5 (Appendix 9E, Table C-20-6).

6 *Clear Creek*

7 As described above, flows in Clear Creek below Whiskeytown Dam are not
8 anticipated to differ under Alternative 5 relative to the Second Basis of
9 Comparison except in May due to the release of spring attraction flows in
10 accordance with the 2009 NMFS BO. Therefore, there would be no change in the
11 amount of potentially suitable spawning and rearing habitat for steelhead (as
12 indexed by WUA) available under Alternative 5 as compared to the Second Basis
13 of Comparison.

14 *Feather River*

15 As described above, Flows in the low flow channel of the Feather River are not
16 anticipated to differ under Alternative 5 relative to the Second Basis of
17 Comparison. Therefore, there would be no change in the amount of potentially
18 suitable spawning habitat for steelhead (as indexed by WUA) available under
19 Alternative 5 as compared to the Second Basis of Comparison. The majority of
20 spawning activity by steelhead in the Feather River occurs in this reach with a
21 lesser amount of spawning occurring downstream of the Thermalito Complex.

22 Modeling results indicate that, in general, there would be similar amounts of
23 spawning habitat for steelhead in the Feather River below Thermalito available
24 from December through April under Alternative 5 and the Second Basis of
25 Comparison.

26 *American River*

27 Modeling results indicate that, in general, there would be similar amounts of
28 spawning habitat for steelhead in the American River downstream of Nimbus
29 Dam available from December through April under Alternative 5 and the Second
30 Basis of Comparison.

31 *Changes in Delta Hydrodynamics*

32 Sacramento River-origin steelhead generally move through the Delta during
33 spring however there is less information on their timing relative to Chinook
34 salmon. Thus, hydrodynamics in the entire January through June period have the
35 potential to affect juvenile steelhead.

36 On the Sacramento River near the confluence of Georgiana Slough, the median
37 proportion of positive velocities under Alternative 5 was moderately lower
38 relative to the Second Basis of Comparison from January to April and slightly
39 lower in May and June (Appendix 9K). On the San Joaquin River near the
40 Mokelumne River confluence, the median proportion of positive velocities was
41 slightly greater under Alternative 5 relative to Second Basis of Comparison in
42 January, February, April and May and similar in March and June. In Old River
43 downstream of the facilities, the median proportion of positive velocities was
44 substantially higher under Alternative 5 during January, April, and May and

1 moderately higher in February. Values in March and June were almost
2 indistinguishable between scenarios. On Old River upstream of the facilities, the
3 median proportion of positive velocities was moderately lower in January and
4 February, slightly lower March and June, and slightly higher in April and May
5 under Alternative 5 relative to Second Basis of Comparison. On the San Joaquin
6 River downstream of Head of Old River, the median proportion of positive
7 velocities was similar for both scenarios in January, February, March and June,
8 but slightly to moderately lower in April and May.

9 *Summary of Effects on Steelhead*

10 The multiple model and analysis outputs described above characterize the
11 anticipated conditions for steelhead and their response to change under
12 Alternative 5 as compared to the Second Basis of Comparison. The analysis of
13 the effects of Alternative and Second Basis of Comparison for steelhead relied on
14 the WUA analysis for habitat and water temperature model output for the rivers at
15 various locations downstream of the CVP and SWP facilities. The WUA analysis
16 indicated that the availability of steelhead spawning and rearing habitat in Clear
17 Creek and steelhead spawning habitat in the Sacramento, Feather and American
18 rivers would be similar under Alternative 5 and the Second Basis of Comparison.
19 The analysis of temperatures indicates somewhat higher temperatures and greater
20 likelihood of exceedance of thresholds under Alternative 5 as compared to the
21 Second Basis of Comparison in the Sacramento and Feather rivers. In drier years,
22 the likelihood of adverse temperature effects would be increased under
23 Alternative 5 as compared to the Second Basis of Comparison. There would be
24 little change in flows or temperatures in Clear Creek under Alternative 5 relative
25 to the Second Basis of Comparison.

26 These numerical model results suggest that overall, effects on steelhead could be
27 slightly more adverse under Alternative 5 than under the Second Basis of
28 Comparison, particularly in the Feather and American rivers. However,
29 implementation of a fish passage program under Alternative 5 intended to address
30 the limited availability of suitable habitat for steelhead in the Sacramento River
31 reaches downstream of Keswick Dam and in the American River could provide a
32 benefit to Central Valley steelhead in the Sacramento and American rivers. This
33 is particularly important in light of anticipated increases in water temperature
34 associated with climate change in 2030. In addition to fish passage, preparation
35 and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and
36 actions under Alternative 5 intended to increase the efficiency of the Tracy and
37 Skinner Fish Collection Facilities could benefit steelhead under Alternative 5 in
38 comparison to the Second Basis of Comparison. Thus, on balance and over the
39 long term, the adverse effects on steelhead under Alternative 5 would be less than
40 those under the Second Basis of Comparison.

41 *Green Sturgeon*

42 Changes in operations that influence temperature and flow conditions could affect
43 Green Sturgeon. The following describes those changes and their potential
44 effects.

1 *Changes in Water Temperature*

2 Changes in water temperature could affect Green Sturgeon in the Sacramento and
3 Feather rivers. The following describes temperature conditions in those water
4 bodies.

5 *Sacramento River*

6 Monthly water temperature in the Sacramento River at Keswick Dam under
7 Alternative and the Second Basis of Comparison generally would be similar
8 (differences less than 0.5°F). Average monthly water temperatures in September
9 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
10 1.2°F) in drier years. Similarly, water temperatures in October of critical years
11 could be 0.9°F warmer under Alternative 5. (Appendix 6B). A similar pattern in
12 temperatures generally would be exhibited at downstream locations along the
13 Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend Bridge, Red Bluff,
14 Hamilton City, and Knights Landing), with differences in average monthly
15 temperatures at Knights Landing progressively increasing (up to 1.0°F warmer) in
16 June and up to up to 4.6°F cooler in September of wetter years under
17 Alternative 5 relative to the Second Basis of Comparison.

18 *Feather River*

19 Long-term average monthly water temperature in the Feather River at the low
20 flow channel under Alternative 5 relative to the Second Basis of Comparison
21 generally would be similar (less than 0.5°F differences). Water temperatures
22 could be up to 1.5°F warmer in November and December of some water year
23 types and up to 1.2°F cooler in September of wetter years. Although temperatures
24 in the river would become progressively higher in the downstream direction, the
25 differences between Alternative 5 and Second Basis of Comparison exhibit a
26 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
27 with water temperature differences under Alternative 5 generally increasing in
28 most water year types relative to the Second Basis of Comparison at the
29 confluence with Sacramento. Water temperatures under Alternative 5 could be
30 somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)
31 at the confluence with Sacramento River from July to September in wetter years.

32 *Changes in Exceedances of Water Temperature Thresholds*

33 Changes in water temperature could result in the exceedance of established water
34 temperature thresholds for Green Sturgeon in the Sacramento and Feather rivers.
35 The following describes the extent of those exceedance for each of those rivers.

36 *Sacramento River*

37 Average monthly water temperatures in the Sacramento River at Bend Bridge
38 under both Alternative 5 and Second Basis of Comparison would exceed the
39 water temperature threshold of 63°F established for Green Sturgeon larval rearing
40 in August and September, with exceedances under Alternative 5 occurring about
41 7 percent of the time in August and about 12 percent of the time in September.
42 This is 1 to 2 percent more frequently than under the Second Basis of
43 Comparison. Average monthly water temperatures at Bend Bridge could be as
44 high as about 73°F during this period. Temperature conditions in the Sacramento

1 River under Alternative 5 could be more likely to result in adverse effects on
2 Green Sturgeon rearing than under the Second Basis of Comparison because of
3 the slightly increased frequency of exceedance of the 63°F threshold in August
4 and September.

5 *Feather River*

6 Average monthly water temperatures in the Feather River at Gridley Bridge under
7 both Alternative 5 and Second Basis of Comparison would exceed the water
8 temperature threshold of 64°F established for Green Sturgeon spawning,
9 incubation, and rearing in May, June, and September; no exceedances under either
10 scenarios would occur in July and August. The frequency of exceedances would
11 be high, with both Alternative 5 and Second Basis of Comparison exceeding the
12 threshold in June nearly 100 percent of the time. The magnitude of the
13 exceedance also would be substantial, with average monthly temperatures higher
14 than 72°F in June, and higher than 75°F in July and August. Water temperatures
15 under Alternative 5 would exceed the threshold about 7 percent more frequently
16 in May than under the Second Basis of Comparison and about 33 percent less
17 frequently in September. Temperature conditions in the Feather River under
18 Alternative 5 could be more likely to result in adverse effects on Green Sturgeon
19 rearing than under the Second Basis of Comparison because of the increased
20 frequency of exceedance of the 64°F threshold in May. The reduction in
21 exceedance frequency in September may have less effect on rearing Green
22 Sturgeon as many juvenile sturgeon may have migrated downstream to the lower
23 Sacramento River and Delta by this time.

24 *Changes in Delta Outflow*

25 As described in Appendix 9P, mean (March to July) Delta outflow was used an
26 indicator of potential year class strength and the likelihood of producing a strong
27 year class of sturgeon. The median value over the 82-year CalSim II modeling
28 period of mean (March to July) Delta outflow was predicted to be 16 percent
29 higher under Alternative 5 than under the Second Basis of Comparison. In
30 addition, the likelihood of mean (March to July) Delta outflow exceeding the
31 threshold of 50,000 cfs was the same under both alternatives.

32 *Summary of Effects on Green Sturgeon*

33 The temperature threshold analysis in the Sacramento and Feather rivers both
34 suggest that average monthly water temperatures under Alternative 5 would
35 exceed thresholds for Green Sturgeon more frequently than under the Second
36 Basis of Comparison, although the frequency of exceedance would be relatively
37 small (1-2 percent). However, average monthly water temperatures likely mask
38 daily temperatures excursions that could exceed important thresholds. Therefore,
39 while the differences in threshold exceedance are relatively minor, the likelihood
40 of adverse effects on Green Sturgeon under Alternative 5 would likely be greater
41 than under the Second Basis of Comparison. The analysis based on Delta
42 outflows suggests that Alternative 5 provides higher mean (March to July)
43 outflows which could result in stronger year classes of juvenile sturgeon relative
44 to the Second Basis of Comparison. However, early life stage survival in the

1 natal rivers is crucial in development of a strong year class; therefore, based
 2 primarily on the analysis of water temperatures, Alternative 5 could be more
 3 likely to result in adverse effects on Green Sturgeon than the Second Basis of
 4 Comparison.

5 *White Sturgeon*

6 Changes in water temperature conditions in the Sacramento and Feather rivers
 7 would be the same as those described above for Green Sturgeon.

8 The water temperature threshold established for White Sturgeon spawning and
 9 egg incubation in the Sacramento River at Hamilton City is 61°F from March
 10 through June. Although there would be no exceedances of the threshold in March
 11 and April, water temperatures under both Alternative 5 and Second Basis of
 12 Comparison would exceed this threshold in May and June. The average monthly
 13 water temperatures in May under Alternative 5 would exceed this threshold about
 14 56 percent of the time (about 7 percent more frequently than under the Second
 15 Basis of Comparison). In June, the temperature under Alternative 5 would exceed
 16 the threshold about 87 percent of the time (about 13 percent more frequently than
 17 the Second Basis of Comparison). Average monthly water temperatures during
 18 May and June under Alternative 5 would as high as about 65°F.

19 Changes in Delta outflows would be the same as those described above for Green
 20 Sturgeon. Mean (March to July) Delta outflow was predicted to be 13 percent
 21 higher under the No Action Alternative than under the Second Basis of
 22 Comparison. In addition, the likelihood of mean (March to July) Delta outflow
 23 exceeding the threshold of 50,000 cfs was the same under both alternatives.

24 *Summary of Effects on White Sturgeon*

25 The increased frequency of exceedance of water temperature thresholds under
 26 Alternative 5 could increase the potential for adverse effects on White Sturgeon
 27 relative to the Second Basis of Comparison. The analysis based on Delta
 28 outflows suggests that the No Action Alternative provides higher mean (March to
 29 July) outflows which could result in stronger year classes of juvenile sturgeon
 30 relative to the Second Basis of Comparison. However, early life stage survival in
 31 the natal rivers is crucial in development of a strong year class; therefore, based
 32 primarily on the analysis of water temperatures, Alternative could be more likely
 33 to result in adverse effects on White Sturgeon than the Second Basis of
 34 Comparison.

35 *Delta Smelt*

36 The potential effects of the No Action Alternative as compared to the Second
 37 Basis of Comparison were analyzed based on differences in proportional
 38 entrainment and the fall abiotic index as described below.

39 As described in Appendix 9G, a proportional entrainment regression model
 40 (based on Kimmerer 2008, 2011) was used to simulate adult Delta Smelt
 41 entrainment, as influenced by OMR flow in December through March. Results
 42 indicate that the percentage of entrainment of migrating and spawning adult Delta
 43 Smelt under Alternative 5 would be 7 to 8.3 percent, depending on the water year

1 type, with a long-term average percent entrainment of 7.6 percent. Percent
2 entrainment of adult Delta Smelt under Alternative 5 would be similar to results
3 under Second Basis of Comparison. Under the Second Basis of Comparison, the
4 long-term average entrainment would be 9 percent.

5 A proportional entrainment regression model (based on Kimmerer 2008) also was
6 used to simulate larval and early juvenile Delta Smelt entrainment, as influenced
7 by OMR flow and location of X2 in March through June. Results indicate that
8 the percentage of entrainment of larval and early juvenile Delta Smelt under
9 Alternative 5 would be 1.3 to 19.3 percent, depending on the water year type, with
10 a long term average percent entrainment of 8.6 percent, and highest entrainment
11 under Critical water year conditions. Percent entrainment of larval and early
12 juvenile Delta Smelt under Alternative 5 would be lower than results under the
13 Second Basis of Comparison by up to 9.4 percent. Under the Second Basis of
14 Comparison, the long-term average percent entrainment would be 15.5 percent,
15 and highest entrainment would occur under critical dry water year conditions, at
16 23.6 percent.

17 The predicted position of Fall X2 (in September through December) is used as an
18 indicator of fall abiotic habitat index for Delta Smelt. Feyrer et al. (2010) used
19 X2 location as an indicator of the extent of habitat available with suitable salinity
20 for the rearing of older juvenile Delta Smelt. Feyrer et al. (2010) concluded that
21 when X2 is located downstream (west) of the confluence of the Sacramento and
22 San Joaquin Rivers, at a distance of 70 to 80 km from the Golden Gate Bridge,
23 there is a larger area of suitable habitat. The overlap of the low salinity zone (or
24 X2) with the Suisun Bay/Marsh results in a two-fold increase in the habitat index
25 (Feyrer et al. 2010).

26 The average September through December X2 position in km was used to
27 evaluate the fall abiotic habitat availability for Delta Smelt under the Alternatives.
28 X2 values simulated in the CalSim II model for each Alternative were averaged
29 over September through December, and compared. Results indicate that under
30 the No Action Alternative, the X2 position would range from 75.8 km to 92.3 km,
31 depending on the water year type, with a long term average X2 position of 84 km.
32 The most eastward location of X2 is predicted under Critical water year
33 conditions. The X2 positions predicted under Alternative 5 would be similar to
34 results under the Second Basis of Comparison in drier water year types. In wetter
35 years, the X2 location would be further west under Alternative 5 than under the
36 Second Basis of Comparison, by 6.1 to 9.8 km.

37 Overall, Alternative 5 likely would result in better conditions for Delta Smelt than
38 would the Second Basis of Comparison, primarily due to lower percentage
39 entrainment for larval and juvenile life stages, and more favorable location of Fall
40 X2 in wetter years, and on average. Given the current condition of the Delta
41 Smelt population, even small differences between alternatives may be important.

1 *Longfin Smelt*

2 The effects of the Alternative 5 as compared to the Second Basis of Comparison
3 were analyzed based on the direction and magnitude of OMR flows during the
4 period (December through June) when adult, larvae, and young juvenile Longfin
5 Smelt are present in the Delta in the vicinity of the export facilities
6 (Appendix 5A). The analysis was augmented with calculated Longfin Smelt
7 abundance index values (Appendix 9G) per Kimmerer et al. (2009), which is
8 based on the assumptions that lower X2 values reflect higher flows and that
9 transporting Longfin Smelt farther downstream leads to greater Longfin Smelt
10 survival. The index value indicates the relative abundance of Longfin Smelt and
11 not the calculated population.

12 Under Alternative 5, Longfin Smelt abundance index values range from
13 1,204 under critical water year conditions to a high of 16,683 under wet water
14 year conditions, with a long-term average value of 8,015. Under the Second Basis
15 of Comparison, Longfin Smelt abundance index values range from 947 under
16 critical water year conditions to a high of 15,822 under wet water year conditions,
17 with a long-term average value of 7,257.

18 Results indicate that the Longfin Smelt abundance index values would be greater
19 in every water year type under Alternative 5 than under the Second Basis of
20 Comparison, with a long-term average index for Alternative 5 that is about
21 10 percent higher than the long term average index for the Second Basis of
22 Comparison. For below normal, dry, and critical water years, the Longfin Smelt
23 abundance index values would be over 20 percent greater under Alternative 5 than
24 under the Second Basis of Comparison, with the greatest difference (30.8 percent)
25 predicted under dry conditions.

26 Overall, based on the lower frequency and magnitude of negative OMR flows and
27 the higher Longfin Smelt abundance index values, especially in dry and critical
28 years, Alternative 5 would be likely have a lower potential for adverse effects on
29 the Longfin Smelt population as compared to the Second Basis of Comparison.

30 *Sacramento Splittail*

31 Under Alternative 5, flows entering the Yolo Bypass over the Fremont Weir
32 generally would be slightly lower compared to the Second Basis of Comparison
33 (Appendix 5A, Table C-26-6), thus potentially providing lower value to
34 Sacramento Splittail because of the lower area of potential habitat (inundation)
35 and the lower frequency of inundation. Given the relatively minor changes in
36 flows into the Yolo Bypass, and the inherent uncertainty associated with the
37 resolution of the CalSim II model (average monthly outputs), it is concluded that
38 no definitive difference in effects on Sacramento Splittail between Alternative 5
39 and the Second Basis of Comparison could be discerned.

1 *Reservoir Fishes*

2 *Changes in Available Habitat (Storage)*

3 As described in Chapter 5, Surface Water Resources and Water Supplies, changes
4 in CVP and SWP water supplies and operations under Alternative 5 as compared
5 to the Second Basis of Comparison generally would result in lower reservoir
6 storage in CVP and SWP reservoirs in the Central Valley Region. Storage levels
7 in Shasta Lake, Lake Oroville, and Folsom Lake would be lower under
8 Alternative 5 as compared to the Second Basis of Comparison in the fall and
9 winter months due to the inclusion of Fall X2 criteria under Alternative 5.

10 The highest reductions in Shasta Lake and Lake Oroville storage could be in
11 excess of 20 percent. Storage in Folsom Lake could be reduced up to around
12 10 percent in some months of some water year types. Additional information
13 related to monthly reservoir elevations is provided in Appendix 5A, CalSim II and
14 DSM2 Modeling. The reduction in reservoir storage under Alternative 5 may
15 suggest that the amount of habitat for reservoir fishes could be reduced under
16 Alternative 5 as compared to the Second Basis of Comparison. However, it is
17 anticipated that aquatic habitat within the CVP and SWP water supply reservoirs
18 is not limiting, such that this potential reduction in habitat may have little adverse
19 effect on reservoir fishes.

20 *Changes in Black Bass Nesting Success*

21 Black bass nest survival in CVP and SWP reservoirs is anticipated to be near
22 100 percent in March and April due to increasing reservoir elevations. For May,
23 the likelihood of nest survival for Largemouth Bass in Lake Shasta being in the
24 40 to 100 percent range is about 2 percent higher under Alternative 5 as compared
25 to the Second Basis of Comparison. For June, the likelihood of nest survival
26 being greater than 40 percent for Largemouth Bass is similar (within 1 percent)
27 under Alternative 5 and Second Basis of Comparison; however, nest survival of
28 greater than 40 percent is likely only in about 20 percent of the years evaluated.
29 The likelihood of nest survival for Smallmouth Bass in Lake Shasta exhibits
30 nearly the same pattern. For Spotted Bass, the likelihood of nest survival being
31 greater than 40 percent is high (100 percent) in May under both Alternative 5 and
32 the Second Basis of Comparison. For June, Spotted Bass nest survival would be
33 less than for May due to greater daily reductions in water surface elevation as
34 Shasta Lake is drawn down. The likelihood of survival being greater than
35 40 percent is higher (by about 12 percent) under Alternative 5 as compared to the
36 Second Basis of Comparison.

37 For May and June, the likelihood of nest survival for Largemouth Bass in Lake
38 Oroville being in the 40 to 100 percent range is higher under Alternative 5 as
39 compared to the Second Basis of Comparison, about 13 percent higher in May
40 and about 4 percent higher in June. However, June nest survival of greater than
41 40 percent is likely only in about 40 percent of the years evaluated. The
42 likelihood of nest survival for Smallmouth Bass in Lake Oroville exhibits nearly
43 the same pattern. For Spotted Bass, the likelihood of nest survival being greater
44 than 40 percent is 100 percent in May under Alternative 5 as compared to about
45 94 percent under the Second Basis of Comparison. For June, Spotted Bass

1 survival would be less than for May due to greater daily reductions in water
 2 surface elevation as Lake Oroville is drawn down. The likelihood of survival
 3 being greater than 40 percent is substantially higher (on the order of 20 percent)
 4 under Alternative 5 as compared to the Second Basis of Comparison.

5 Black bass nest survival in Folsom Lake is near 100 percent in March, April, and
 6 May due to increasing reservoir elevations. For June, the likelihood of nest
 7 survival for Largemouth Bass and Smallmouth Bass in Folsom Lake being in the
 8 40 to 100 percent range is somewhat (around 7 percent) higher under
 9 Alternative 5 than under the Second Basis of Comparison. For Spotted Bass, nest
 10 survival for June would be less than for May due to greater daily reductions in
 11 water surface elevation. However, the likelihood of survival being greater than
 12 40 percent is similar under Alternative 5 as compared to the Second Basis of
 13 Comparison.

14 *Summary of Effects on Reservoir Fishes*

15 Reservoir storage is anticipated to be reduced under Alternative 5 relative to the
 16 Second Basis of Comparison and this reduction could affect the amount of warm
 17 and cold water habitat available within the reservoirs. However, it is unlikely that
 18 aquatic habitat within the CVP and SWP water supply reservoirs is limiting.

19 The analysis of black bass nest survival based on changes in water surface
 20 elevation during the spawning period indicated that the likelihood of high
 21 (>40 percent) nest survival in most of the reservoirs under Alternative 5 would be
 22 similar under Alternative 5 and the Second Basis of Comparison. Overall, the
 23 results of the habitat and nest survival analysis suggest that effects on reservoir
 24 fishes would be similar under the No Action Alternative and the Second Basis of
 25 Comparison.

26 *Other Species*

27 Several other fish species could be affected by changes in operations that
 28 influence temperature and flow. The following describes the extent of these
 29 changes and the potential effects on these species.

30 *Pacific Lamprey*

31 Little information is available on factors that influence populations of Pacific
 32 Lamprey in the Sacramento River, but they are likely affected by many of the
 33 same factors as salmon and steelhead because of the parallels in their life cycles.

34 *Changes in Water Temperature*

35 The following describes anticipated changes in average monthly water
 36 temperature in the Sacramento, Feather, and American rivers and the potential for
 37 those changes to affect Pacific Lamprey.

38 *Sacramento River*

39 Monthly water temperature in the Sacramento River at Keswick Dam under
 40 Alternative 5 and the Second Basis of Comparison generally would be similar
 41 (differences less than 0.5°F). Average monthly water temperatures in September
 42 under Alternative 5 would be lower (up to 0.9°F) in wetter years and higher (up to
 43 1.2°F) in drier years. Similarly, water temperatures in October of critical years

1 could be 0.9°F warmer under Alternative 5 (Appendix 6B, Table 5-5-6). A
2 similar pattern in temperatures generally would be exhibited at downstream
3 locations along the Sacramento River (i.e., Ball's Ferry Jelly's Ferry, Bend
4 Bridge, Red Bluff, Hamilton City, and Knights Landing), with differences in
5 average monthly temperatures at Knights Landing progressively increasing (up to
6 1.0°F warmer) in June and up to up to 4.6°F cooler in September of wetter years
7 under Alternative 5 relative to the Second Basis of Comparison. Given the
8 generally minor differences in flows and water temperatures between
9 Alternative 5 and the Second Basis of Comparison, it is anticipated that the effect
10 on Pacific Lamprey in the Sacramento River generally would be the same under
11 both scenarios.

12 *Feather River*

13 Long-term average monthly water temperature in the Feather River at the low
14 flow channel under Alternative 5 relative to the Second Basis of Comparison
15 generally would be similar (less than 0.5°F differences). Water temperatures
16 could be up to 1.5°F warmer in November and December of some water year
17 types and up to 1.2°F cooler in September of wetter years. Although temperatures
18 in the river would become progressively higher in the downstream direction, the
19 differences between Alternative 5 and Second Basis of Comparison exhibit a
20 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
21 with water temperature differences under Alternative 5 generally increasing in
22 most water year types relative to the Second Basis of Comparison at the
23 confluence with Sacramento. Water temperatures under Alternative 5 could be
24 somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler (September)
25 at the confluence with Sacramento River from July to September in wetter years.

26 Due to the similarity of water temperatures under Alternative 5 and Second Basis
27 of Comparison from January through August, there would be little difference in
28 potential effects on Pacific Lamprey adults during their upstream migration.

29 *American River*

30 Average monthly water temperatures in the American River at Nimbus Dam
31 under Alternative 5 generally would be similar (differences less than 0.5°F) to the
32 Second Basis of Comparison, with the exception of during June and August of
33 below normal years, when temperatures under Alternative 5 could be as much as
34 0.9°F higher. This pattern generally would persist downstream to Watt Avenue
35 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F
36 and 2.1°F higher, respectively, than under the Second Basis of Comparison in
37 June. Due to the similarity of water temperatures under Alternative 5 and Second
38 Basis of Comparison from January through May, there would be little difference
39 in potential effects on Pacific Lamprey adults during their upstream migration.
40 The higher water temperatures during June and August may increase the
41 likelihood of adverse effects on Pacific Lamprey during their holding, and
42 spawning periods.

1 *Summary of Effects on Pacific Lamprey*

2 In general, Pacific Lamprey can tolerate higher temperatures than salmonids, up
3 to around 72°F during their entire life history. Because lamprey ammocoetes
4 remain in the river for several years, any substantial flow reductions or
5 temperature increases could result in adverse effects on larval larvae. Given
6 similarity in water temperatures during their spawning and incubation period, it is
7 likely that Alternative 5 would have a similar potential to affect Pacific Lamprey
8 in the Sacramento, Feather, and American rivers than would the Second Basis of
9 Comparison. This conclusion likely applies to other species of lamprey that
10 inhabit these rivers (e.g., River Lamprey).

11 *Striped Bass, American Shad, and Hardhead*

12 Changes in operations influence temperature and flow conditions that could affect
13 Striped Bass, American Shad, and Hardhead. The following describes those
14 changes and their potential effects.

15 *Changes in Water Temperature*

16 Changes in water temperature that affect Striped Bass, American Shad, and
17 Hardhead could occur in the Sacramento, Feather, and American rivers. The
18 following describes temperature conditions in those water bodies.

19 *Sacramento River*

20 As described above for lampreys, monthly water temperature in the Sacramento
21 River at Keswick Dam under Alternative and the Second Basis of Comparison
22 generally would be similar (within about 0.5°F). Average monthly water
23 temperatures in September under Alternative 5 would be lower (up to 0.9°F) in
24 wetter years and higher (up to 1.2°F) in drier years. Similarly, water temperatures
25 in October of critical years could be 0.9°F warmer under Alternative 5
26 (Appendix 6B, Table 5-5-6). A similar temperature pattern generally would be
27 exhibited downstream at Ball's Ferry, Jelly's Ferry, and Bend Bridge, with
28 average monthly temperatures in June progressively increasing by a small margin
29 under Alternative 5 relative to the Second Basis of Comparison.

30 *Feather River*

31 Long-term average monthly water temperature in the Feather River at the low
32 flow channel under Alternative 5 relative to the Second Basis of Comparison
33 generally would be similar (less than 0.5°F differences). Water temperatures
34 could be up to 1.5°F warmer in November and December of some water year
35 types and up to 1.2°F cooler in September of wetter years. Although temperatures
36 in the river would become progressively higher in the downstream direction, the
37 differences between Alternative 5 and Second Basis of Comparison exhibit a
38 similar pattern at the downstream locations (Robinson Riffle and Gridley Bridge),
39 with water temperature differences under Alternative 5 generally increasing in
40 most water year types relative to the Second Basis of Comparison at the
41 confluence with the Sacramento River. Water temperatures under Alternative 5
42 could be somewhat (0.8°F to 1.6°F) cooler on average and up to 3.9°F cooler
43 (September) at the confluence with Sacramento River from July to September in
44 wetter years.

1 *American River*

2 Average monthly water temperatures in the American River at Nimbus Dam
3 under Alternative 5 generally would be similar (differences less than 0.5°F) to the
4 Second Basis of Comparison, with the exception of during June and August of
5 below normal years, when differences under Alternative 5 could be as much as
6 0.9°F higher. This pattern generally would persist downstream to Watt Avenue
7 and the mouth, although temperatures under Alternative 5 would be up to 1.6°F
8 and 2.1°F higher, respectively, than under the Second Basis of Comparison in
9 June.

10 *Changes in Position of X2*

11 Alternative 5 would result in a more westward X2 position as compared to the
12 Second Basis of Comparison during April and May, with similar values in June
13 (Appendix 5A, Section C Table C-16-6). Based on Kimmerer (2002) and
14 Kimmerer et al. (2009), this change in X2 would likely increase the survival index
15 and the habitat index as measured by salinity for Striped Bass and abundance and
16 habitat index for American Shad.

17 *Summary of Effects on Striped Bass, American Shad, and Hardhead*

18 Because Striped Bass, American Shad, and Hardhead can tolerate higher
19 temperatures than salmonids, it is unlikely that the slightly increased temperatures
20 during some months under Alternative 5 would have substantial adverse effects
21 on these species in the American River. Given the generally minor differences in
22 water temperatures between Alternative 5 and the Second Basis of Comparison, it
23 is anticipated that the effect of water temperatures on Striped Bass, American
24 Shad, and Hardhead generally would be the same under both scenarios. Overall,
25 Alternative 5 likely would have similar effects on Hardhead and a slightly lower
26 potential for adverse effects on Striped Bass and American Shad as compared to
27 the Second Basis of Comparison, primarily due to the potential for increased
28 survival for these two species during larval and juvenile life stages, and more
29 favorable location of Spring X2 on average.

30 *Stanislaus River/Lower San Joaquin River*

31 *Fall-Run Chinook Salmon*

32 Changes in operations influence temperature and flow conditions that could affect
33 fall-run Chinook Salmon in the Stanislaus River downstream of Goodwin Dam
34 and in the San Joaquin River below Vernalis. The following describes those
35 changes and their potential effects.

36 *Changes in Water Temperature (Stanislaus River)*

37 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
38 under Alternative 5 and Second Basis of Comparison generally would be similar
39 (differences less than 0.5°F), except in August through October when long-term
40 average monthly temperatures could be up to 1.0°F warmer than under the Second
41 Basis of Comparison. These differences would be of higher magnitude in drier
42 years with average monthly water temperatures in September as much as 1.9°F
43 warmer under Alternative 5 as compared to the Second Basis of Comparison
44 (Appendix 6B, Table B-17-6).

1 Downstream at Orange Blossom Bridge, average monthly water temperatures in
 2 October and April under Alternative 5 would be lower in all water year types than
 3 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in
 4 April. In most other months, long-term average monthly water temperatures
 5 under Alternative 5 generally would be similar to water temperatures under the
 6 Second Basis of Comparison. Water temperatures under Alternative 5 could be
 7 up to 1.3°F warmer in drier years from July to September than under the Second
 8 Basis of Comparison. (Appendix 6B, Table B-18-6).

9 Downstream at the confluence with the San Joaquin River, average monthly water
 10 temperatures in October, April and May would be lower by 2.0°F in October,
 11 1.9°F in April and 0.6°F in May. Differences in water temperatures between
 12 Alternative 5 and the Second Basis of Comparison would be even greater in these
 13 months in some water year types. In most other months, long-term average
 14 monthly water temperatures under Alternative 5 generally would be similar, but
 15 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of
 16 Comparison (Appendix 6B, Table B-19-6).

17 *Changes in Exceedance of Water Temperature Thresholds*
 18 *(Stanislaus River)*

19 While specific water temperature thresholds for fall-run Chinook Salmon in the
 20 Stanislaus River are not established, temperatures generally suitable for fall-run
 21 Chinook Salmon spawning (56°F) would be exceeded in October and November
 22 over 30 percent of the time in the Stanislaus River at Goodwin Dam under
 23 Alternative 5 ((Appendix 6B, Figure B-17-1 and B-17-2)). Similar exceedances
 24 would occur under the Second Basis of Comparison, although up to 10 percent
 25 more frequently in November. Water temperatures for rearing from January to
 26 May generally would be below 56°F, except in May when average monthly water
 27 temperatures would reach about 60°F under both conditions (Appendix 6B,
 28 Figure B-17-8).

29 Downstream at Orange Blossom Bridge, water temperatures suitable for fall-run
 30 Chinook Salmon spawning would be exceeded frequently under both
 31 Alternative 5 and Second Basis of Comparison during October and November.
 32 Under Alternative 5, average monthly water temperatures would exceed 56°F
 33 about 57 percent of the time in October (Appendix 6B, Figure B-18-1). This,
 34 however, would be about 28 percent less frequently than under the Second Basis
 35 of Comparison. In November, average monthly water temperatures would exceed
 36 56°F about 33 percent of the time under Alternative 5, which would be about
 37 5 percent more frequently than under the Second Basis of Comparison
 38 (Appendix 6B, Figure B-18-2).

39 During January through May, rearing fall-run Chinook Salmon under
 40 Alternative 5 would be subjected to average monthly water temperatures that
 41 exceed 56° in March (less than 10 percent of the time) and May (about 30 percent
 42 of the time) under Alternative 5 which is about 10 percent more frequently than
 43 under the Second Basis of Comparison (Appendix 6B, Figure B-18-8).

1 *Changes in Egg Mortality (Stanislaus River)*

2 For fall-run Chinook Salmon in the Stanislaus River, the long-term average egg
3 mortality rate is predicted to be around 8.5 percent, with higher mortality rates (in
4 excess of 15 percent) occurring in critical dry years under Alternative 5. Overall,
5 egg mortality would be similar under Alternative 5 and the Second Basis of
6 Comparison (Appendix 9C, Table B-8).

7 *Changes in Delta Hydrodynamics*

8 San Joaquin River-origin fall run Chinook salmon smolts are most abundant in the
9 Delta during the months of April, May and June. Near the confluence of the San
10 Joaquin River and the Mokelumne River, the median proportion of positive
11 velocities was slightly to moderately higher under Alternative 5 relative to Second
12 Basis of Comparison in April and May, respectively whereas values in June were
13 similar (Appendix 9K). On Old River downstream of the facilities, the median
14 proportion of positive velocities was substantially higher in April and May and
15 slightly higher in June under Alternative 5 relative to Second Basis of
16 Comparison. In Old River upstream of the facilities, the median proportion of
17 positive velocities was slightly higher under Alternative 5 April and May and
18 slightly lower in June. On the San Joaquin River downstream of the Head of Old
19 River, the median proportion of positive velocities was slightly to moderately
20 lower under Alternative 5 relative to Second Basis of Comparison in April and
21 May, respectively, and similar in June.

22 *Changes in Junction Entrainment*

23 Entrainment at the Head of Old River junction was substantially higher under
24 Alternative 5 relative to Second Basis of Comparison during the months of April
25 and May and slightly lower in June (Appendix 9L). For the Turner Cut junction,
26 median entrainment under Alternative 5 was moderately lower in April and May
27 relative to Second Basis of Comparison and slightly lower in June. At the
28 Columbia Cut junction, median entrainment under Alternative 5 was slightly
29 lower in June relative to the Second Basis of Comparison. Median entrainment
30 was substantially lower under Alternative 5 relative to Second Basis of
31 Comparison in April and May. A similar pattern of entrainment under
32 Alternative 5 relative to Second Basis of Comparison was observed at the Middle
33 River and Old River junctions.

34 *Summary of Effects on Fall-Run Chinook Salmon*

35 The multiple model and analysis outputs described above characterize the
36 anticipated conditions for fall-run Chinook Salmon and their response to change
37 under the No Action Alternative as compared to the Second Basis of Comparison.
38 In the Stanislaus River, the analysis of the effects of the No Action
39 Alternative and Second Basis of Comparison for fall-run Chinook Salmon relied
40 on the water temperature model output for the rivers at various locations
41 downstream of Goodwin Dam. The analysis of temperatures indicates lower
42 temperatures and a slightly lower likelihood of exceedance of suitable
43 temperatures for spawning and rearing of fall-run Chinook Salmon under
44 Alternative 5 as compared to the Second Basis of Comparison in the Stanislaus

1 River below Goodwin Dam and in the San Joaquin River at Vernalis. The effect
 2 of lower temperatures is not reflected in the similar overall mortality of fall-run
 3 Chinook Salmon eggs predicted by Reclamation's salmon survival model for fall-
 4 run in the Stanislaus River. As described above, the instream flow patterns under
 5 Alternative 5 are anticipated to benefit fall-run Chinook Salmon in the Stanislaus
 6 River and downstream in the lower San Joaquin River below Vernalis.

7 Implementation of a fish passage project under Alternative 5, primarily intended
 8 to address the limited availability of suitable habitat for steelhead in the Stanislaus
 9 River reaches downstream of Goodwin Dam, is not likely to provide benefit to
 10 fall-run Chinook Salmon unless passage for fall-run Chinook Salmon was
 11 provided and additional habitat could be accessed. Any potential benefit to fall-
 12 run Chinook Salmon is uncertain. However, actions implemented under
 13 Alternative 5 intended to increase the efficiency of the Tracy and Skinner Fish
 14 Collection Facilities could improve the overall salvage survival of fall-run
 15 Chinook Salmon.

16 On balance, given the small differences in the modeling results and the potential
 17 benefits anticipated by actions not captured in the models, it is concluded that
 18 effects on fall-run Chinook Salmon under Alternative 5 and Second Basis of
 19 Comparison would be similar.

20 *Steelhead*

21 Changes in operations that influence temperature and flow conditions in the
 22 Stanislaus River downstream of Goodwin Dam and the San Joaquin River below
 23 Vernalis could affect steelhead. The following describes those changes and their
 24 potential effects.

25 *Changes in Water Temperature (Stanislaus River)*

26 Average monthly water temperatures in the Stanislaus River at Goodwin Dam
 27 under Alternative 5 and Second Basis of Comparison generally would be similar
 28 (differences less than 0.5°F), except in August through October when long-term
 29 average monthly temperatures could be up to 1.0°F warmer than under the Second
 30 Basis of Comparison. These differences would be of higher magnitude in drier
 31 years with average monthly water temperatures in September as much as 1.9°F
 32 warmer under Alternative 5 as compared to the Second Basis of Comparison.

33 Downstream at Orange Blossom Bridge, average monthly water temperatures in
 34 October and April under Alternative 5 would be lower in all water year types than
 35 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in
 36 April. In most other months, long-term average monthly water temperatures
 37 under Alternative 5 generally would be similar to water temperatures under the
 38 Second Basis of Comparison. Water temperatures under Alternative 5 could be
 39 up to 1.3°F warmer in drier years from July to September than under the Second
 40 Basis of Comparison. (Appendix 6B, Table B-18-6).

41 Downstream at the confluence with the San Joaquin River, average monthly water
 42 temperatures in October, April and May would be lower by 2.0°F in October,
 43 1.9°F in April and 0.6°F in May. Differences in water temperatures between

1 Alternative 5 and the Second Basis of Comparison would be even greater in these
2 months in some water year types. In most other months, long-term average
3 monthly water temperatures under Alternative 5 generally would be similar, but
4 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of
5 Comparison.

6 *Changes in Exceedance of Water Temperature Thresholds*
7 *(Stanislaus River)*

8 Average monthly water temperatures in the Stanislaus River at Orange Blossom
9 Bridge would frequently exceed the temperature threshold (56°F) established for
10 adult steelhead migration under both Alternative 5 and Second Basis of
11 Comparison during October and November. Under Alternative 5, average
12 monthly water temperatures would exceed 56°F about 57 percent of the time in
13 October which is about 28 percent less frequently than under the Second Basis of
14 Comparison (Appendix 6B, Figure B-18-1). In November, average monthly
15 water temperatures would exceed 56°F about 33 percent of the time under
16 Alternative 5, which would be about 10 percent more frequently than under the
17 Second Basis of Comparison.

18 In January through May, the temperature threshold at Orange Blossom Bridge is
19 55°F, which is intended to support steelhead spawning. This threshold would not
20 be exceeded under either Alternative 5 or Second Basis of Comparison during
21 January or February. In March through May, however, exceedances would occur
22 under both Alternative 5 and the Second Basis of Comparison in each month, with
23 the threshold most frequently exceeded (40 percent) under Alternative 5 in May
24 (Appendix 9N). Average monthly water temperatures under Alternative 5 would
25 exceed the threshold 4 percent more frequently in March 26 percent less
26 frequently in April and 5 percent less frequently in May than under the Second
27 Basis of Comparison.

28 From June through November, the temperature threshold of 65°F established to
29 support steelhead rearing would be exceeded by both Alternative 5 and Second
30 Basis of Comparison in all months but November. The differences between
31 Alternative 5 and Second Basis of Comparison, however, would be small, with
32 average monthly water temperatures under Alternative 5 generally exceeding the
33 threshold by 3 percent to 8 percent more frequently than under the Second Basis
34 of Comparison.

35 Average monthly water temperatures also would exceed the threshold (52°F)
36 established for smoltification at Knights Ferry. At Goodwin Dam, about 4 miles
37 upstream of Knights Ferry, average monthly water temperatures under
38 Alternative 5 would exceed 52°F in March, April, and May about 8 percent,
39 37 percent, and 68 percent of the time, respectively. Alternative 5 would result in
40 exceedances of the smoltification threshold occurring up to 6 percent more
41 frequently during the January through May period. Farther downstream at Orange
42 Blossom Bridge, the temperature threshold for smoltification is higher (57°F) and
43 would be exceeded less frequently. The magnitude of the exceedance also would
44 be less. Average monthly water temperatures under Alternative 5 and the Second

1 Basis of Comparison would not exceed the threshold during January through
 2 April. In May, the threshold would be exceeded 8 percent of the time under
 3 Alternative 5. Compared to the Second Basis of Comparison, the 57°F at Orange
 4 Blossom Bridge would be exceeded about 8 percent less frequently in April and
 5 6 percent less frequently in May under Alternative 5.

6 Overall, the temperature differences between Alternative 5 and Second Basis of
 7 Comparison would be relatively small, with the exception of substantial
 8 differences in the frequency of exceedances in October when the average monthly
 9 water temperatures under Alternative 5 would exceed the threshold for adult
 10 steelhead migration about 28 percent less frequently and in April during the
 11 spawning period when the frequency would be about 26 percent less. Given the
 12 frequency of exceedance under both Alternative 5 and Second Basis of
 13 Comparison and the generally stressful temperature conditions in the river, the
 14 substantial differences (improvements) in October and April under Alternative 5
 15 suggest that there would be less potential to result in adverse effects on steelhead
 16 under Alternative 5 than under the Second Basis of Comparison. Even during
 17 months when the differences would be relatively small, the lower frequency of
 18 exceedances under Alternative 5 suggest that there would be less potential to
 19 result in adverse effects on steelhead under Alternative 5 than under the Second
 20 Basis of Comparison.

21 *Changes in Delta Hydrodynamics*

22 Stanislaus River-origin steelhead generally move through the Delta during spring
 23 however there is less information on their timing relative to Chinook salmon.
 24 Thus, hydrodynamics in the entire January through June period have the potential
 25 to affect juvenile steelhead.

26 On the San Joaquin River near the Mokelumne River confluence, the median
 27 proportion of positive velocities was slightly greater under Alternative 5 relative
 28 to Second Basis of Comparison in January, February, April and May and similar
 29 in March and June. In Old River downstream of the facilities, the median
 30 proportion of positive velocities was substantially higher under Alternative 5
 31 during January, April, and May and moderately higher in February. Values in
 32 March and June were almost indistinguishable between scenarios. On Old River
 33 upstream of the facilities, the median proportion of positive velocities was
 34 moderately lower in January and February, slightly lower in March and June, and
 35 slightly higher in April and May under Alternative 5 relative to Second Basis of
 36 Comparison. On the San Joaquin River downstream of Head of Old River, the
 37 median proportion of positive velocities was similar for both scenarios in January,
 38 February, March, and June, but slightly to moderately lower in April and May.

39 *Summary of Effects on Steelhead*

40 The analysis of the effects of the No Action Alternative and Second Basis of
 41 Comparison for steelhead relied on the water temperature model output for the
 42 rivers at various locations downstream of Goodwin Dam. Given the frequency of
 43 exceedance under both Alternative 5 and Second Basis of Comparison and the
 44 generally stressful temperature conditions in the river, the substantial differences

1 (improvements) in October and April under Alternative 5 suggest that there would
2 be less potential to result in adverse effects on steelhead under Alternative 5 than
3 under the Second Basis of Comparison.

4 Implementation of a fish passage program under Alternative 5 intended to address
5 the limited availability of suitable habitat for steelhead in the Stanislaus River
6 reaches downstream of Goodwin Dam could provide a benefit to steelhead,
7 however, the extent of benefit is uncertain. In addition, the potential effects of
8 Alternative 5 could be offset by actions intended to reduce predation risk on
9 steelhead in the Stanislaus River and increase the efficiency of the Tracy and
10 Skinner Fish Collection Facilities. The actions to augment spawning gravel in the
11 Stanislaus River under Alternative 5 also could benefit steelhead.

12 The numerical model results for effects on steelhead under Alternative 5 and
13 Second Basis of Comparison do not definitively show distinct differences.
14 However, in consideration of the potentially beneficial effects resulting from the
15 actions that would be implemented under Alternative 5 that are not included in the
16 numerical models (see Appendix 5A, Section B), Alternative 5 has a much greater
17 potential to address the long-term sustainability of steelhead than does the Second
18 Basis of Comparison. Alternative 5 includes provisions for fish passage upstream
19 of New Melones Dam to address long-term temperature increases associated with
20 climate change. Even though the success of fish passage is uncertain, it is
21 concluded that the potential for adverse effects on steelhead under Alternative 5
22 would clearly be less than that under the Second Basis of Comparison, principally
23 because the Second Basis of Comparison does not include a strategy to address
24 water temperatures critical to steelhead sustainability over the long term with
25 climate change by 2030.

26 *White Sturgeon*

27 Evidence of White Sturgeon spawning has been recorded in the San Joaquin River
28 upstream of the confluence with the Stanislaus River. While flows in the San
29 Joaquin River upstream of the Stanislaus River are expected to be similar under all
30 alternatives, flow contributions from the Stanislaus River could influence water
31 temperatures in the San Joaquin River where White Sturgeon eggs or larvae may
32 occur during the spring and early summer. The magnitude of influence on water
33 temperature would depend on the proportional flow contribution of the Stanislaus
34 River and the temperatures in both the Stanislaus and San Joaquin rivers. The
35 potential for an effect on White Sturgeon eggs and larvae would be influenced by
36 the proportion of the population occurring in the San Joaquin River. In
37 consideration of this uncertainty, it is not possible to distinguish potential effects
38 on White Sturgeon between alternatives.

39 *Reservoir Fishes*

40 As described in Chapter 5, Surface Water Resources and Water Supplies, changes
41 in CVP and SWP water supplies and operations under Alternative 5 as compared
42 to the Second Basis of Comparison would result in lower Storage levels in New
43 Melones Reservoir under Alternative 5 as compared to the Second Basis of

1 Comparison due to increased instream releases to support fish flows under the
2 2009 NMFS BO.

3 Storage levels in New Melones Reservoir would be lower under Alternative 5 as
4 compared to the Second Basis of Comparison (Appendix 5A), especially in
5 critical years when the difference could be as much as 23 percent. Using storage
6 volume as an indicator of available availability for fish species inhabiting these
7 reservoirs, these results suggest that the amount of habitat for reservoir fishes
8 could be decreased under Alternative 5 as compared to the Second Basis of
9 Comparison. However, it is anticipated that aquatic habitat within the CVP and
10 SWP water supply reservoirs is not limiting, such that this potential reduction in
11 habitat may have little adverse effect on reservoir fishes.

12 Nest survival for black bass species in New Melones is higher than in the other
13 reservoirs during May and June. For March, Largemouth Bass and Smallmouth
14 Bass nest survival is predicted to be above 40 percent in all of the years simulated.
15 For April, the likelihood that nest survival of Largemouth Bass and Smallmouth
16 Bass is between 40 and 100 percent is substantially less (about 25 percent) under
17 Alternative 5 as compared to the Second Basis of Comparison. For May, the
18 likelihood of high nest survival is similar under Alternative 5 and the Second
19 Basis of Comparison. For June, the likelihood of survival being greater than
20 40 percent for Largemouth Bass and Smallmouth Bass in New Melones is
21 somewhat (about 10 percent) higher under Alternative 5 as compared to the
22 Second Basis of Comparison. For Spotted Bass, nest survival in March is
23 anticipated to be near 100 percent in every year under both Alternative 5 and
24 Second Basis of Comparison. The likelihood of survival being greater than
25 40 percent is about 6 percent lower in April under Alternative 5 than under the
26 Second Basis of Comparison, but is still reasonably high (about 90 percent). For
27 May, the likelihood of high Spotted Bass nest survival is similar under
28 Alternative 5 and the Second Basis of Comparison. For June, Spotted Bass nest
29 survival would be greater than 40 percent in all of the simulation years under both
30 Alternative 5 and the Second Basis of Comparison. Overall, the analysis suggests
31 that conditions under Alternative 5 have the potential to influence black bass
32 nesting success, especially in April and May in comparison to the Second Basis of
33 Comparison. However, nesting success under Alternative 5 would still exceed
34 40 percent most of the time under both alternatives. Therefore, it is concluded
35 that there would be no definitive difference in effects on reservoir fish between
36 Alternative 5 and the Second Basis of Comparison.

37 *Other species*

38 Changes in operations that influence temperature and flow conditions in the
39 Stanislaus River downstream of Keswick Dam and the San Joaquin River at
40 Vernalis could affect other species such as lampreys, Hardhead, and Striped Bass.

41 As described above, average monthly water temperatures in the Stanislaus River
42 at Goodwin Dam under Alternative 5 and Second Basis of Comparison generally
43 would be similar (differences less than 0.5°F), except in August through October
44 when long-term average monthly temperatures could be up to 1.0°F warmer than

1 under the Second Basis of Comparison. These differences would be of higher
2 magnitude in drier years with average monthly water temperatures in September
3 as much as 1.9°F warmer under Alternative 5 as compared to the Second Basis of
4 Comparison.

5 Downstream at Orange Blossom Bridge, average monthly water temperatures in
6 October and April under Alternative 5 would be lower in all water year types than
7 the Second Basis of Comparison by as much as 1.4°F in October and 1.6°F in
8 April. In most other months, long-term average monthly water temperatures
9 under Alternative 5 generally would be similar to water temperatures under the
10 Second Basis of Comparison. Water temperatures under Alternative 5 could be
11 up to 1.3°F warmer in drier years from July to September than under the Second
12 Basis of Comparison (Appendix 6B, Table B-18-6).

13 Downstream at the confluence with the San Joaquin River, average monthly water
14 temperatures in October, April and May would be lower by 2.0°F in October,
15 1.9°F in April and 0.6°F in May. Differences in water temperatures between
16 Alternative 5 and the Second Basis of Comparison would be even greater in these
17 months in some water year types. In most other months, long-term average
18 monthly water temperatures under Alternative 5 generally would be similar, but
19 could be somewhat higher (up to 1.1°F) in June, compared to the Second Basis of
20 Comparison.

21 In general, lamprey species can tolerate higher temperatures than salmonids, up to
22 around 72°F during their entire life history. Because lamprey ammocoetes remain
23 in the river for several years, any substantial flow reductions or temperature
24 increases could adversely affect larval lamprey. Given the similar flows and
25 temperatures during their spawning and incubation period, it is likely that the
26 potential to affect lamprey species in the Stanislaus and San Joaquin rivers would
27 be similar under Alternative 5 and the Second Basis of Comparison.

28 In general, Striped Bass and Hardhead also can tolerate higher temperatures than
29 salmonids. Given the similar flows and temperatures during their spawning and
30 incubation period, it is likely that the potential to affect Striped Bass and
31 Hardhead in the Stanislaus and San Joaquin rivers would be similar under
32 Alternative 5 and the Second Basis of Comparison.

33 *San Francisco Bay Area Region*

34 *Killer Whale*

35 As described above for the comparison of Alternative 1 to the No Action
36 Alternative, it is unlikely that the Chinook Salmon prey base of killer whales,
37 supported heavily by hatchery production of fall-run Chinook Salmon, would be
38 appreciably affected by any of the alternatives.

39 **9.4.3.7 Summary of Environmental Consequences**

40 The results of the environmental consequences of implementation of
41 Alternatives 1 through 5 as compared to the No Action Alternative and the
42 Second Basis of Comparison are presented in Tables 9.4 and 9.5, respectively.

1 **Table 9.4 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Trinity River Region</p> <p><u>Coho Salmon</u></p> <p>Overall, the temperature model outputs for each of the Coho Salmon life stages suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be slightly less frequent (1 percent). Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 1 and the No Action Alternative are likely to have similar effects on the Coho Salmon population in the Trinity River.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Although the water temperatures under Alternative 1 could result in adverse effects on spring-run Chinook Salmon in the Trinity River, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures as compared to the No Action Alternative. However, implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River. Given the relatively minor changes in water temperature and water temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), and the uncertainty of the hatchery benefits, Alternative 1 and the No Action Alternative are likely to have similar effects on spring-run Chinook Salmon in the Trinity River.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Although the combined analysis based on water temperature suggests that operations under Alternative 1 could be slightly less adverse than under the No Action Alternative, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures (and similar egg mortality) between Alternative 1 and the No Action Alternative. In addition, the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting benefits associated with actions that were not modeled, it is concluded that Alternative 1 and the No Action Alternative are likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Although the analysis based on water temperature suggests that operations under Alternative 1 could be slightly less adverse than under the No Action Alternative, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures between Alternative 1 and the No Action Alternative. Given these small differences in water temperatures and the inherent uncertainty in the temperature model,</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Alternative 1 and the No Action Alternative are likely to have similar effects on steelhead in the Trinity River.</p> <p><u>Green Sturgeon</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that water temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the comparison of storage and the analysis of nesting suggest that effects on reservoir fishes would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>On average, the temperature of water released at Lewiston Dam generally would be similar under Alternative 1 and the No Action Alternative. Given the similarities in water temperatures, it is likely that the effects on Pacific Lamprey would be similar.</p> <p><u>Eulachon</u></p> <p>Given that the highest increases in flow under Alternative 1 would be less than 10 percent in the Trinity River, with a smaller relative change in the lower Klamath River and Klamath River estuary, and that water temperatures in the Klamath River are unlikely to be affected by changes upstream at Lewiston Dam, it is likely that Alternative 1 would have a similar potential to influence Eulachon in the Klamath River as the No Action Alternative.</p> <p>Sacramento River System</p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under the Alternative 1 would be more likely to result in adverse effects on winter-run Chinook Salmon than would the No Action Alternative. In addition, the potentially beneficial effects resulting from the RPA actions under the No Action Alternative that are not included in the numerical suggest that the No Action Alternative has a much greater potential to address the long-term sustainability of winter-run Chinook Salmon than does the Alternative 1. It is concluded that the potential for adverse effects on winter-run Chinook Salmon under Alternative 1 would be greater than those under the No Action Alternative, principally because Alternative 1 does not include fish passage to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on spring-run Chinook Salmon. However, it is concluded that the potential for adverse effects on spring-run Chinook Salmon under Alternative 1 would be greater, principally because Alternative 1 does not include fish passage to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on fall-run Chinook Salmon. This potential distinction between the two scenarios, however, may be partially balanced by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for benefits associated with the RPA actions under the No Action Alternative, it is likely that the effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The output from SALMOD indicated that late fall-run Chinook Salmon production would be similar. The analyses attempting to assess the effects on routing, entrainment, and salvage of juvenile salmonids in the Delta suggest that salvage (as an indicator of potential losses of juvenile salmon at the export facilities) of Sacramento River-origin Chinook Salmon is predicted to be higher under Alternative 1 in every month.</p> <p>Although survival in the Delta may be lower, given the similarity in the SALMOD outputs, it is likely that the effects on late fall-run Chinook Salmon would be similar.</p> <p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly less adverse, particularly in the Feather River. However, Alternative 1 would not include fish passage and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery that would occur under the No Action Alternative. Therefore, it is concluded that the adverse effects on steelhead under Alternative 1 would be greater than those under the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>Overall, the temperature model outputs suggest that thermal conditions and effects on Green Sturgeon generally would be slightly less adverse under Alternative 1. The analysis based on Delta outflows suggests that Alternative 1 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile Green Sturgeon relative to the No Action Alternative. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, Alternative 1 could be less likely to result in adverse effects on Green Sturgeon than the No Action Alternative.</p> <p><u>White Sturgeon</u></p> <p>Overall, the temperature model outputs suggest that thermal conditions and effects on White Sturgeon generally would be slightly less adverse under Alternative 1. The analysis based on Delta outflows suggests that Alternative 1 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile White Sturgeon relative to the No Action Alternative. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, Alternative 1 could be less likely to result in adverse effects on White Sturgeon than the No Action Alternative.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Delta Smelt</u></p> <p>Overall, Alternative 1 is likely to result in increased adverse effects on Delta Smelt primarily due to the potential for increased percentage entrainment during larval and juvenile life stages, and less favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between Alternative 1 and the No Action Alternative may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the increase in frequency and magnitude of negative OMR flows and the lower Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be greater.</p> <p><u>Sacramento Splittail</u></p> <p>Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between Alternative 1 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (>40 percent) nest survival in most of the reservoirs would be similar in March, April, and May under Alternative 1 would be similar to or slightly lower than under and the No Action Alternative, but somewhat lower in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under Alternative 1 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Based on the similar water temperatures during their spawning and incubation period, it likely that conditions for and effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Based on the similar water temperatures during their spawning and incubation period, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, however, Alternative 1 likely would have slightly greater potential for adverse effects on Striped Bass and American Shad as compared to the No Action Alternative, primarily due to the potential for reduced survival during larval and juvenile life stages, and less favorable location of Spring X2 on average.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operation under Alternative 1 would be less likely to result in adverse effects on fall-</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>run Chinook Salmon. This potential distinction between the two scenarios, however, may be partially balanced by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for benefits associated with the RPA actions under the No Action Alternative, there would be no definitive difference in effects on fall-run Chinook Salmon between Alternative 1 and the No Action Alternative.</p> <p><u>Steelhead</u></p> <p>The temperature model outputs suggest that the differences in the magnitude and frequency of exceedance of suitable temperatures for the various lifestages have the potential for adverse effects on the steelhead populations in the Stanislaus River under Alternative 1. However, the magnitude of this effect is uncertain. It is concluded that the potential for adverse effects on steelhead would be greater, principally because Alternative 1 does not include fish passage to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, predicted nest survival is generally above 40 percent in all months evaluated, although survival would vary among months. In June, the likelihood of survival being greater than 40 percent is lower under Alternative 1. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, effects on black bass nesting success would be similar.</p> <p><u>Other Species</u></p> <p>In general, lamprey species can tolerate higher temperatures than salmonids, up to around 72°F during their entire life history. Given the similar temperatures during their spawning and incubation period, it is likely that the potential to affect lamprey species in the Stanislaus and San Joaquin rivers would be similar.</p> <p>In general, Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similar temperatures during their spawning and incubation period, it is likely that the potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Pacific Ocean <u>Killer Whale</u> Given conclusions from NMFS (2009c), and the fact that at approximately 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	
Alternative 2	<p>Trinity River Region <u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u> Similar effects.</p> <p>Sacramento River System <u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u> The effects under Alternative 2 may become more adverse due to the lack of fish passage and other actions, such as structural improvements for temperature control on the American River; gravel augmentation, floodplain restoration and pulse flows, in Clear Creek; and measures to increase the efficiency of the Tracy and Skinner Fish Collection Facilities. Thus, it is concluded that the potential for adverse effects on salmonids and sturgeon under Alternative 2 would be greater than under the No Action Alternative.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, Striped Bass, American Shad, and Hardhead</u> Similar effects.</p> <p>Stanislaus River/Lower San Joaquin River <u>Fall-run Chinook Salmon and Steelhead</u> The effects under Alternative 2 may become more pronounced due to the lack of fish passage and other actions that would occur under the No Action Alternative such as gravel augmentation, floodplain restoration and inundation flows, and freshwater migratory habitat restoration in the Stanislaus River; and measures to increase the efficiency of the Tracy and Skinner Fish Collection Facilities.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u> Similar effects.</p> <p>Pacific Ocean <u>Killer Whale</u> Similar effects.</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p>
Alternative 3	<p>Trinity River Region <u>Coho Salmon and Spring-run Chinook Salmon</u> Overall, the water temperature model outputs suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be less frequent (by 1 to 2 percent) under Alternative 3. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 3 and the No Action Alternative are likely to have similar effects on the Coho Salmon population in the Trinity River. This conclusion also applies to spring-run Chinook Salmon,</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>although the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks relative to Alternative 3.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the temperature model outputs suggest that the temperature of water released at Lewiston Dam generally would be similar under both scenarios, although the exceedance of water temperature thresholds would be less frequent (by up to 2 percent) under Alternative 3. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), Alternative 3 is likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River as compared to the No Action Alternative. However, the implementation of the Hatchery Management Plan (RPA Action II.6.3) under the No Action Alternative could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks relative to Alternative 3.</p> <p><u>Steelhead</u></p> <p>Overall, the differences in the frequency of threshold exceedance between Alternative 3 and the No Action Alternative would be relatively minor and are unlikely to affect steelhead spawning in the Trinity River. This slight reduction in the frequency of threshold exceedance provided by Alternative 3 suggest that temperature conditions under Alternative 3 could be slightly less likely to affect steelhead than under the No Action Alternative. However, the relatively small differences in flows and water temperatures under Alternative 3 as compared to the No Action Alternative would likely have similar effects on steelhead in the Trinity River as compared to the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>Given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that water temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, while reservoir storage and nest survival would be slightly higher under Alternative 3, it is uncertain whether these differences would be biologically meaningful. Thus, it is concluded that effects on black bass likely would be similar for Alternative 3 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Overall, it is likely that effects on Pacific Lamprey would be similar. This conclusion likely also applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p><u>Eulachon</u></p> <p>Given that the highest increases in flow would be less than 10 percent in the Trinity River, with a smaller relative increase in the lower Klamath River and</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Klamath River estuary, and that water temperatures in the Klamath River would unlikely to be affected by changes upstream at Lewiston Dam, it is likely that effects would have a similar potential to influence Eulachon in the Klamath River.</p> <p>Sacramento River System</p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, given the small differences between alternatives and the uncertainty regarding the non-operational components, distinguishing a clear difference between alternatives is difficult. The non-operational components associated with Alternative 3 could benefit winter-run Chinook Salmon over the short term if successful. However, these measures would not address the long-term temperature challenges in the river downstream of Shasta Dam that would be addressed under the No Action Alternative. It is concluded that the potential for adverse effects on winter-run Chinook Salmon under Alternative 3 would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse. However, the ocean harvest restriction component and predator control measures could reduce spring-run Chinook Salmon mortality. These non-operational components could benefit spring-run Chinook Salmon over the short term if successful. However, these measures would not address the long-term temperature challenges in the river downstream of Shasta Dam that would be addressed through fish passage under the No Action Alternative. It is concluded that the potential for adverse effects on spring-run Chinook Salmon under Alternative 3 would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference between these two scenarios based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Adverse effects of Alternative 3 could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. However, Alternative 3 does not contain the RPA actions that could provide benefit under the No Action Alternative. Thus, effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest that potential effects on late fall-run Chinook Salmon would be similar. Discerning a meaningful difference between these two scenarios based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Because fish passage under the No Action Alternative is not expected</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>to directly benefit late fall-run Chinook Salmon, the non-operational actions intended to benefit salmonids under both alternatives are expected to balance. Thus, it is concluded that the effects on late fall-run Chinook Salmon would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Steelhead</u></p> <p>The model results suggest that overall, effects on steelhead could be slightly less adverse, particularly in the Feather River. The ocean harvest restriction component and predator control measures could reduce steelhead mortality. This potential distinction may be partially offset and become more adverse by the lack of the benefits of implementation of fish passage. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. Thus, on balance and over the long term, the adverse effects on steelhead under Alternative 3 would be greater than those under the No Action Alternative.</p> <p><u>Green Sturgeon</u></p> <p>The temperature model outputs suggest that thermal conditions and effects on Green Sturgeon in the Sacramento and Feather rivers generally would be slightly less adverse under Alternative 3. By contrast, the analysis based on Delta outflows suggests that Alternative 3 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile sturgeon. However, early life stage survival in the natal rivers is crucial in development of a strong year class, and actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of green sturgeon. Therefore, based primarily on the analysis of water temperatures, adverse effects on Green Sturgeon would be less likely.</p> <p><u>White Sturgeon</u></p> <p>Given the general similarity in results and the inherent uncertainty associated with the resolution of the temperature model, the effects likely would be similar. However, the analysis based on Delta outflows suggests that Alternative 3 provides lower mean (March to July) outflows which could result in weaker year classes of juvenile sturgeon. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting effects of increased Delta outflow and improved salvage survival under the No Action Alternative, there would be no definitive difference in effects on White Sturgeon.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely would result in increased adverse effects, primarily due to increased percentage entrainment during larval and juvenile life stages, and less favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the increase in frequency and magnitude of negative OMR flows and the lower Longfin Smelt abundance index values, potential adverse effects likely would be greater.</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Sacramento Splittail</u></p> <p>Flows entering the Yolo Bypass generally would be somewhat higher than under the No Action Alternative from December through March, especially during wetter years, providing similar value to Sacramento Splittail because of the similar area of potential habitat (inundation). Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between Alternative 3 and the No Action Alternative.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar in March, April, and May, but somewhat lower in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Overall, the results of the habitat and nest survival analysis suggest that conditions in the reservoirs likely to support self-sustaining populations of black bass would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Pacific Lamprey</u></p> <p>Pacific Lamprey would be subjected to the same temperature conditions described above for salmonids. Based on the somewhat increased water temperatures from January through the summer, it is likely that there would be little difference in potential effects on Pacific Lamprey in the Sacramento, Feather, and American rivers This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Other Species</u></p> <p>Based on the similar water temperatures during their spawning and incubation period under Alternative 3, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar under Alternative 1 and the No Action Alternative.</p> <p>Alternative 3 would result in a more eastward X2 position as compared to the No Action Alternative during April and May, with similar values in June (Appendix 5A, Section C Table C-16-2). Based on Kimmerer (2002) and Kimmerer et al. (2009), this change in X2 would likely reduce the survival index and the habitat index as measured by salinity for Striped Bass and abundance and habitat index for American Shad.</p> <p>In addition, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches under Alternative 3 could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Overall, Alternative 3 likely would have similar effects on Hardhead, but slightly greater potential for adverse effects on Striped Bass and American Shad as compared to the No Action Alternative, primarily due to the potential for reduced survival during larval and</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>juvenile life stages, and less favorable location of Spring X2 on average.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, likely would have similar effects on the fall-run Chinook Salmon population in the San Joaquin River watershed.</p> <p>Beneficial effects to juvenile fall-run Chinook Salmon could result from implementation of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions under Alternative 3 would benefit fall-run Chinook Salmon.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance under both Alternative 3 and the No Action Alternative, water temperature conditions for steelhead in the Stanislaus River would be generally stressful in the fall, late spring, and summer months. The differences in temperature exceedance between Alternative 3 and the No Action Alternative would be relatively small, with no clear benefit associated with either alternative. However, because Alternative 3 generally would exceed thresholds less frequently during the warmest months, it may have slightly less impact than under the No Action Alternative. Alternative 3 also could provide additional beneficial effects to juvenile steelhead as a result of trap and haul passage through the Delta. It remains uncertain, however, if predator management actions under Alternative 3 would benefit steelhead.</p> <p>This potential distinction between the two alternatives, however, may be partially offset by the benefits of implementation of fish passage under the No Action Alternative intended to address the limited availability of suitable habitat for in the Stanislaus River reaches downstream of New Melones Dam. In addition, RPA actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of steelhead under the No Action Alternative.</p> <p>Implementation of the fish passage program under the No Action could provide a benefit to Central Valley steelhead in the Stanislaus River. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition, RPA actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of steelhead under the No Action Alternative. Thus, it is concluded that the potential for adverse effects on steelhead would be greater, principally because Alternative 3 does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>While the analyses suggest that the effects could be more adverse, most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under Alternative 3 and the No Action Alternative.</p> <p><u>Other Species</u></p> <p>In general, lampreys, Striped Bass and Hardhead also can tolerate higher water temperatures than salmonids. Thus, temperature effects on these species are expected to be similar under both alternatives.</p> <p>Predator controls related to Striped Bass could result in adverse effects.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 4	<p>Trinity River Region</p> <p><u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u></p> <p>The effects are identical as described under Alternative 1 as compared to the No Action Alternative.</p> <p>Sacramento River System</p> <p><u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u></p> <p>CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison and Alternative 1. Therefore the effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p>Conditions related to salmonid survival could be improved under Alternative 4 by implementation of a trap and haul program, changes in Striped Bass bag limits, and changes in PMFC/NMFS harvest limits. However, these benefits would not likely exceed those described for the No Action Alternative, particularly in consideration of the provision of fish passage to address long-term temperature challenges on listed salmonids caused by climate change.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, American Shad, and Hardhead</u></p> <p>The effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p><u>Striped Bass</u></p> <p>The effects in the Sacramento River system would be similar to those described under Alternative 1.</p> <p>Conditions for Striped Bass could be influenced by implementation of a predator control program that reduces the size restrictions and increases the catch</p>	<p>Implement fish passage programs at Shasta, Folsom, and New Melones dams to reduce temperature impacts on Chinook Salmon and steelhead.</p> <p>Mitigation measures for other substantial impacts have not been identified at this time.</p>

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>limit for Striped Bass taken in the sport fishery. This also could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Stanislaus River/Lower San Joaquin River <u>Fall-run Chinook Salmon and Steelhead</u> The effects in the Stanislaus River/Lower San Joaquin River system would be similar to those described under Alternative 1. Beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the Chinook Salmon population.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u> The effects in the Stanislaus River/Lower San Joaquin River system would be similar to those described under Alternative 1.</p> <p><u>Striped Bass</u> The effects in the Stanislaus River/Lower San Joaquin River system would be similar as described under Alternative 1 as compared to the No Action Alternative. Conditions for Striped Bass could be influenced by implementation of a predator control program that reduces the size restrictions and increases the catch limit for Striped Bass taken in the sport fishery. This also could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Pacific Ocean <u>Killer Whale</u> It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 5	<p>Trinity River Region <u>Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, Steelhead, and Green Sturgeon</u> Effects would be similar.</p> <p><u>Reservoir Fishes</u> Effects would be similar.</p> <p><u>Pacific Lamprey</u> Effects would be similar.</p> <p><u>Eulachon</u> Effects would be similar.</p> <p>Sacramento River System <u>Winter-run Chinook Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, Late Fall-run Chinook Salmon, Steelhead, Green Sturgeon, and White Sturgeon</u> Effects would be similar.</p> <p><u>Delta Smelt, Longfin Smelt, and Sacramento Splittail</u> Effects would be similar.</p> <p><u>Reservoir Fishes</u> Effects would be similar.</p> <p><u>Pacific Lamprey and Other Species</u> Effects would be similar.</p>	Mitigation measures for other substantial impacts have not been identified at this time.

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon and Steelhead</u></p> <p>The analysis of temperatures indicates somewhat higher temperatures in some water year types and a higher likelihood of exceedance of suitable temperatures for spawning, and lower likelihood of exceeding suitable temperature for rearing of fall-run Chinook Salmon. The frequency of exceedance of temperature thresholds for steelhead smoltification and rearing could be more stressful. However, the higher flows in April and May and lower temperatures in April and May could benefit steelhead spawning. Given the variability in the results and the inherent uncertainty associated with the resolution of the models, it is concluded that Alternative 5 is likely to have similar effects on fall-run Chinook Salmon and steelhead in the Stanislaus and lower San Joaquin rivers.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the analysis suggests that conditions under Alternative 5 have the potential to negatively influence black bass nesting success, especially in April and May. However, nesting success under Alternative 5 would still exceed 40 percent most of the time. Therefore, it is likely that the effects on black basses in New Melones Reservoir would be similar.</p> <p><u>Other Species</u></p> <p>Given the similar water temperatures, it is likely that the potential to affect lamprey species in the Stanislaus and San Joaquin rivers would be similar.</p> <p>Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similar water temperatures, it is likely that the potential effects to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	

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3 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

1 **Table 9.5 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
<p>No Action Alternative</p>	<p>Trinity River Region</p> <p><u>Coho Salmon</u></p> <p>Overall, the temperature model outputs for each of the Coho Salmon life stages suggest that the temperature of water released at Lewiston Dam generally would be similar, although the exceedance of water temperature thresholds would be slightly more frequent (1 percent). Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that the No Action Alternative and Second Basis of Comparison are likely to have similar effects on the Coho Salmon population in the Trinity River.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>Overall, water temperature could have adverse effects on spring-run Chinook Salmon in the Trinity River; however, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in flows and water temperatures. However, the implementation of the Hatchery Management Plan could reduce the impacts of hatchery Chinook Salmon on natural spring-run Chinook Salmon in the Trinity River. Thus, given these relatively minor changes in temperature and temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), and the uncertainty of the hatchery benefits, it is concluded that the No Action Alternative and Second Basis of Comparison are likely to have similar effects on the spring-run Chinook Salmon in the Trinity River.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Although the combined analysis based on water temperature suggests that operations could be slightly more adverse, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperatures (as well as egg mortality). In addition, these potential adverse effects could be offset by implementation of the Hatchery Management Plan (RPA Action II.6.3), which could reduce the impacts of hatchery Chinook Salmon on natural fall-run Chinook Salmon in the Trinity River, and increase the genetic diversity and diversity of run-timing for these stocks. Overall, given the small differences in the numerical model results and the inherent uncertainty in the temperature model, as well as the potential for offsetting benefits associated with actions that were not modeled, it is concluded that the No Action Alternative is likely to have similar effects on the fall-run Chinook Salmon population in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Although the combined analysis based on water temperature suggests that operations could be slightly more adverse, these effects would not occur in every year and are not anticipated to be substantial based on the relatively small differences in water temperature exceedances. Overall, given these small differences and the inherent uncertainty in the temperature model, these two scenarios are likely to have similar effects on the steelhead population in the Trinity River.</p>	<p>Not considered for this comparison.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Green Sturgeon</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that temperature conditions for Green Sturgeon in the Trinity River or lower Klamath River and estuary would be similar.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the comparison of storage and the analysis of black bass nesting suggest that effects would be similar.</p> <p><u>Pacific Lamprey</u></p> <p>Overall, given the similarities between average monthly water temperatures at Lewiston Dam, it is likely that the effects would be similar. This conclusion likely applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p><u>Eulachon</u></p> <p>Given that the highest reductions in flow would be less than 10 percent in the Trinity River, which would represent even a smaller proportion in the lower Klamath River and Klamath River estuary, and that water temperatures in the Klamath River are unlikely to be affected by changes upstream at Lewiston Dam, it is likely the conditions would be similar for Eulachon in the Klamath River.</p> <p>Sacramento River System</p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that the No Action Alternative would be less likely to result in adverse effects on winter-run Chinook Salmon. In consideration of the potentially beneficial effects resulting from the RPA actions that are not included in the numerical models, the No Action Alternative has a much greater potential to address the long-term sustainability of winter-run Chinook Salmon than does the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse with a small likelihood that spring-run Chinook Salmon production would be lower under the No Action Alternative. However, it is concluded that the potential for adverse effects on spring-run Chinook Salmon suggested by the results of the numerical models would likely be offset by the potential benefits of the RPA actions that are not included in the numerical models, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030. On balance and over the long term, the adverse effects on spring-run Chinook Salmon would be less than those under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for greater adverse effects on fall-run Chinook Salmon under the No Action Alternative as compared to the Second Basis of Comparison. However, discerning a meaningful difference between these two scenarios based on the quantitative results is not possible</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>because of the similarity in results and the inherent uncertainty of the models. In addition, any adverse effect of the No Action Alternative could be offset by the potentially beneficial effects resulting from the RPA actions evaluated qualitatively for the No Action Alternative. Thus, it is concluded that the effects on fall-run Chinook Salmon would be less adverse under the No Action Alternative than under the Second Basis of Comparison.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The model results suggest that overall, effects on late fall-run Chinook Salmon could be slightly less adverse. Potential effects may be lessened further due to actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of salmonids, including late fall-run Chinook Salmon. Thus, it is concluded that the potential for adverse effects on late fall-run Chinook Salmon would be lower under the No Action Alternative compared to the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly more adverse, particularly in the Feather and American rivers. However, implementation of a fish passage program under the No Action Alternative intended to address the limited availability of suitable habitat for steelhead in the Sacramento River reaches downstream of Keswick Dam and in the American River could provide a benefit to Central Valley steelhead in the Sacramento and American rivers. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition to fish passage, preparation and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could benefit steelhead under the No Action Alternative in comparison to the Second Basis of Comparison. Thus, it is concluded that the effects on steelhead would be less adverse under the No Action Alternative than under the Second Basis of Comparison.</p> <p><u>Green Sturgeon</u></p> <p>The increased frequency of exceedance of temperature thresholds under the No Action Alternative could increase the potential for adverse effects on Green Sturgeon in the Sacramento and Feather rivers relative to the Second Basis of Comparison. However, the analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile Green Sturgeon relative to the Second Basis of Comparison. In addition, actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of Green Sturgeon. However, early life stage survival in the natal rivers is crucial in development of a strong year class. In addition, actions under the No Action Alternative intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could improve the overall salvage survival of green sturgeon. Therefore, based primarily on the analysis of water temperatures, the No Action Alternative could be more</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>likely to result in adverse effects on Green Sturgeon than the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>Overall, the increased frequency of exceedance of temperature thresholds in June under the No Action Alternative could increase the potential for effects on White Sturgeon in the Sacramento River relative to the Second Basis of Comparison, however, these effects are uncertain and may include reduced spawning and/or increased growth. The analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile White Sturgeon relative to the Second Basis of Comparison. However, early life stage survival in the natal rivers is crucial in development of a strong year class. Therefore, based primarily on the analysis of water temperatures, the No Action Alternative could be more likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely to result in better conditions for Delta Smelt, primarily due to lower percentage entrainment for larval and juvenile life stages, and more favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even these small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be less.</p> <p><u>Sacramento Splittail</u></p> <p>Overall, the slight flow decreases under the No Action Alternative could result in less spawning habitat for Sacramento Splittail than under the Second Basis of Comparison because of the decreased area of potential habitat (inundation). Given the relatively minor changes in flows into the Yolo Bypass and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), it is concluded that there would be no definitive difference in effects on Sacramento Splittail between the No Action Alternative and Second Basis of Comparison.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar from March through May and somewhat higher in June. Most black bass spawning likely occurs prior to June, such that drawdowns during June would likely affect only a small proportion of the spawning population. Thus, it is concluded that effects on black bass nesting success would be similar under the No Action Alternative and the Second Basis of Comparison.</p> <p><u>Pacific Lamprey</u></p> <p>Given the relatively minor changes in water temperature and water temperature threshold exceedance, and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>likely that effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the relatively minor changes in temperature and temperature threshold exceedance, and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, the No Action Alternative likely would be similar for Hardhead and have a slightly lower potential for adverse effects on Striped Bass and American Shad as compared to the Second Basis of Comparison, primarily due to the potential for increased survival during larval and juvenile life stages, and more favorable location of Spring X2 on average.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon</u></p> <p>The water temperature model outputs for each of the life stages suggest that thermal conditions and effects on fall-run Chinook Salmon in the Stanislaus River generally would be similar, although water temperatures under the No Action Alternative could be somewhat more suitable for fall-run Chinook Salmon spawning/egg incubation. Because the No Action Alternative has the potential for beneficial effects resulting from the RPA actions, it is concluded that the effects on fall-run Chinook Salmon would be less adverse relative to the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>The water temperature model outputs suggest that the differences in the magnitude and frequency of exceedance of suitable temperatures for the various lifestages could have the potential for adverse effects on steelhead in the Stanislaus River. However, the direction and magnitude of this effect is uncertain. It is concluded that the potential for adverse effects on steelhead would be lower, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>Evidence of White Sturgeon spawning has been recorded in the San Joaquin River upstream of the confluence with the Stanislaus River. While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar under all alternatives, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, predicted nest survival is generally above 40 percent in all months evaluated, although survival would vary among months. Given the relatively high survival in general and the uncertainty caused by the inconsistency in changes in survival, it is likely that effects would be similar.</p> <p><u>Other Species</u></p> <p>In general, Pacific Lamprey, Striped Bass, and Hardhead also can tolerate higher temperatures than salmonids. Given the relatively minor changes in temperature and temperature threshold exceedance, the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that the potential to affect these species in the Stanislaus and San Joaquin rivers would be similar.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>Given conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	
Alternative 1	No effects on aquatic resources.	Not considered for this comparison.
Alternative 2	<p>Trinity River Region</p> <p><u>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</u></p> <p>Sacramento River System</p> <p>The CVP and SWP operations under Alternative 2 are identical to the CVP and SWP operations under the No Action Alternative. Therefore, changes in physical conditions that affect aquatic resources in the Central Valley Region would be the same as the impacts described for the No Action Alternative Compared to the Second Basis of Comparison. However, actions to provide fish passage to portions of the Sacramento, American, and Stanislaus rivers upstream of their dams would not be undertaken under Alternative 2 or the Second Basis of Comparison.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>The effects are identical as described under the No Action Alternative as compared to the Second Basis of Comparison.</p>	Not considered for this comparison.
Alternative 3	<p>Trinity River Region</p> <p><u>Coho Salmon and Chinook Salmon</u></p> <p>Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is concluded that Alternative 3 and the Second Basis of</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Comparison are likely to have similar effects on Coho Salmon and Chinook Salmon in the Trinity River.</p> <p><u>Steelhead</u></p> <p>Differences in water temperature conditions for steelhead in the Trinity River would be minor as described above for salmon. These results suggest that conditions for steelhead in the Trinity River generally would be similar.</p> <p><u>Green Sturgeon</u></p> <p>The results of the water temperature analysis suggests similar effects on Green Sturgeon in the Trinity River and lower Klamath River and estuary.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, reservoir storage and nest survival suggest similar effects on black bass.</p> <p><u>Pacific Lamprey and Eulachon</u></p> <p>Overall, water temperature conditions for Pacific Lamprey and Eulachon in the Trinity River and Klamath River downstream of the confluence generally would be similar. This conclusion likely also applies to other species of lamprey that inhabit the Trinity and lower Klamath rivers (e.g., River Lamprey).</p> <p>Sacramento River System</p> <p><u>Winter-run Chinook Salmon</u></p> <p>The numerical model results suggest that effects on winter-run Chinook Salmon would be similar, with a small likelihood that winter-run Chinook Salmon escapement would be higher. The ocean harvest restrictions under Alternative 3 could provide a benefit, although the effects of the predator management program are uncertain. Overall, given the small differences, distinguishing a clear difference between alternatives is difficult. The non-operational components could benefit winter-run Chinook Salmon relative to the Second Basis of Comparison over the short term if successful. Thus, the potential for adverse effects on winter-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The numerical model results suggest that overall, effects on spring-run Chinook Salmon could be slightly more adverse with a small likelihood that spring-run Chinook Salmon production would be lower. Although the operational components could have greater adverse effects on spring-run Chinook Salmon, the non-operational components could benefit spring-run Chinook Salmon over the short term if successful. The ocean harvest restrictions could increase spring-run Chinook Salmon numbers by reducing ocean harvest and the trap and haul program and predator control measures could reduce predation on juvenile spring-run Chinook Salmon and thereby increase survival. The effects of the trap and haul and predator management programs are uncertain. Thus, the potential for adverse effects on spring-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, adverse effects could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. Thus, the potential for adverse effects on fall-run Chinook Salmon would be slightly less under Alternative 3 than under the Second Basis of Comparison.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for less adverse effects on late fall-run Chinook Salmon. However, discerning meaningful differences based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, any adverse effects could be offset by the potentially beneficial effects resulting from predator control and ocean harvest restrictions. Thus, the effects on late fall-run Chinook Salmon would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>Steelhead</u></p> <p>Overall, the results of the numerical models suggest a slightly greater potential for adverse effects on steelhead. However, discerning a meaningful difference between based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, any adverse effects could be offset by the potentially beneficial effects resulting from predator control. Thus, the effects on steelhead would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>Green and White Sturgeon</u></p> <p>The slightly reduced frequency of exceedance of temperature thresholds could reduce the potential for adverse effects on sturgeon in the Sacramento and Feather rivers. The analysis based on Delta outflows suggests that there would be similar mean (March to July) outflows which would have similar effects on year class strength of juvenile sturgeon. Therefore, based primarily on the analysis of water temperatures, Alternative 3 could be less likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, effects would be similar with regard to estimated entrainment and predicted location of Fall X2. However, given the current condition of the Delta Smelt population, even small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values in drier years, the potential for adverse effects likely to be lower. Given the current condition of the Longfin Smelt population, even these small differences between alternatives may be important.</p> <p><u>Sacramento Splittail</u></p> <p>Flows entering the Yolo Bypass generally would be similar. Given the relatively minor changes in flows into</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model (average monthly outputs), there would be no definitive difference in effects on Sacramento Splittail between Alternative 3 and the Second Basis of Comparison.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar. Thus, it is likely that effects on black bass would be similar.</p> <p><u>Other Species</u></p> <p>Changes in average monthly water temperature would be small. In general, lampreys, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), likely to have similar effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers.</p> <p>However, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, likely would have similar effects on the fall-run Chinook Salmon population in the San Joaquin River watershed.</p> <p>Beneficial effects to juvenile fall-run Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions under fall-run Chinook Salmon would benefit the fall-run Chinook Salmon population.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance under both Alternative 3 and the Second Basis of Comparison, water temperature conditions for steelhead in the Stanislaus River would be generally similar. Discerning a meaningful difference based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. Thus, the effects on steelhead would be similar under Alternative 3 and the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In</p>	

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Alternative	Potential Change	Consideration for Mitigation Measures
	<p>consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (>40 percent) nest survival in New Melones would be similar to or higher. This suggests that conditions in New Melones could be more likely to support self-sustaining populations of black bass.</p> <p><u>Other Species</u></p> <p>In general, Striped Bass and Hardhead also can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that the potential effects to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p>However, the increased bag limits and ability of anglers to retain Striped Bass that are 12 inches in length versus 18 inches could reduce the ability to meet the doubling goals for Striped Bass populations under the requirements of Section 3406(b)(1) of CVPIA.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p>	
Alternative 4	<p>Trinity River Region</p> <p><u>Coho Salmon, spring-run and fall-run Chinook Salmon, steelhead, Green Sturgeon, Reservoir Fishes, Pacific Lamprey, River Lamprey, and Eulachon</u></p> <p>The effects would be identical.</p> <p>Sacramento River System</p> <p>The CVP and SWP operations under Alternative 4 are identical to the CVP and SWP operations under the Second Basis of Comparison. Therefore, changes in aquatic habitat conditions at CVP and SWP reservoirs, in the rivers downstream of the reservoirs, and in the Delta would be the same as under the Second Basis of Comparison.</p> <p><u>Winter-run, spring-run, fall-run, and late fall-run Chinook Salmon, and steelhead</u></p> <p>The effects in the Sacramento River system would be similar, although Alternative 4 could produce beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. However, the magnitude of these potential benefits remain uncertain.</p> <p><u>Green Sturgeon, White Sturgeon, Delta Smelt, Longfin Smelt, Sacramento Splittail, Reservoir Fishes, Pacific Lamprey, River Lamprey, American Shad, and Hardhead</u></p> <p>The effects in the Sacramento River system would be identical.</p> <p><u>Striped Bass</u></p> <p>The effects in the Sacramento River system would be similar, although predator control would result in adverse effects on Striped Bass.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Stanislaus River/Lower San Joaquin River <u>Fall-run Chinook Salmon and Steelhead</u> The effects in the Stanislaus River/Lower San Joaquin River system would be similar. Beneficial effects to Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the Chinook Salmon population.</p> <p><u>White Sturgeon, Reservoir Fishes, and Other Species</u> The effects in the Stanislaus River/Lower San Joaquin River system would be identical.</p> <p><u>Striped Bass</u> The effects in the Stanislaus River/Lower San Joaquin River system would be similar. Predation controls related to Striped Bass would result in adverse effects.</p> <p>Pacific Ocean <u>Killer Whale</u> It is unlikely that the Chinook Salmon prey base of killer whales, supported heavily by hatchery production of fall-run Chinook Salmon, would be appreciably affected.</p> <p>Beneficial effects due to benefits to fall-run Chinook Salmon as a result of trap and haul passage through the Delta and ocean harvest restrictions. It remains uncertain, however, if predator management actions would benefit the fall-run Chinook Salmon population.</p>	
Alternative 5	<p>Trinity River Region <u>Coho Salmon, Spring-run Chinook Salmon, Fall-run Chinook Salmon, and Steelhead</u> Monthly water temperature generally would be similar (less than 0.5°F differences), with the exception of drier years when temperatures could be as much as 2.2°F cooler in November and 1.5°F warmer in December. Average monthly water temperatures could be slightly (up to 0.6°F) higher during July and August and lower (up to 0.7°F) in September. Lower September temperatures may result in slightly better conditions for spring-run Chinook Salmon spawning. Similarly, temperature conditions could be slightly better for fall-run Chinook Salmon spawning because of the reduced temperatures in November during critical dry years.</p> <p>Water temperature thresholds for Coho Salmon, fall-run Chinook Salmon, and steelhead would be exceeded slightly more frequently (less than 1 percent), whereas thresholds for spring-run Chinook Salmon would be exceeded less frequently (up to 4 percent) in August in September.</p> <p>Discerning a meaningful difference based on the quantitative results is not possible because of the similarity in results (generally differences less than 5 percent) and the inherent uncertainty of the models. In addition, implementation of a Hatchery Management Plan could reduce the impacts of hatchery Chinook Salmon on natural Chinook Salmon in the Trinity River and increase the genetic diversity and diversity of run-timing for these stocks, but the potential magnitude of these benefits is uncertain.</p> <p>Alternative 5 is likely to have similar effects on Chinook Salmon and steelhead in the Trinity River.</p> <p><u>Reservoir Fishes</u> Overall, the comparison of storage and the analysis of nesting suggest that effects would be similar.</p>	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Other Species</u></p> <p>The minor differences in average monthly water temperatures described above for salmonids apply to Pacific Lamprey, Eulachon, and other aquatic species in the Trinity River. These minor differences suggest that conditions for aquatic species in the Trinity River and Klamath River downstream of the confluence generally would be similar under Alternative 5 and the Second Basis of Comparison.</p> <p>Sacramento River System</p> <p><u>Winter-run Chinook Salmon</u></p> <p>Overall, the quantitative results from the numerical models suggest that operations would be less likely to result in adverse effects on winter-run Chinook Salmon. In consideration of the potentially beneficial effects resulting from actions that are not included in the numerical models, the potential for adverse effects on winter-run Chinook Salmon under Alternative 5 would clearly be less than those under the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to winter-run Chinook Salmon sustainability over the long term with climate change by 2030.</p> <p><u>Spring-run Chinook Salmon</u></p> <p>The numerical model results suggest that, overall, Alternative 5 likely would have similar or slightly greater adverse effects on the spring-run Chinook Salmon population in the Sacramento River watershed as compared to the Second Basis of Comparison. The potential for adverse effects on spring-run Chinook Salmon suggested by the results of the numerical models would likely be offset by the potential benefits of the actions that are not included in the numerical models, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to spring-run Chinook Salmon sustainability over the long term with climate change by 2030. On balance and over the long term, the adverse effects on spring-run Chinook Salmon under Alternative 5 would be less than those under the Second Basis of Comparison.</p> <p><u>Fall-run Chinook Salmon</u></p> <p>Overall, the results of the numerical models suggest the potential for greater adverse effects on fall-run Chinook Salmon. However, discerning a meaningful difference between these two scenarios based on the quantitative results is difficult because of the similarity in results (generally differences less than 5 percent), the inherent uncertainty of the models, and the potential for offsetting benefits. Thus, the effects on fall-run Chinook Salmon would be similar.</p> <p><u>Late Fall-run Chinook Salmon</u></p> <p>The numerical model results suggest that overall, Alternative 5 is likely to have less adverse effect on late fall-run Chinook Salmon in the Sacramento River. Benefits may be enhanced by actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities to improve the overall salvage survival of salmonids, including late fall-run Chinook Salmon. Thus, the potential for adverse effects on late fall-run Chinook Salmon would be less under Alternative 5 relative to the Second Basis of Comparison.</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Steelhead</u></p> <p>The numerical model results suggest that overall, effects on steelhead could be slightly more adverse, particularly in the Feather and American rivers. However, implementation of a fish passage program intended to address the limited availability of suitable habitat for steelhead in the Sacramento River reaches downstream of Keswick Dam and in the American River could provide a benefit to Central Valley steelhead in the Sacramento and American rivers. This is particularly important in light of anticipated increases in water temperature associated with climate change in 2030. In addition to fish passage, preparation and implementation of an HGMP for steelhead at the Nimbus Fish Hatchery and actions intended to increase the efficiency of the Tracy and Skinner Fish Collection Facilities could benefit steelhead. Thus, on balance and over the long term, the adverse effects on steelhead under Alternative 5 would be less than those under the Second Basis of Comparison.</p> <p><u>Green Sturgeon</u></p> <p>Overall, the increased frequency of exceedance of temperature thresholds could increase the potential for adverse effects on Green Sturgeon in the Sacramento and Feather rivers. However, analysis based on Delta outflows suggests that Alternative 5 provides higher mean (March to July) outflows which could result in stronger year classes of juvenile sturgeon relative to the Second Basis of Comparison. However, early life stage survival in the natal rivers is crucial in development of a strong year class; therefore, based primarily on the analysis of water temperatures, Alternative 5 could be more likely to result in adverse effects on Green Sturgeon than the Second Basis of Comparison.</p> <p><u>White Sturgeon</u></p> <p>The increased frequency of exceedance of temperature thresholds under Alternative 5 could increase the potential for adverse effects on White Sturgeon relative to the Second Basis of Comparison. However, the analysis based on Delta outflows suggests that the No Action Alternative provides higher mean (March to July) outflows which could result in stronger year classes of juvenile sturgeon relative to the Second Basis of Comparison. Early life stage survival in the natal rivers is crucial in development of a strong year class; therefore, based primarily on the analysis of water temperatures, Alternative 5 could be more likely to result in adverse effects on White Sturgeon than the Second Basis of Comparison.</p> <p><u>Delta Smelt</u></p> <p>Overall, likely would result in better conditions for Delta Smelt, primarily due to lower percentage entrainment for larval and juvenile life stages, and more favorable location of Fall X2 in wetter years, and on average. Given the current condition of the Delta Smelt population, even small differences between alternatives may be important.</p> <p><u>Longfin Smelt</u></p> <p>Overall, based on the decrease in frequency and magnitude of negative OMR flows and the higher Longfin Smelt abundance index values, especially in dry and critical dry years, potential adverse effects on the Longfin Smelt population likely would be less.</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p><u>Sacramento Splittail</u></p> <p>Overall, the slight adverse effects related to spawning habitat for Sacramento Splittail because of the decreased area of potential habitat (inundation) and the potential for a slight decrease in the frequency of inundation. Given the relatively minor changes in flows into the Yolo Bypass, and the inherent uncertainty associated with the resolution of the CalSim II model, no definitive difference in effects on Sacramento Splittail could be discerned.</p> <p><u>Reservoir Fishes</u></p> <p>The analysis of black bass nest survival based on changes in water surface elevation during the spawning period indicated that the likelihood of high (greater than 40 percent) nest survival in most of the reservoirs would be similar. Overall, the results of the nest survival analysis suggest that effects on reservoir fishes would be similar.</p> <p><u>Pacific Lamprey</u></p> <p>Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model (average monthly outputs), it is likely that conditions for and effects on Pacific Lamprey in the Sacramento, Feather, and American rivers would be similar. This conclusion likely applies to other species of lamprey that inhabit these rivers (e.g., River Lamprey).</p> <p><u>Striped Bass, American Shad, and Hardhead</u></p> <p>In general, Striped Bass, American Shad, and Hardhead can tolerate higher temperatures than salmonids. Given the similarity of the results and the inherent uncertainty associated with the resolution of the temperature model, it is likely that thermal conditions for and effects on Striped Bass, American Shad, and Hardhead in the Sacramento, Feather, and American rivers would be similar. Overall, Alternative 5 likely would have similar effects on Hardhead and a slightly lower potential for adverse effects on Striped Bass, American Shad, and Hardhead as compared to the Second Basis of Comparison, primarily due to the potential for increased survival for these two species during larval and juvenile life stages, and more favorable location of Spring X2 on average.</p> <p>Stanislaus River/Lower San Joaquin River</p> <p><u>Fall-run Chinook Salmon</u></p> <p>The analysis of temperatures indicates lower temperatures and a lesser likelihood of exceedance of suitable temperatures for spawning and rearing of fall-run Chinook Salmon in the Stanislaus River below Goodwin Dam and in the San Joaquin River at Vernalis. As described above, the instream flow patterns are anticipated to benefit fall-run Chinook Salmon in the Stanislaus River and downstream in the lower San Joaquin River below Vernalis.</p> <p>Implementation of a fish passage project under Alternative 5, intended to address the limited availability of suitable habitat for steelhead in the Stanislaus River reaches downstream of Goodwin Dam, likely would not provide benefit to fall-run Chinook Salmon unless passage was provided and additional habitat could be accessed. Potential benefits to fall-run Chinook Salmon associated with fish passage is nevertheless uncertain. However, actions implemented under Alternative 5 intended to increase the efficiency of the Tracy and</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>Skinner Fish Collection Facilities could improve the overall salvage survival of fall-run Chinook Salmon. Overall, given the small differences in the modeling results and the potential benefits anticipated by actions not captured in the models, effects on fall-run Chinook Salmon would be similar.</p> <p><u>Steelhead</u></p> <p>Given the frequency of exceedance and the generally stressful temperature conditions in the river, the substantial lower temperatures in October and April suggest that there would be less potential to result in adverse effects on steelhead.</p> <p>Implementation of a fish passage program under Alternative 5 intended to address the limited availability of suitable habitat for steelhead in the Stanislaus River reaches downstream of Goodwin Dam could provide a benefit to steelhead. In addition, the potential effects of Alternative 5 could be offset by actions intended to reduce predation risk on steelhead in the Stanislaus River and increase the efficiency of the Tracy and Skinner Fish Collection Facilities. The actions to augment spawning gravel in the Stanislaus River under Alternative 5 also could benefit steelhead.</p> <p>The numerical model results for effects on steelhead under Alternative 5 and Second Basis of Comparison do not definitively show distinct differences. However, in consideration of the potentially beneficial effects resulting from the actions that would be implemented under Alternative 5 that are not included in the numerical models, Alternative 5 has a much greater potential to address the long-term sustainability of steelhead than does the Second Basis of Comparison. Alternative 5 includes provisions for fish passage upstream of New Melones Dam to address long-term temperature increases associated with climate change. Even though the success of fish passage is uncertain, the potential for adverse effects on steelhead under Alternative 5 would clearly be less than that under the Second Basis of Comparison, principally because the Second Basis of Comparison does not include a strategy to address water temperatures critical to steelhead sustainability over the long term with climate change by 2030.</p> <p><u>White Sturgeon</u></p> <p>Evidence of White Sturgeon spawning has been recorded in the San Joaquin River upstream of the confluence with the Stanislaus River. While flows in the San Joaquin River upstream of the Stanislaus River are expected to be similar under all alternatives, flow contributions from the Stanislaus River could influence water temperatures in the San Joaquin River where White Sturgeon eggs or larvae may occur during the spring and early summer. The magnitude of influence on water temperature would depend on the proportional flow contribution of the Stanislaus River and the temperatures in both the Stanislaus and San Joaquin rivers. The potential for an effect on White Sturgeon eggs and larvae would be influenced by the proportion of the population occurring in the San Joaquin River. In consideration of this uncertainty, it is not possible to distinguish potential effects on White Sturgeon between alternatives.</p> <p><u>Reservoir Fishes</u></p> <p>Overall, the analysis suggests that conditions under Alternative 5 have the potential to influence black bass</p>	

Alternative	Potential Change	Consideration for Mitigation Measures
	<p>nesting success, especially in April and May in comparison to the Second Basis of Comparison. However, nesting success under Alternative 5 would still exceed 40 percent most of the time under both alternatives. Therefore, there would be no definitive difference in effects on reservoir fish between Alternative 5 and the Second Basis of Comparison.</p> <p><u>Other Species</u></p> <p>In general, Striped Bass and Hardhead can tolerate higher temperatures than salmonids. Given the similar flows and temperatures during their spawning and incubation period, it is likely that the potential to affect Striped Bass and Hardhead in the Stanislaus and San Joaquin rivers would be similar.</p> <p>Pacific Ocean</p> <p><u>Killer Whale</u></p> <p>Given conclusions from NMFS (2009c), and the fact that at least 75 percent of fall-run Chinook Salmon available for Southern Residents are produced by Central Valley hatcheries, it is likely that Central Valley fall-run Chinook Salmon as a prey base for killer whales would not be appreciably affected.</p>	

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Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the Second Basis of Comparison are considered to be "similar."

4 **9.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,
6 reduce, eliminate, or compensate for adverse environmental effects of
7 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation
8 measures were not included to address adverse impacts under the alternatives as
9 compared to the Second Basis of Comparison because this analysis was included
10 in this EIS for information purposes only.

11 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared
12 to the No Action Alternative would result in adverse impacts. Potential
13 mitigation measures that could be considered to reduce the adverse water
14 temperature impacts include implementation of fish passage programs. Mitigation
15 measures for other substantial adverse impacts have not been identified at this
16 time.

17 **9.4.3.8.1 Fish Passage Programs**

18 Implementation of Alternatives 1, 2, 3, and 4 would result in adverse impacts due
19 to high water temperatures in the streams downstream of the dams. A potential
20 mitigation measure to reduce these effects would be:

- 21 • Implement fish passage programs at Shasta and Keswick, Oroville and
22 Thermalito, Folsom and Nimbus, and New Melones dams to reduce
23 temperature impacts on Chinook Salmon and steelhead under Alternatives 1,
24 2, 3, and 4.

1 These programs would be similar to programs implemented under the 2009
 2 NMFS BO, as included in the No Action Alternative and Alternative 5. This
 3 mitigation measure would be in response to the climate change effects anticipated
 4 in 2030 in addition to the changes under Alternatives 1, 2, 3, and 4.

5 **9.4.3.9 Cumulative Effects Analysis**

6 As described in Chapter 3, the cumulative effects analysis considers projects,
 7 programs, and policies that are not speculative; and are based upon known or
 8 reasonably foreseeable long-range plans, regulations, operating agreements, or
 9 other information that establishes them as reasonably foreseeable.

10 The cumulative effects analysis under Alternatives 1 through 5 for Fish and
 11 Aquatic Resources are summarized in Table 9.6.

12 **Table 9.6 Summary of Cumulative Effects on Fish and Aquatic Resources of**
 13 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions Included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise: <ul style="list-style-type: none"> • Implementation of Federal and state policies and programs, including Clean Water Act (e.g. Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs • General plans for 2030. • Trinity River Restoration Program. • Central Valley Project Improvement Act programs • Iron Mountain Mine Superfund Site • Nimbus Fish Hatchery Fish Passage Project • Folsom Dam Water Control Manual Update 	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce carryover storage in reservoirs, stream flows and Delta outflow, and the availability of CVP and SWP water supplies as compared to past conditions. These future actions could modify surface water conditions (e.g., flow) and affect habitat for fish and aquatic resources. However, many of these actions are intended to improve habitat conditions for aquatic resources or water quality, and thus the alternatives would not contribute to an adverse cumulative effect on aquatic resources. In addition, these actions were or would be subject to compliance with ESA, CESA, and other environmental laws and requirements, which serve to reduce the potential for impacts on aquatic resources.

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Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> • FERC Relicensing for the Middle Fork of the American River Project • Lower Mokelumne River Spawning Habitat Improvement Project • Dutch Slough Tidal Marsh Restoration • Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation • Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project • San Joaquin River Restoration Program • Stockton Deep Water Ship Channel Dissolved Oxygen Project • Grasslands Bypass Project • Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) 	
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> • Bay-Delta Water Quality Control Plan Update • FERC Relicensing Projects • Bay Delta Conservation Plan (including the California WaterFix alternative) • Shasta Lake Water Resources Investigation, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations • El Dorado Water and Power Authority Supplemental Water Rights Project • Sacramento River Water Reliability Project • Semitropic Water Storage District Delta Wetlands 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, and increased water allocated to improve habitat conditions. It is unclear how these future reasonably foreseeable actions would influence aquatic resources because project details are not available. However, as described above, these actions would be subject to environmental regulations that avoid or limit the potential for cumulative effects on aquatic resources. Some of these actions (e.g., FERC relicensing projects) could cumulatively contribute to reducing adverse effects of climate change on aquatic resources if fish passage and improved water temperature control result from the FERC process.</p>

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> • North Bay Aqueduct Alternative Intake • Irrigated Lands Regulatory Program • San Luis Reservoir Low Point Improvement Project • <i>Westlands Water District v. United States Settlement</i> • Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS) 	
<p>No Action Alternative with Associated Cumulative Effects in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of No Action Alternative would result in changes in stream flows, increased Delta outflow, and reduced CVP and SWP water supplies as compared to conditions prior to the BOs. These RPA actions are intended and anticipated to put fish and aquatic resources on a more favorable trajectory than would occur without these actions.</p>
<p>Alternative 1 with Associated Cumulative Effects in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
<p>Alternative 2 with Associated Cumulative Effects in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions.</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	<p>The effects of Alternative 2 on water temperature relative to the No Action Alternative could contribute incrementally to the cumulative effects on listed salmonids because the alternative provides no mechanism for addressing long-term temperature increases.</p>

Scenarios	Actions	Cumulative Effects of Actions
Alternative 3 with Associated Cumulative Effects in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p> <p>Increased bag limits for Striped Bass and Pikeminnow</p> <p>Increased ocean salmon fishing harvest limitations</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
Alternative 4 with Associated Cumulative Effects in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Increased bag limits for Striped Bass and Pikeminnow</p> <p>Increased ocean salmon fishing harvest limitations</p> <p>No implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternatives 1 and 4 with reasonably foreseeable actions would result in changes in stream flows, reduced Delta outflows, and increased CVP and SWP water exports as compared to the No Action Alternative with reasonably foreseeable actions. Favorable conditions for listed salmonids could be less available as compared to the No Action Alternative because access to habitat upstream of Shasta, Folsom, and New Melones dams would not be available. In addition, implementation of these alternatives could contribute cumulatively to impacts on listed Delta species by comparison to the No Action Alternative with reasonably foreseeable actions.</p>
Alternative 5 with Associated Cumulative Effects in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	<p>Implementation of Alternative 5 with reasonably foreseeable actions would result in changes in stream flows, increased Delta outflows, and reduced CVP and SWP water exports as compared to the No Action Alternative with these added actions.</p>

1 **9.5 References**

2 Aasen, G. 2011. Fish Salvage at the State Water Project’s and Central Valley
3 Project’s Fish Facilities during the 2010 Water Year. IEP Newsletter.
4 Vol. 24, Number 1, Spring.

5 Aasen, G. 2012. Fish Salvage at the State Water Project’s and Central Valley
6 Project’s Fish Facilities during the 2011 Water Year. IEP Newsletter.
7 Vol. 25, Number 1, Fall/Winter.

- 1 Aceituno, M. E. 1993. The Relationship Between Instream Flow and Physical
2 Habitat Availability for Chinook Salmon in the Stanislaus River,
3 California. U.S. Fish and Wildlife Service, Ecological Services,
4 Sacramento Field Office, Sacramento, California.
- 5 Acuna et al. (Acuna, S., D. Deng, P. Lehman, S. the). 2012. Sublethal Dietary
6 Effects of Microcystis on Sacramento Splittail, Pogonichthys
7 macrolepidotus. *Aquat Toxicol* no. 110-111:1-8. doi:
8 10.1016/j.aquatox.2011.12.004.
- 9 Adams et al. (Adams, P. B., C. Grimes, J. E. Hightower, S. T. Lindley, M. L.
10 Moser, and M. J. Parsley). 2007. Population Status of North American
11 Green Sturgeon, *Acipenser medirostris*. *Environmental Biology of*
12 *Fishes* 79: 339-356.
- 13 AFRP (Anadromous Fish Restoration Program). 2011. Videography monitoring
14 of Adult Sturgeon in the Feather River Basin, California.
- 15 AFRP (Anadromous Fish Restoration Program). 2012. Draft CVPIA Fiscal Year
16 2012 Annual Work Plan. 3406(b)(1).
- 17 Ainsley et al. (Ainsley, S., J. Pombo, T. Wright, and E. Loury). 2013. Pilot
18 study: the Feasibility of Using Fyke Traps in the Lower San Joaquin River
19 to Capture Adult Striped Bass. FISHBIO, Oakdale, California. July.
- 20 Aplers et al. (Alpers, C., C. Eagles-Smith, C. Foe, S. Klasing, M. Marvin-
21 DiPasquale, D. Slotton, and L. Winham-Myers). 2008. Mercury
22 Conceptual Model. Sacramento (CA): Delta Regional Ecosystem
23 Restoration Implementation Plan.
- 24 Anderson et al. (Anderson, J., C. Watry, and A. Gray). 2007. Upstream Fish
25 Passage at a Resistance Board Weir using Infrared and Digital Technology
26 in the Lower Stanislaus River, California. 2006–2007 Annual Data
27 Report. Prepared for the U.S. Fish and Wildlife Service.
- 28 ARG (American River Group). 2011. Annual Report of Activities,
29 October 1, 2010 to September 30, 2011. October.
- 30 ARG (American River Group). 2012. Annual Report of Activities,
31 October 1, 2011 to September 30, 2012. September.
- 32 Arthur et al. (Arthur, J. F., M. D. Ball, and S. Y. Baughman). 1996. Summary of
33 Federal and State Water Project Environmental Impacts in the San
34 Francisco Bay-Delta estuary, California. In *The San Francisco Bay: The*
35 *Ecosystem*, edited by J.T. Hollibaugh, 445-495. Seventy-fifth annual
36 meeting of the Pacific Division, American Association for the
37 Advancement of Science. Held at San Francisco State University,
38 June 19-24, 1994. San Francisco, California.
- 39 Azat, J. 2012. Central Valley Chinook salmon harvest and escapement.
40 Interagency Ecological Program Newsletter: 25(2).

- 1 Baerwald et al. (Baerwald, M. R., B. M. Schreier, G. Schumer, and B. May).
2 2012. Detection of Threatened Delta Smelt in the Gut Contents of the
3 Invasive Mississippi Silverside in the San Francisco Estuary using
4 TaqMan Assays, Transactions of the American Fisheries Society 141:
5 1600-1607.
- 6 Bain, M. B., and N. J. Stevenson, editors. 1999. Aquatic Habitat Assessment:
7 Common Methods. American Fisheries Society, Bethesda, Maryland.
- 8 Barnett-Johnson, R., C. B. Grimes, C. F. Royer, and C. J. Donohoe. 2007.
9 Identifying the contribution of wild and hatchery Chinook salmon
10 (*Oncorhynchus tshawytscha*) to the ocean fishery using otolith
11 microstructure as natural tags. Canadian Journal of Fisheries and Aquatic
12 Sciences 64:1683–1692.
- 13 Bartholomew, J. L. 2012. 3.2.4 Salmonid ceratomyxosis. AFS-FHS (American
14 Fisheries Society-Fish Health Section). FHS Blue Book: Suggested
15 Procedures for the Detection and Identification of Certain Finfish and
16 Shellfish Pathogens, 2014 Edition.
- 17 Baxa et al. (Baxa, D.V., A. Stover, M. Clifford, T. Kurobe1, S.J. Teh, P. Moyle,
18 and R.P. Hedrick). 2013. *Henneguya* sp. in Yellowfin Goby
19 *Acanthogobius flavimanus* from the San Francisco Estuary. SpringerPlus
20 2013, 2:420.
- 21 Baxter, R. D. 1999. Status of Splittail in California. California Fish and Game
22 85: 28–30.
- 23 Baxter et al. (Baxter, R., R. Breuer, L. Brown, M. Chotkowski, F. Feyrer, M.
24 Gingras, B. Herbold, A. Mueller-Solger, M. Nobriga, T. Sommer, and K.
25 Souza). 2008. Pelagic Organism Decline Progress Report: 2007
26 Synthesis of Results. Technical Report 227. Interagency Ecological
27 Program for the San Francisco Estuary.
- 28 Baxter et al. (Baxter, R., R. Breuer, L. Brown, L. Conroy, F. Feyrer, S. Fong, K.
29 Gehrts, L. Grimaldo, B. Herbold, P. Hrodey, A. Mueller-Solger, T.
30 Sommer, and K. Souza). 2010. Pelagic Organism Decline Work Plan and
31 Synthesis of Results. Interagency Ecological Program for the San
32 Francisco Estuary.
- 33 Beamesderfer et al. (Beamesderfer, R., M. Simpson, G. Kopp, J. Inman, A. Fuller,
34 and D. Demko). 2004. Historical and Current Information on Green
35 Sturgeon Occurrence in the Sacramento and San Joaquin Rivers and
36 Tributaries. Prepared by for State Water Contractors, Sacramento,
37 California.
- 38 Beamesderfer et al. (Beamesderfer, R., M. Simpson, and G. Kopp). 2007. Use of
39 Life History Information in a Population Model for Sacramento Green
40 Sturgeon. Environmental Biology of Fishes 79: 315-337.

- 1 Bennett, W. A. 2005. Critical Assessment of the Delta Smelt Population in the
 2 San Francisco Estuary, California. San Francisco Estuary and Watershed
 3 Science 3: Article 1.
- 4 Bennett, W. A., and P. B. Moyle. 1996. Where Have All The Fishes Gone?
 5 Interactive Factors Producing Fish Declines in the Sacramento-San
 6 Joaquin Estuary. San Francisco Bay: the ecosystem. Edited by J. T.
 7 Hollibaugh, 519-542. American Association for the Advancement of
 8 Science, Pacific Division, San Francisco, California.
- 9 Bennett et al. (Bennett, W. A., J. A. Hobbs, and S. J. the). 2008. Interplay of
 10 Environmental Forcing and Growth-Selective Mortality in the Poor
 11 Year-Class Success of Delta Smelt in 2005. Final Report. Fish Otolith
 12 and Condition Study 2005. Prepared for the Pelagic Organism Decline
 13 Management Team.
- 14 Benson et al. (Benson, R. L., S. Turo, and B. W. McCovey). 2007. Migration
 15 and Movement Patterns of Green Sturgeon (*Acipenser medirostris*) in the
 16 Klamath and Trinity Rivers, California, USA. Environmental Biology of
 17 Fishes 79: 269-279.
- 18 BLM (Bureau of Land Management). 1995. Mainstem Trinity River watershed
 19 analysis.
- 20 Bootland, L. M., and J. C. Leong. 1999. Infectious Hematopoietic Necrosis
 21 Virus (IHNV). Viral, Bacterial and Fungal Infections, Vol. II. Edited by
 22 P. T. K. Woo and D. W. Bruno, 519-542. CAB International Publishing.
- 23 Bourez, W. 2011. Subject: Relating Delta Smelt Index to X2 position, Delta
 24 Flows, and Water Use. Memorandum from MBK Engineers to the
 25 Northern California Water Association. December 15.
- 26 Bowen et al. (Bowen, M., S. Siegfried, C. Liston, L. Hess, and C. Karp). 1998.
 27 Fish Collections and Secondary Louver Efficiency at the Tracy Fish
 28 Collection Facility, October 1993 to September 1995. Tracy Fish
 29 Collection Facility Studies, Volume 7. Bureau of Reclamation.
- 30 Brandes, P. L., and J. S. McClain. 2001. Juvenile Chinook Salmon Abundance,
 31 Distribution, and Survival in the Sacramento-San Joaquin Estuary. Edited
 32 by R. L. Brown. Contributions to the biology of Central Valley
 33 Salmonids. California Department of Fish and Game Fish Bulletin 179:
 34 39-137.
- 35 Brown, K. 2007. Evidence of Spawning by Green Sturgeon, *Acipenser*
 36 *medirostris*, in the Upper Sacramento River, California. Environmental
 37 Biology of Fishes 79: 297-303.
- 38 Brown, M. 2011. Clear Creek Technical Team report for the OCAP BiOps
 39 Integrated Annual Review. U.S. Fish and Wildlife Service.
- 40 Brown, L. 2013. Ecological Contest for the Delta: A Lot Can Happen in
 41 150 Years. USGS California Water Science Center.

- 1 Brown, L. R., and J. T. May. 2006. Variation in Spring Nearshore Resident Fish
2 Species Composition and Life Histories in the Lower San Joaquin
3 Watershed and Delta. *San Francisco Estuary and Watershed Science* 4(1).
- 4 Brown, L. R., and D. Michniuk. 2007. Littoral Fish Assemblages of the
5 Alien-dominated Sacramento–San Joaquin Delta, California 1980–1983
6 and 2001–2003. *Estuaries and Coasts* 30: 186-200.
- 7 Brown, L. R., and P. B. Moyle. 1993. Distribution, Ecology, and Status of Fishes
8 of the San Joaquin River Drainage, California. *California Fish and Game*
9 79: 96-113.
- 10 Brown et al. (Brown, L. R., R. Baxter, G. Castillo, L. Conrad, S. Culberson, G.
11 Erickson, F. Feyrer, S. Fong, K. Gehrts, L. Grimaldo, B. Herbold, J.
12 Kirsch, A. Mueller-Solger, S. B. Slater, T. Sommer, K. Souza, and E. Van
13 Nieuwenhuysse). 2014. Synthesis of Studies in the Fall Low-Salinity
14 Zone of the San Francisco Estuary, September–December 2011.
15 Scientific Investigations Report 2014–5041. Reston, Virginia. U.S.
16 Geological Survey.
- 17 Brown et al. (Brown R., S. Greene, P. Coulston, and S. Barrow). 1996. An
18 Evaluation of the Effectiveness of Fish Salvage Operations at the Intake of
19 the California Aqueduct, 1979-1993. *San Francisco Bay: the ecosystem.*
20 Edited by J.T. Hollibaugh, 497-518. Pacific Division of the American
21 Association for the Advancement of Science, San Francisco, California.
- 22 Brown et al. (Brown, R., B. Cavallo, and K. Jones). 2004. The Effects of the
23 Feather River Hatchery on naturally spawning Salmonids. Oroville
24 Facilities Relicensing (FERC Project Number 2100). Draft Report SP-F9.
25 Prepared by California Department of Water Resources, Sacramento,
26 California, and Pacific States Marine Fisheries Commission, Portland,
27 Oregon.
- 28 Brown et al. (Brown, M., S. Giovannetti, J. Earley, and P. Bratcher). 2012. Clear
29 Creek Technical Team Report for the Coordinated Long-term Operation
30 BiOps Integrated Annual Review. U.S. Fish and Wildlife Service.
- 31 Buchanan R. A., J. R. Skalski, P. L. Brandes and A. Fuller. 2013. Route Use and
32 Survival of Juvenile Chinook Salmon through the San Joaquin River
33 Delta, *North American Journal of Fisheries Management*, 33(1): 216-229.
- 34 Budy et al. (Budy, P., G. P. Thiede, N. Bouwes, C. E. Petrosky, and H. Schaller).
35 2002. Evidence Linking Delayed Mortality of Snake River Salmon to
36 their Earlier Hydrosystem Experience. *North American Journal of*
37 *Fisheries Management* 22: 35–51.
- 38 Burau et al. (Burau, J. R., S. G. Monismith, M. T. Stacey, R. N. Oltmann, J. R.
39 Lacy, and D. H. Schoellhamer). 2000. Recent Research on the
40 Hydrodynamics of the Sacramento-San Joaquin River Delta and North
41 San Francisco Bay. *Interagency Ecological Program Newsletter* 13:
42 45-53.

- 1 Busby et al. (Busby, P. J., T. C. Wainwright, and R. S. Waples). 1994. Status
2 Review for Klamath Mountains Province steelhead. NOAA Technical
3 Memorandum NMFS-NWFSC-19. National Marine Fisheries Service.
- 4 Busby et al. (Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S.
5 Waples, F. W. Waknitz, and I. V. Lagomarsino). 1996. Status Review of
6 West Coast steelhead from Washington, Idaho, Oregon, and California.
7 NOAA Technical Memorandum NMFS–NWFSC–27. June.
- 8 Calduch-Verdiell N, MacKenzie BR, Vaupel JW, Andersen KH. 2014. A life
9 history evaluation of the impact of maternal effects on recruitment and
10 fisheries reference points. *Can J Fish Aquat Sci* 71: 1113–1120. doi:
11 10.1139/cjfas-2014-0034. June.
- 12 CALFED Bay-Delta Program. 2000a. Volume I: Ecological Attributes of the
13 San Francisco Bay-Delta Watershed. Ecosystem Restoration Program
14 Plan.
- 15 CALFED Bay-Delta Program. 2000b. Multi-species Conservation Strategy.
16 Final Programmatic Environmental Impact Statement/Environmental
17 Impact Report.
- 18 CALFED. 2004. Environmental Water Program Pilot Flow Augmentation
19 Project: Concept Proposal for Flow Acquisition on Lower Clear Creek.
20 August.
- 21 CALFED Bay-Delta Program. 2007. Green Sturgeon (*Acipenser medirostris*).
22 In Delta Regional Ecosystem Restoration Implementation Plan. Draft
23 Report.
- 24 CalFish (California Fish). 2014. Fish Species by Location – ‘Lake Piru-Piru
25 Creek’. California Fish Site accessed October 30, 2014.
26 <http://calfish.ucdavis.edu/>
- 27 CA Lakes. 2014. Lake Piru Fishing. California’s Greatest Lakes. Site accessed
28 October 30, 2014.
29 http://www.californiasgreatestlakes.com/piru/piru_fishing.html
- 30 Carey, M.P., Sanderson, B.L., Barnas, K.A., and Olden, J.D. 2012. Native
31 invaders – challenges for science, management, policy, and society. *Fron.*
32 *Eco. Environ.* 10(7):373-381.
- 33 Castillo et al. (Castillo, G., J. Morinaka, J. Lindberg, R. Fujimura, B. Baskerville-
34 Bridges, J. Hobbs, G. Tigan, L. Ellison). 2012. Pre-screen Loss and Fish
35 Facility Efficiency for Delta Smelt at the South Delta’s State Water
36 Project, California. *San Francisco Estuary and Watershed Science*, 10(4).
- 37 Cavallo et al. (Cavallo, B., J. Merz, and J. Setka). 2012. Effects of Predator and
38 Flow Manipulation on Chinook Salmon (*Oncorhynchus tshawytscha*)
39 Survival in an Imperiled Estuary. *Environmental Biology of Fishes*: doi.
40 10.1007/s10641-012-9993-5

Chapter 9: Fish and Aquatic Resources

- 1 CCTT (Clear Creek Technical Team). 2014. 2014 Clear Creek Technical Team
2 Report for the Coordinated Long-Term Operation Biological Opinions
3 Integrated Annual Review. October 3.
- 4 CCWA (Central Coastal Water Authority). 2013. Central Coast Water Authority
5 Fiscal Year 2013/14 Budget. April 25.
- 6 Cech et al. (Cech, J. J., S. J. Mitchell, and T. E. Wragg). 1984. Comparative
7 Growth of Juvenile White Sturgeon and Striped Bass: effects of
8 Temperature and Hypoxia. *Estuaries* 7: 12-18.
- 9 CHSRG (California Hatchery Scientific Review Group). 2012. California
10 Hatchery Review Report. Prepared for the US Fish and Wildlife Service
11 and Pacific States Marine Fisheries Commission. June.
- 12 City of Hemet. 2012. City of Hemet General Plan 2030, Environmental Impact
13 Report, Final. January 12.
- 14 City of San Diego. 2014a. El Capitan Reservoir. Site accessed October 30, 2014
15 <http://www.sandiego.gov/water/recreation/reservoirs/lowerotay.shtml>
- 16 City of San Diego. 2014b. Lower Otay Reservoir. Site accessed May 29.
17 <http://www.sandiego.gov/water/recreation/reservoirs/elcapitan.shtml>
- 18 Clemens et al. (Clemens, B. J., M. G. Mesa, R. J. Magie, D. A. Young, and C. B.
19 Schreck). 2012. Pre-spawning Migration of Adult Pacific Lamprey,
20 *Entosphenus tridentatus*, in the Willamette River, Oregon, U.S.A.
21 *Environmental Biology of Fishes* 93: 245-254.
- 22 Cooke et al. (Cooke, S. J., S. G. Hinch, G. T. Crossin, D. A. Patterson, K. A.
23 English, M. C. Healy, J. M. Shrimpton, G. Van Der Kraak, and A. P.
24 Farrell). 2006. Mechanistic Basis of Individual Mortality in Pacific
25 salmon during spawning migrations. *Ecology* 87: 1575–1586.
- 26 County of San Bernardino. 2011. County of San Bernardino General Plan
27 Amendment and Greenhouse Gas Reduction Plan, Draft Supplemental
28 Program Environmental Impact Report. March.
- 29 CRA (California Resources Agency). 2005. Delta Smelt Action Plan.
- 30 CSP (California State Parks). 2010. Silverwood Lake State Recreation Area
31 Nature Center Interpretive Project Plan. April.
- 32 CSP (California State Parks). 2013. Bethany Reservoir State Recreation Area.
- 33 Cunningham, C., N. Hendrix, E. Dusek-Jennings, R. Lessard, and R. Hilborn.
34 2015. Delta Chinook Final Report to the Delta Science Panel. Available
35 online:
36 deltacouncil.ca.gov/sites/default/files/2039%20Final%20Report.pdf
- 37 CVPIA (Central Valley Project Improvement Act). 2014. Draft CVPIA Fiscal
38 Year 2015 Annual Work Plan, Clear Creek Restoration, CVPIA Section
39 3406 (b)(12).

- 1 CVRWQCB (Central Valley Regional Water Quality Control Board). 2002.
2 Upper Sacramento River TMDL for Cadmium, Copper, and Zinc. Final
3 Report.
- 4 CVRWQCB (Central Valley Regional Water Quality Control Board). 2011.
5 Water Quality Control Plan (Basin Plan) for the California Water Quality
6 Control Board Central Valley Region, 4th Edition, Revised October 2011,
7 with Approved Amendments: The Sacramento River Basin and the San
8 Joaquin River Basin.
- 9 Davis et al. (Davis, J. A., D. Yee, J. N. Collins, S. E. Schwarzbach, and S. N.
10 Luoma). 2003. Potential for Increased Mercury Accumulation in the
11 Estuary Food Web. *San Francisco Estuary and Watershed Science* 1.
- 12 Dege, M., and L. R. Brown. 2004. Effect of Outflow on Spring and Summertime
13 Distribution and Abundance of Larval and Juvenile Fishes in the Upper
14 San Francisco Estuary. Early life history of fishes in the San Francisco
15 Estuary and watershed. Edited by F. Feyrer, L. R. Brown, R. L. Brown,
16 and J.J. Orsi, 49-66. *American Fisheries Society Symposium* 39.
- 17 Del Rosario et al. (Del Rosario, R. B., Y. J. Redler, K. Newman, P. L. Brandes, T.
18 Sommer, K. Reece, R. Vincik). 2013. Migration Patterns of Juvenile
19 winter-run-sized Chinook Salmon (*Oncorhynchus tshawytscha*) through
20 the Sacramento–San Joaquin Delta. *San Francisco Estuary and Watershed
21 Science*, 11(1).
- 22 DFG (California Department of Fish and Game [now known as Department of
23 Fish and Wildlife]). 1985. Status of winter-run Chinook Salmon,
24 *Oncorhynchus tshawytscha*, in the Sacramento River. January 25.
- 25 DFG (California Department of Fish and Game [now known as Department of
26 Fish and Wildlife]). 1992. A Re-examination of Factors Affecting
27 Striped Bass Abundance in the Sacramento-San Joaquin estuary. WRINT-
28 DFG-Exhibit 2. Entered by the California Department of Fish and Game
29 for the State Water Resources Control Board 1992 Water Rights Phase of
30 the Bay-Delta Estuary Proceedings.
- 31 DFG (California Department of Fish and Game [now known as Department of
32 Fish and Wildlife]). 1998a. Age, Growth, And Life History Of Klamath
33 River Basin steelhead trout (*Oncorhynchus mykiss irideus*) as Determined
34 from Scale Analysis. Inland Fisheries Division. Administration
35 Report 98-3.
- 36 DFG (California Department of Fish and Game [now known as Department of
37 Fish and Wildlife]). 1998b. A Status Review of the spring-run Chinook
38 Salmon in the Sacramento River Drainage. Candidate species status
39 report 98-1. Report to the Fish and Game Commission.
- 40 DFG (California Department of Fish and Game [now known as Department of
41 Fish and Wildlife]). 2002a. California Department of Fish and Game
42 Comments to NMFS Regarding Green Sturgeon Listing.

Chapter 9: Fish and Aquatic Resources

- 1 DFG (California Department of Fish and Game [now known as Department of
2 Fish and Wildlife]). 2002b. Fishing California's Sacramento Valley–
3 Central Sierra Region. October.
- 4 DFG (California Department of Fish and Game [now known as Department of
5 Fish and Wildlife]). 2007. San Joaquin River Fishery and Aquatic
6 Resources Inventory. Final Report September 2003–September 2005.
- 7 DFG (California Department of Fish and Game [now known as Department of
8 Fish and Wildlife]). 2008a. California Aquatic Invasive Species
9 Management Plan. State of California Resources Agency.
- 10 DFG (California Department of Fish and Game [now known as Department of
11 Fish and Wildlife]). 2008b. 2007 Sturgeon Fishing Report Card:
12 Preliminary Data Report.
- 13 DFG (California Department of Fish and Game [now known as Department of
14 Fish and Wildlife]). 2009a. A Status Review of the Longfin Smelt
15 (*Spirinchus thaleichthys*) in California. Report to the Fish and Game
16 Commission. January 23.
- 17 DFG (California Department of Fish and Game [now known as Department of
18 Fish and Wildlife]). 2009b. 2008 Sturgeon Fishing Report Card:
19 Preliminary Data Report. June 17.
- 20 DFG (California Department of Fish and Game [now known as Department of
21 Fish and Wildlife]). 2010. 2009 Sturgeon Fishing Report Card:
22 Preliminary Data Report. March 29.
- 23 DFG (California Department of Fish and Game [now known as Department of
24 Fish and Wildlife]). 2011. 2010 Sturgeon Fishing Report Card:
25 Preliminary Data Report. April 20.
- 26 DFG (California Department of Fish and Game [now known as Department of
27 Fish and Wildlife]). 2012a. Central Valley Chinook Salmon In-River
28 Escapement Monitoring Plan. Fisheries Branch Administrative Report
29 Number: 2012-1. January.
- 30 DFG (California Department of Fish and Game [now known as Department of
31 Fish and Wildlife]). 2012b. 2011 Sturgeon Fishing Report Card:
32 Preliminary Data Report. March 23.
- 33 DFG and USFWS (California Department of Fish and Game [now known as
34 Department of Fish and Wildlife] and U.S. Fish and Wildlife Service).
35 2010. Hatchery and Stocking Program Environmental Impact
36 Report/Environmental Impact Statement. Final. January.
- 37 DFW (California Department of Fish and Wildlife). 2013b. 2012 Sturgeon
38 Fishing Report Card: Preliminary Data Report. July 12.
- 39 DFW (California Department of Fish and Wildlife). 2014a. 2014. Annual
40 Report Trinity River Basin Salmon and Steelhead Monitoring Project:
41 Chinook and Coho Salmon and Fall Midwater Trawl-run Steelhead

- 1 Run-Size Estimates Using Mark-Recapture Methods 2013 Annual Fish
 2 Abundance Summary received by Scott Wilson, Regional Manager,
 3 Region 3/California Department of Wildlife via technical memorandum
 4 from Dave Contreras, Environmental Scientist/California Department of
 5 Wildlife. 2014. -2014 Season. August 2014. 92 pp.
- 6 DFW (California Department of Fish and Wildlife). 2014b. Trends in
 7 Abundance of Selected Species, dated January 15, 2014. Site accessed
 8 July 17, 2015. <http://www.dfg.ca.gov/delta/data/fmwt/Indices/>.
- 9 DFW (California Department of Fish and Wildlife). 2015. GrandTab California
 10 Central Valley Chinook Population Database Report compiled on April
 11 15, 2015. Site accessed 2015. Available at:
 12 <https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=84381&inline=1>.
- 13 DOI (U.S. Department of the Interior). 2000. Record of Decision for the Trinity
 14 River Mainstem Fishery Restoration Environmental Impact
 15 Statement/Environmental Impact Report.
- 16 DOI (U.S. Department of the Interior). 2012. Assessment of Action in the
 17 Central Valley of California between 1992 and 2011.
- 18 DOI and DFG (Department of the Interior and California Department of Fish and
 19 Game [now known as Department of Fish and Wildlife]). 2012. Klamath
 20 Facilities Removal Final Environmental Impact Statement/Environmental
 21 Impact Report. December.
- 22 Dugdale et al. (Dugdale, R. C., F. P. Wilkerson, V. E. Hogue, and A. Marchi).
 23 2007. The Role of Ammonium and Nitrate in Spring Bloom Development
 24 in San Francisco Bay. *Estuarine, Coastal and Shelf Science* 73: 17-29.
- 25 Durand, J. 2008. Delta foodweb conceptual model. Delta Regional Ecosystem
 26 Restoration Implementation Plan (DRERIP). Sacramento, California.
- 27 DVM (Diamond Valley Marina). 2014. Diamond Valley Lake Fishing. Site
 28 accessed October 30, 2014. <http://www.dvmarina.com/fishing/index.php>.
- 29 DWR (California Department of Water Resources). 1980. Upper Sacramento
 30 River Spawning Gravel Study Executive Summary. December.
- 31 DWR (California Department of Water Resources). 1985. Sacramento River
 32 Spawning Gravel Studies, Executive Summary. June.
- 33 DWR (California Department of Water Resources). 1987. Recreation Use
 34 Survey of San Luis Reservoir, O'Neill Forebay, and Los Banos Detention
 35 Reservoir, Merced County, 1986.
- 36 DWR (California Department of Water Resources). 1994. Sacramento River
 37 Bank Erosion Investigation. Memorandum Progress Report.
 38 September 23.
- 39 DWR (California Department of Water Resources). 1997. Quail Lake. July.

Chapter 9: Fish and Aquatic Resources

- 1 DWR (California Department of Water Resources). 2000a. Suisun Marsh
2 Monitoring Program. Reference Guide. Version 2. June.
- 3 DWR (California Department of Water Resources). 200b. Pyramid Lake. May.
- 4 DWR (California Department of Water Resources). 2003a. Fish Distribution in
5 the Feather River downstream of Thermalito diversion dam to the
6 Confluence with the Sacramento River. SP-F3.2 Task 1 and F21 Task 2.
7 Draft Report. Oroville Facilities Relicensing FERC Project No. 2100.
- 8 DWR (California Department of Water Resources). 2003b. Final Assessment of
9 Sturgeon Distribution and Habitat Use. Oroville Facilities Relicensing
10 FERC Project No. 2100. SP-F3.2 Task 3a.
- 11 DWR (California Department of Water Resources). 2004a. Assessment of
12 Potential Project Effects on Splittail Habitat. SP-F3.2 Task 3B. Final
13 Report. Oroville Facilities Relicensing, FERC Project No. 2100.
- 14 DWR (California Department of Water Resources). 2004b. Evaluation of Project
15 Effects on Instream Flows and Fish Habitat. SP F-16 Phase 2 Report.
16 Oroville Facilities Relicensing, FERC Project No. 2100.
- 17 DWR (California Department of Water Resources). 2004c. Evaluation of Project
18 Effects on Fish Disease. SP-F2. Oroville Facilities Relicensing, FERC
19 Project No. 2100.
- 20 DWR (California Department of Water Resources). 2004d. Draft Environmental
21 Impact Report for the Simulation of Natural Flows in Middle Piru Creek.
22 November.
- 23 DWR (California Department of Water Resources). 2004e. Oroville Facilities
24 Relicensing, Final report: Evaluation of methods and devices used in the
25 capture, sorting, holding, transport, and release of fish SP-F15, Task 3.
- 26 DWR (California Department of Water Resources). 2005. Fish passage
27 Improvement, an Element of CALFED's Ecosystem Restoration Program.
28 Bulletin 250.
- 29 DWR (California Department of Water Resources). 2006. Settlement Agreement
30 for Licensing of the Oroville Facilities, FERC Project No. 2100. March.
- 31 DWR (California Department of Water Resources). 2007. Monterey Plus Draft
32 Environmental Impact Report. October.
- 33 DWR (California Department of Water Resources). 2009a. Central Valley
34 spring-run Chinook Salmon and steelhead in the Sacramento River Basin.
35 Background Report.
- 36 DWR (California Department of Water Resources). 2009b. East Branch
37 Extension Phase I Improvements Project, Draft Supplemental
38 Environmental Impact Report No. 2. March.
- 39 DWR (California Department of Water Resources). 2010a. Perris Dam
40 Remediation Program, Draft Environmental Impact Report. January.

- 1 DWR (California Department of Water Resources). 2010b. Release Site
 2 Predation Study. Fishery Improvements Section, Bay-Delta Office.
 3 Sacramento, California.
- 4 DWR (California Department of Water Resources). 2012. Implementation
 5 Strategy: Habitat Restoration and Other Actions for Listed Delta Fish.
 6 Fish Restoration Program Agreement.
- 7 DWR (California Department of Water Resources). 2013a. Thermalito Facilities.
 8 Site accessed March 4, 2013.
 9 <http://www.water.ca.gov/swp/facilities/Oroville/thermalito.cfm>
- 10 DWR (California Department of Water Resources). 2013b. Upper Feather River
 11 Lakes. April.
- 12 DWR et al. (California Department of Water Resources, Yuba County Water
 13 Agency, Bureau of Reclamation). 2007. Draft Environmental Impact
 14 Report/Environmental Impact Statement for the Proposed Lower Yuba
 15 River Accord. June.
- 16 DWR et al. (California Department of Water Resources, Bureau of Reclamation,
 17 U.S. Fish and Wildlife Service, and National Marine Fisheries Service).
 18 2013. Environmental Impact Report/ Environmental Impact Statement for
 19 the Bay Delta Conservation Plan. Draft. December.
- 20 Earley et al. (Earley, J. T., D. J. Colby, and M. R. Brown). 2010. Juvenile
 21 Salmonid Monitoring in Clear Creek, California, from October 2008
 22 through September 2009. U.S. Fish and Wildlife Service.
- 23 EBMUD (East Bay Municipal Utility District). 1999. East Bay Watershed
 24 Master Plan. February 29, 1996 (Revised March 15, 1999). March 15.
- 25 EBMUD (East Bay Municipal Utility District). 2012. Mokelumne River
 26 hatchery fish information received by Jose Setka, Fisheries and Wildlife
 27 Division.
- 28 EBMUD (East Bay Municipal Utility District). 2013. Draft Environmental
 29 Impact Report Chabot Dam Seismic Upgrade. December.
- 30 EBMUD (East Bay Municipal Utility District). 2014. San Pablo Reservoir. Site
 31 accessed October 30, 2014. [https://www.ebmud.com/recreation/san-](https://www.ebmud.com/recreation/san-pablo-reservoir)
 32 [pablo-reservoir](https://www.ebmud.com/recreation/san-pablo-reservoir).
- 33 EBPRD (East Bay Parks and Recreation District). 2014. Del Valle Regional
 34 Park. Site accessed April 18, 2014.
 35 http://www.ebparks.org/parks/del_valle.
- 36 Edmunds, J. L., K. M. Kuivila, B. E. Cole, and J. E. Cloern. 1999. Do
 37 Herbicides Impair Phytoplankton Primary Production in the Sacramento-
 38 San Joaquin River Delta? In Proceedings of the Technical Meeting: Toxic
 39 Substances Hydrology Program, Volume 2: Contamination of Hydrologic
 40 Systems and Related Ecosystems. U.S. Geological Survey Water
 41 Resources Investigation Report 99.4018B.

- 1 Emmett et al. (Emmett, R. L., S. L. Stone, S. A. Hinton, and M. E. Monaco).
2 1991. Distribution and Abundance of Fishes and Invertebrates in West
3 Coast Estuaries. Volume 2: Species Life History Summaries. Estuarine
4 Living Marine Resources Program Report No. 8. NOAA/NOS Strategic
5 Environmental Assessments Division, Rockville, Maryland.
- 6 Engle et al. (Engle, J., C. Enos, K. McGourty, T. Porter, B. Reed, J. Scammell-
7 Tinling, K. Schaeffer, S. Siegel, and E. Crumb). 2010. Suisun Marsh
8 Tidal Marsh and Aquatic Habitats Conceptual Model. Chapter 2: Aquatic
9 Environment. Final Review Draft. Suisun Marsh Habitat Management,
10 Restoration, and Preservation Plan.
- 11 Erickson et al. (Erickson, D. L., J. A. North, J. E. Hightower, J. Weber, and L.
12 Lauck). 2002. Movement and Habitat Use of Green Sturgeon *Acipenser*
13 *medirostris* in the Rogue River, Oregon, USA. *Journal of Applied*
14 *Ichthyology* 18: 565-569.
- 15 Everest, L. 1997. Summer steelhead Surveys, North Fork Trinity River, Trinity
16 County, California, 1978–1997. USDA Forest Service, Weaverville
17 Ranger District, Shasta-Trinity National Forests.
- 18 Farley, T. C. 1966. Striped Bass, *Roccus Saxatilis*, Spawning in the Sacramento–
19 San Joaquin River Systems during 1963 and 1964. In J. L. Turner and D.
20 W. Kelley (eds.), *Ecological Studies of the Sacramento–San Joaquin*
21 *Estuary, Part II – Fishes of the Delta*. California Department of Fish and
22 Game, Fish Bulletin 136.
- 23 Faulkner et al. 2010 Trap and Haul from Cramer
- 24 FERC (Federal Energy Regulatory Commission). 2007a. Final Environmental
25 Impact Statement for Hydropower License, Klamath Hydroelectric
26 Project, FERC Project No. 2082-027. FERC/EIS-0201F.
- 27 FERC (Federal Energy Regulatory Commission). 2007b. Final Environmental
28 Impact Statement for Hydropower License, Oroville Facilities, FERC
29 Project No. 2100-052, California.
- 30 FERC (Federal Energy Regulatory Commission). 2013. Draft Environmental
31 Impact Statement for the Drum-Spaulding Hydroelectric Project (Project
32 No. 2310-193) and Yuba-Bear Hydroelectric Project (Project No. 2266-
33 102). May.
- 34 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
35 *General Information – Licensing*. Site accessed April 29, 2015.
36 <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>
- 37 Feyrer, F. 2004. Ecological Segregation of Native and Alien Larval Fish
38 Assemblages in the Southern Sacramento-San Joaquin Delta. *Early Life*
39 *History of Fishes in the San Francisco Estuary and Watershed*.
40 Symposium 39. Edited by F. Feyrer, L. R. Brown, R. L. Brown, and J. J.
41 Orsi, 67-79. American Fisheries Society, Bethesda, Maryland.

- 1 Feyrer, F., and M. Healey. 2003. Fish Community Structure and Environmental
2 Correlates in the Highly Altered Southern Sacramento-San Joaquin Delta.
3 *Environmental Biology of Fishes* 66: 123-132.
- 4 Feyrer et al. (Feyrer, F., B. Herbold, S. A. Matern, and P. B. Moyle). 2003.
5 Dietary Shifts in a Stressed Fish Assemblage: Consequences of a Bivalve
6 Invasion in the San Francisco Estuary. *Environmental Biology of Fishes*
7 67: 277-288.
- 8 Feyrer et al. (Feyrer, F., T. R. Sommer, and R. D. Baxter). 2005. Spatial-
9 Temporal Distribution and Habitat Associations of Age-0 Splittail in the
10 Lower San Francisco Estuary Watershed. *Copeia*, 2005(1), pp. 159-168.
- 11 Feyrer et al. (Feyrer, F., T. Sommer, and W. Harrell). 2006. Managing Floodplain
12 Inundation for Native Fish: Production Dynamics of Age-0 Splitail
13 (*Pogonichthys macrolepidotus*) in California's Yolo Bypass.
14 *Hydrobiologia* 573: 213–226.
- 15 Feyrer et al. (Feyrer, F., M. L. Nobriga, and T. R. Sommer). 2007. Multi-decadal
16 Trends for Three Declining Fish Species: Habitat Patterns and
17 Mechanisms in the San Francisco Estuary, California, U.S.A. *Canadian*
18 *Journal of Fisheries and Aquatic Sciences* 64: 723-734.
- 19 Feyrer et al. (Feyrer, F., K. Newman, M. Nobriga, and T. Sommer). 2010.
20 Modeling the Effects of Future Freshwater Flow on the Abiotic Habitat of
21 an Imperiled Estuarine Fish. *Estuaries and Coasts* 34: 120-128.
- 22 Fish, M. A. 2010. A White Sturgeon Year-Class Index for the San Francisco
23 Estuary and Its Relation to Delta Outflow. IEP Newsletter. Vol. 23,
24 Number 2, Spring.
- 25 FISHBIO (FISHBIO Environmental, LLC). 2007. 2007 Stanislaus River data
26 report. Final Data.
- 27 FISHBIO (FISHBIO Environmental, LLC). 2010a. Fall/Winter Migration
28 Monitoring at the Tuolumne River Weir 2009/10 Annual Report.
29 Prepared For: Turlock Irrigation District and Modesto Irrigation District.
30 March.
- 31 FISHBIO (FISHBIO Environmental, LLC). 2010b. FISHBIO Fall-Run Chinook
32 Salmon Update. Posted on the FISHBIO blog on December 15, 2010.
33 Accessed at [http://fishbio.com/field-notes/population-dynamics/fishbio-](http://fishbio.com/field-notes/population-dynamics/fishbio-fall-run-chinook-salmon-update-2)
34 [fall-run-chinook-salmon-update-2](http://fishbio.com/field-notes/population-dynamics/fishbio-fall-run-chinook-salmon-update-2) on October 13, 2015.
- 35 FISHBIO (FISHBIO Environmental, LLC). 2011. Fall/Winter Migration
36 Monitoring at the Tuolumne River Weir 2010 Annual Report. Prepared
37 For: Turlock Irrigation District and Modesto Irrigation District. March.
- 38 FISHBIO (FISHBIO Environmental, LLC). 2013a. 2013 Seine Report and
39 Summary Update, Tuolumne River. Prepared For: Turlock Irrigation
40 District and Modesto Irrigation District. March.

- 1 FISHBIO (FISHBIO Environmental, LLC). 2013b. Outmigrant Trapping of
2 Juvenile Salmon in the Lower Tuolumne River, 2013. Prepared For:
3 Turlock Irrigation District and Modesto Irrigation District. March.
- 4 Fisher, F. W. 1994. Past and Present Status of Central Valley Chinook Salmon.
5 Conservation Biology 8: 870–873.
- 6 Foott et al. (Foott, J. S., K. True, and R. Stone). 2006. Histological Evaluation
7 and Viral Survey of Juvenile Longfin Smelt (*Spirinchus thaleichthys*) and
8 Threadfin Shad (*Dorosoma petenense*) collected in the Sacramento-San
9 Joaquin River Delta, April-October 2006.
- 10 Ford, J.K.B., and G.M. Ellis. 2006. Selective foraging by fish-eating killer
11 whales *Orcinus orca* in British Columbia. Marine Ecology Progress
12 Series. 316:185-199.
- 13 Franks, Sierra E.; & Lackey, Robert T. 2015. Forecasting the Most Likely Status
14 of Wild Salmon in the California Central Valley in 2100. San Francisco
15 Estuary and Watershed Science, 13(1). jmie_sfews_25999. Retrieved
16 from: <http://escholarship.org/uc/item/3vt5z15p>
- 17 Frantzich, J. 2014. Yolo Bypass as a Source of Delta Phytoplankton: Not Just a
18 Legend of the Fall? Presented at the Interagency Ecological Program 2014
19 Annual Workshop, Friday February 28, 2014. Site accessed
20 May 19, 2015. <http://www.water.ca.gov/aes/staff/frantzich.cfm>.
- 21 Gingras, M. 1997. Mark/Recapture Experiments at Clifton Court Forebay to
22 Estimate Pre-screening Loss to Juvenile Fishes, 1976-1993. Technical
23 Report 55. Interagency Ecological Program for the San Francisco
24 Bay/Delta Estuary. September.
- 25 Glibert, P. M. 2010. Long-Term Changes in Nutrient Loading and Stoichiometry
26 and Their Relationships with Changes in the Food Web and Dominant
27 Pelagic Fish Species in the San Francisco Estuary, California. Reviews in
28 Fisheries Science, 18: 2, 211 — 232. First published on 27 August 2010.
- 29 Glibert et al. (Glibert, P. M., D. Fullerton, J. M. Burkholder, J. C. Cornwell, and
30 T. M. Kana). 2011. Ecological Stoichiometry, Biogeochemical Cycling,
31 Invasive Species, and Aquatic Food Webs: San Francisco Estuary and
32 Comparative Systems. Reviews in Fisheries Science, 19:4, 358-417.
- 33 Glibert et al. (Glibert, P. M., F. P. Wilkerson, R. C. Dugdale, A. E. Parker, J.
34 Alexander, S. Blaser, and S. Murasko). 2014. Phytoplankton
35 communities from San Francisco Bay Delta respond differently to
36 oxidized and reduced nitrogen substrates—even under conditions that
37 would otherwise suggest nitrogen sufficiency. Frontiers in Marine
38 Science, Vol 1, Article 17, 1-16.
- 39 Good et al. (Good, T. P., R. S. Waples, and P. Adams, editors). 2005. Updated
40 status of federally listed ESUs of West Coast salmon and steelhead.
41 Technical Memorandum NMFS-NWFSC-66.

- 1 Greene et al. (Greene, V. E., L. J. Sullivan, J. K. Thompson, W. J. Kimmerer).
 2 2011. Grazing Impact of the Invasive Clam *Corbula amurensis* on the
 3 Microplankton Assemblage of the Northern San Francisco Estuary.
 4 *Marine Ecology Progress Series* Vol. 431: 183–193, 2011.
- 5 Greenfield et al. (Greenfield, B. K., S. J. Teh, J. R. M. Ross, J. Hunt, G. H. Zhang,
 6 J. A. Davis, G. Ichikawa, D. Crane, S. O. Hung, D. F. Deng, F. C. Teh, P.
 7 G. Green). 2008. Contaminant Concentrations and Histopathological
 8 Effects in Sacramento Splittail (*Pogonichthys macrolepidotus*).
 9 *Environmental Contamination & Toxicology*, August, Vol. 55, Issue 2,
 10 p270-281.
- 11 Gregory, R. S., and C. D. Levings. 1998. Turbidity Reduces Predation on
 12 Migrating Juvenile Pacific Salmon. *Transactions of the American*
 13 *Fisheries Society* 127: 275–285.
- 14 Grimaldo et al. (Grimaldo, L. F., R. E. Miller, C. M. Peregrin, and Z. P.
 15 Hymanson). 2004. Spatial and Temporal Distribution of Native and
 16 Alien Ichthyoplankton in Three Habitat Types of the Sacramento-San
 17 Joaquin Delta. *American Fisheries Society Symposium* 39: 81-96.
- 18 Grimaldo et al. Grimaldo, L. F., T. Sommer, N. Van Ark, G. Jones, E. Holland, P.
 19 B. Moyle, B. Herbold, and P. Smith). 2009. Factors Affecting Fish
 20 Entrainment into Massive Water Diversions in a Freshwater Tidal Estuary:
 21 Can Fish Losses be Managed? *North American Journal of Fisheries*
 22 *Management* 29: 1253-1270.
- 23 Grimaldo et al. Grimaldo, L., R. E. Miller, C. M. Peregrin, and Z. Hymanson).
 24 2012. Fish Assemblages in Reference and Restored Tidal Freshwater
 25 Marshes of the San Francisco Estuary. *San Francisco Estuary and*
 26 *Watershed Science*, 10(1).
- 27 Grossmann et al. (Grossman, G. D., T. Essington, B. Johnson, J. Miller, N. E.
 28 Monsen, and T. N. Pearsons). 2013. Effects of Fish Predation on
 29 Salmonids in the Sacramento River-San Joaquin Delta and Associated
 30 Ecosystems. September 25.
- 31 Grover, A., A. Low, P. Ward, J. Smith, M. Mohr, D. Viele, and C. Tracy. 2004.
 32 Recommendations for developing fishery management objectives for
 33 Sacramento River winter Chinook and Sacramento River spring Chinook.
 34 Pacific Fishery Management Council Interagency Work Group, Progress
 35 Report, Portland, Oregon.
- 36 Gruber et al. (Gruber, J. J., Z. J. Jackson, and J. P. Van Eenennaam). 2012. 2011
 37 San Joaquin River Sturgeon Spawning Survey.
- 38 Hallock, R. J. 1989. Upper Sacramento River steelhead, *Oncorhynchus mykiss*,
 39 1952–1988. Report to the U.S. Fish and Wildlife Service, Red Bluff,
 40 California.
- 41 Hallock et al. (Hallock, R. J., W. F. Van Woert, and L. Shapovalov). 1961. An
 42 Evaluation of Stocking Hatchery-reared Steelhead Rainbow Trout (*Salmo*

- 1 gairdnerii gairdnerii) in the Sacramento River System. California
2 Department of Fish and Game Fish Bulletin 114: 1-74
- 3 Hallock et al. (Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr). 1970. Migrations
4 of Adult King Salmon, *Oncorhynchus tshawytscha*, in the San Joaquin
5 Delta. California Department of Fish and Game Bulletin 151: 1-92.
- 6 Hankin, D.G., and M.C. Healey. 1986. Dependence of exploitation rates for
7 maximum yield and stock collapse on age and sex structure of chinook
8 salmon stocks. *Can. J. Fish. Aquat. Sci.* 43: 1746-1759.
- 9 Hankin, D.G., J.W. Nicholas and T.W. Downey. 1993. Evidence for inheritance
10 of age of maturity in chinook salmon, *Onchorhynchus tshawytscha*. *Can.*
11 *J. fish. Aquat. Sci.* 50:347-358.
- 12 Hanni et al. (Hanni, J., B. Poytress, and H. N. Blalock-Herod). 2006. Spatial and
13 Temporal Distribution Patterns of Pacific and River Lamprey in the
14 Sacramento and San Joaquin Rivers and Delta. Poster. U.S. Fish and
15 Wildlife Service.
- 16 Hannon, J., and B. Deason. 2008. American River steelhead Spawning 2001–
17 2007. Bureau of Reclamation.
- 18 Hannon et al. (Hannon, J., M. Healey, and B. Deason). 2003. American River
19 steelhead Spawning 2001–2003. Bureau of Reclamation.
- 20 Hanson, C. H. 2001. Are Juvenile Chinook Salmon Entrained at Unscreened
21 Diversion in Direct Proportion to the Volume of Water Diverted?
22 Contributions to the Biology of Central Valley Salmonids. California
23 Department of Fish and Game Fish Bulletin 179: 331-342.
- 24 Hanson et al. (Hanson, M.B., Baird, R.W., Ford, J.K.B., Hempelmann, J.A., Van
25 Doornik, D.M., Candy, J.R., Emmons, C.K., Schorr, G.S., Gisborne, B.,
26 Ayles, K.L., Wasser, S.K., Balcomb, K.C., Balcomb-Bartok, K., Sneva,
27 J.G., and Ford, M.J.) 2010. Species and Stock Identification of Prey
28 Consumed by Endangered Southern Resident Killer Whales in their
29 Summer Range. *Endangered Species Research* 11: 69–82. doi:
30 10.3354/esr00263.
- 31 Hanson, M.B., R.W. Baird, C. Emmons, J. Hempelmann, G.S. Schorr, J. Sneva,
32 and D. Van. 2007. Summer diet and prey stock identification of the
33 fish-eating “southern resident” killer whales: Addressing a key recovery
34 need using fish scales, fecal samples, and genetic techniques. Abstract
35 from the 17th Biennial Conference on the Biology of Marine Mammals,
36 Capetown, South Africa. As cited in National Marine Fisheries Service
37 *Endangered Species Act Section 7 Consultation Final Biological Opinion*
38 *and Magnusen-Stevens Fishery Conservation and Management Act*
39 *Essential Fish Habitat Consultation, Implementation of National Flood*
40 *Insurance Program in the State of Washington, Phase One Document –*
41 *Puget Sound Region, September 22, 2008.*

- 1 Hardy, T. D. B., and R. M.C. Addley. 2001. Evaluation of Interim Instream
2 Flow Needs in the Klamath River. Phase II. Final report. Prepared for
3 U.S. Department of the Interior, Washington, D.C.
- 4 Harrell, W. C., and T. R. Sommer. 2003. Patterns of Adult Fish Use on
5 California's Yolo Bypass Floodplain. California Riparian Systems:
6 Processes and Floodplain Management, Ecology, and Restoration. 2001
7 Riparian Habitat and floodplains Conference Proceedings. Edited by P.
8 M. Faber, 88-93. Riparian Habitat Joint Venture.
- 9 Hassler, T. J. 1988. Species Profiles: Life Histories and Environmental
10 Requirements of Coast Fishes and Invertebrates (Pacific Southwest) –
11 Striped Bass. U.S. Fish and Wildlife Service Biological Report 82(11.82).
12 U.S. Army Corps of Engineers, TR EL-82-4.
- 13 Healey, M. C. 1991. Life History of Chinook Salmon (*Oncorhynchus*
14 *tshawytscha*). In: C Groot, L. Margolis (eds.). Pacific Salmon
15 Life-Histories. Vancouver: UBC Press. Pages 313–393.
- 16 Hennessy, A. and T. Enderlein. 2013. Zooplankton Monitoring 2011. IEP
17 Newsletter 26(1):23-30.
- 18 Herren, J. R., and S. S. Kawasaki. 2001. Inventory of Water Diversions in Four
19 Geographic Areas in California's Central Valley. Contributions to the
20 Biology of Central Valley Salmonids, Vol. 2. Edited by R. L. Brown.
21 California Department of Fish and Game. Fish Bulletin 179: 343-355.
- 22 Heublein, J. C. 2006. Migration of Green Sturgeon *Acipenser medirostris* in the
23 Sacramento River. Master's thesis. California State University, San
24 Francisco.
- 25 Heublein et al. (Heublein, J. C., J. T. Kelly, C. E. Crocker, A. P. Klimley, and S.
26 T. Lindley). 2009. Migration of Green Sturgeon *Acipenser medirostris* in
27 the Sacramento River. *Environmental Biology of Fishes* 84: 245-258.
- 28 Hilborn et al. (Hilborn, R., S.P. Cox, F.M.D. Gulland, D.G. Hankin, N.T. Hobbs,
29 D.E. Schindler, and A.W. Trites). 2012. The Effects of Salmon Fisheries
30 on Southern Resident Killer Whales: Final Report of the Independent
31 Science Panel. Prepared for National Marine Fisheries Service and
32 Fisheries and Oceans Canada.
- 33 Hill, A.M. 2010. Trinity River Tributaries steelhead Spawning Survey Report.
34 California Department of Fish and Game. July.
- 35 Honey et al. (Honey, K., R. Baxter, Z. Hymanson, T. Sommer, M. Gingras, and P.
36 Cadrett). 2004. IEP Long-term Fish Monitoring Program Element
37 Review. Interagency Ecological Program for the San Francisco Bay/Delta
38 Estuary. December.
- 39 IEP MAST (Interagency Ecological Program: Management, Analysis, and
40 Synthesis Team). 2015. An updated conceptual model of Delta Smelt
41 biology: our evolving understanding of an estuarine fish. Technical
42 Report 90. San Francisco Bay/Delta Estuary.

- 1 IRP (Independent Review Panel). 2010. Anderson, J. J., R. T. Kneib, S. A.
2 Luthy, and P. E. Smith. Report of the 2010 Independent Review Panel on
3 the Reasonable and Prudent Alternative (RPA) Actions Affecting the
4 Operations Criteria and Plan (OCAP) for State/Federal Water Operations.
5 Delta Stewardship Council/Delta Science Program.
- 6 IRP (Independent Review Panel). 2011. Anderson, J. J., J. A. Gore, R. T. Kneib,
7 M.S. Lorang, and J. Van Sickle. Report of the 2011 Independent Review
8 Panel (IRP) on the Implementation of Reasonable and Prudent
9 Alternative (RPA) Actions Affecting the Operations Criteria And Plan
10 (OCAP) for State/Federal Water Operations. Delta Stewardship
11 Council/Delta Science Program.
- 12 IRP (Independent Review Panel). 2012. Anderson, J. J., J. A. Gore, R. T. Kneib,
13 M.S. Lorang, J. M. Nestler, and J. Van Sickle. Report of the 2012 Delta
14 Science Program Independent Review Panel (IRP) on the Long-term
15 Operations Opinions (LOO) Annual Review. Delta Stewardship
16 Council/Delta Science Program.
- 17 IRP (Independent Review Panel). 2013. Anderson, J. J., J. A. Gore, R. T. Kneib,
18 M.S. Lorang, J. M. Nestler, and J. Van Sickle. Report of the 2013
19 Independent Review Panel (IRP) on the Long-term Operations Biological
20 Opinions (LOBO) Annual Review. Delta Stewardship Council/Delta
21 Science Program.
- 22 IRP (Independent Review Panel). 2014. Anderson, J. J., J. A. Gore, R. T. Kneib,
23 N. E. Monsen, J. M. Nestler, and J. Van Sickle. Independent Review Panel
24 (IRP) Report for the 2014 Long-term Operations Biological Opinions
25 (LOBO) Annual Science Review. Delta Stewardship Council/Delta
26 Science Program.
- 27 Israel, J. 2006. Determining Spawning Population Estimates for Green Sturgeon
28 with Microsatellite DNA. Presentation at the 2006 CALFED Science
29 Conference. Sacramento, California. As cited in Department of Water
30 Resources, *Programmatic Biological Assessment for the 2013-17*
31 *Temporary Barriers Project for National Marine Fisheries Service-*
32 *Managed Species*, October 2012.
- 33 Israel, J. A., and A. P. Klimley. 2008. Life History Conceptual Model for North
34 American Green Sturgeon (*Acipenser medirostris*). Prepared for DRERIP.
35 University of California, Davis, California.
- 36 Israel et al. (Israel, J. A., J. F. Cordes, M. A. Blumberg, and B.) May. 2004.
37 Geographic Patterns of Genetic Differentiation Among Collections of
38 Green Sturgeon. *North American Journal of Fisheries Management* 24:
39 922-931.
- 40 Israel et al. (Israel, J., A. Drauch, and M. Gingras). 2008. Life History
41 Conceptual Model for White Sturgeon (*Acipenser transmontanus*).
42 University of California, Davis and California Department of Fish and
43 Game, Stockton.

- 1 Jackson, Z. 2013. San Joaquin River Sturgeon Investigations – 2011/12 Season
2 Summary. IEP Quarterly Highlights. IEP Newsletter Vol. 26 (1): 4-6.
- 3 Jackson, Z. J., and J. P. Van Eenennaam. 2013. 2012 San Joaquin River
4 Sturgeon Spawning Survey. Stockton Fish and Wildlife Office,
5 Anadromous Fish Restoration Program, U.S. Fish and Wildlife Service.
- 6 Jassby et al. (Jassby, A. D., W. J. Kimmerer, S. G. Monismith, C. Armor, J. E.
7 Cloern, T. M. Powell, J. R. Schubel, and T. J. Vendlinski). 1995.
8 Isohaline Position as a Habitat Indicator for Estuarine Populations.
9 Ecological Applications 5: 272–289.
- 10 Jassby et al. (Jassby, A. D., J. E. Cloern, and B. E. Cole). 2002. Annual Primary
11 Production: Patterns and Mechanisms of Change in a Nutrient-rich Tidal
12 Ecosystem. Limnology and Oceanography 47: 698-712.
- 13 Johnston, S., and K. Kumagai. 2012. Steps Toward Evaluating Fish Predation in
14 the Sacramento River Delta. HTI Hydroacoustic Technology, Inc. Poster
15 for 7th Biennial Bay-Delta Science Conference.
- 16 Keefer, M.L., C.C. Caudill, C.A Peery, and S.R. Lee. 2008. Transporting juvenile
17 salmonids around dams impairs adult migration. Ecological Applications
18 18:1888-1900.
- 19 Kelly et al. (Kelly, J. T., A. P. Klimley, and C. E. Crocker). 2007. Movements of
20 Green Sturgeon, *Acipenser medirostris*, in the San Francisco Bay Estuary,
21 California. Environmental Biology of Fishes 79: 281-295.
- 22 Kennedy, T., and T. Cannon. 2005. Stanislaus River Salmonid Density and
23 Distribution Survey Report (2002-2004). Final Draft. Prepared for the
24 Bureau of Reclamation by the Fishery Foundation of California. October.
- 25 Kimmerer, W. J. 2002. Effects of Freshwater Flow on Abundance of Estuarine
26 Organisms: Physical Effects or Trophic Linkages. Marine Ecology
27 Progress Series 243: 39-55.
- 28 Kimmerer, W. J. 2004. Open Water Processes of the San Francisco Estuary:
29 from Physical Forcing to Biological Responses. San Francisco Estuary
30 and Watershed Science 2 (1).
- 31 Kimmerer, W. J. 2008. Losses of Sacramento River Chinook Salmon and Delta
32 Smelt (*Hypomesus transpacificus*) to Entrainment in Water Diversions in
33 the Sacramento-San Joaquin Delta. San Francisco Estuary and Watershed
34 Science. Vol. 6, Issue 2 (June), Article 2.
- 35 Kimmerer, W. J. 2011. Modeling Delta Smelt Losses at the South Delta Export
36 Facilities. San Francisco Estuary and Watershed Science, 9(1). San
37 Francisco Estuary and Watershed Science, John Muir Institute of the
38 Environment, UC Davis. <http://escholarship.org/uc/item/0rd2n5vb>.
- 39 Kimmerer, W. J., and M. Nobriga. 2008. Investigating Particle Transport and
40 Fate in the Sacramento San Joaquin Delta Using a Particle Tracking
41 Model. San Francisco Estuary and Watershed Science, 6(1).

- 1 Kimmerer et al. (Kimmerer, W. J., J. R. Burau, W. A. Bennett). 1998. Tidally
2 Oriented Vertical Migration and Position Maintenance of Zooplankton in
3 a Temperate Estuary. *Limnol. Oceanogr.*, 43(7), 1998, 1697-1709.
- 4 Kimmerer et al. (Kimmerer, W. J., J. H. Cowan, Jr., L. W. Miller, and K. A.
5 Rose). 2000. Analysis of an Estuarine Striped Bass (*Morone saxatilis*)
6 Population: Influence of Density-dependent Mortality Between
7 Metamorphosis and Recruitment. *Canadian Journal of Fisheries and*
8 *Aquatic Sciences* 57: 478-486.
- 9 Kimmerer, W. J. 2002a. Physical, biological, and management responses to
10 variable freshwater flow into the San Francisco Estuary. *Estuaries* 25:
11 1275–1290.
- 12 Kimmerer, W.J. 2002b. Effects of freshwater flow on abundance of estuarine
13 organisms: physical effects or trophic linkages. *Marine Ecology Progress*
14 *Series* 243:39–55.
- 15 Kimmerer et al. (Kimmerer, W. J., J. H. Cowan, Jr., L. W. Miller, and K. A.
16 Rose). 2001. Analysis of an Estuarine Striped Bass Population: Effects of
17 Environmental Conditions during Early Life. *Estuaries*, Vol. 24, No. 4, p.
18 557-575. August.
- 19 Kimmerer et al. (Kimmerer, W. J., N. Ferm, M. H. Nicolini, C. Penalva). 2005.
20 Chronic Food Limitation of Egg Production in Populations of Copepods of
21 the Genus *Acartia* in the San Francisco Estuary. *Estuaries*, Vol. 28, No. 4,
22 p. 541-550. August.
- 23 Kimmerer et al. (Kimmerer, W., L. Brown, S. Culberson, P. Moyle, M. Nobriga,
24 and J. Thompson). 2008. Aquatic Ecosystems. *The State of Bay-Delta*
25 *Science*. Edited by M. Healey, 73-101. CALFED Science Program.
- 26 Kimmerer et al. (Kimmerer, W. J., E. S. Gross, and M. L. MacWilliams). 2009.
27 Is the Reponse of Estuarine Nekton to Freshwater Flow in the San
28 Francisco Estuary Explained by Variation in Habitat Volume? *Estuaries*
29 *and Coasts*, 32:375-389. Doi 10.1007/s12237-008-9124-x.
- 30 Kimmerer et al. (Kimmerer, W. J., M. L. MacWilliams, E. S. Gross). 2013.
31 Variation of Fish Habitat and Extent of the Low-Salinity Zone with
32 Freshwater Flow in the San Francisco Estuary. *San Francisco Estuary and*
33 *Watershed Science*, 11(4). *San Francisco Estuary and Watershed Science*.
- 34 Kjelson, M. A., and P. L. Brandes. 1989. The Use of Smolt Survival Estimates to
35 Quantify the Effects of Habitat Changes on Salmonid Stocks in the
36 Sacramento-San Joaquin Rivers, California. *Proceedings of the National*
37 *Workshop on Effects of Habitat Alteration on Salmonid Stocks*. Eds. C. D.
38 Levings, L. B. Holtby, and M. A. Henderson. *Canadian Special S*
39 *publication of Fisheries and Aquatic Sciences* 105, p. 100-115.
- 40 Kjelson et al. (Kjelson, M. A., P. F. Raquel, and F. W. Fisher). 1981. Influences
41 of Freshwater Inflow on Chinook Salmon (*Oncorhynchus tshawytscha*) in
42 the Sacramento-San Joaquin Estuary. Edited by R. D. Cross and D. L.

- 1 Williams, 88-108. Proceedings of the National Symposium on Freshwater
2 Inflow to Estuaries, FWS/ OBS-81/04. U.S. Fish and Wildlife Service,
3 Washington, D.C.
- 4 Klimley et al. (Klimley, A. P., P. J. Allen, J. A. Israel, and J. T. Kelly). 2007.
5 The Green Sturgeon and Its Environment: Introduction. Environmental
6 Biology of Fishes 79: 187-190.
- 7 Kogut, N. 2008. Overbite clam, *Corbula amurensis*, Defecated Alive by White
8 Sturgeon, *Acipenser transmontanus*. California Fish and Game 94:
9 143-149.
- 10 Kohlhorst, D. W. 1976. Sturgeon Spawning in the Sacramento River, as
11 Determined by Distribution of Larvae. California Fish and Game Bulletin
12 62: 32-40.
- 13 Kohlhorst et al. (Kohlhorst, D. W., L. W. Botsford, J. S. Brennan, and G. M.
14 Cailliet). 1991. Aspects of the Structure and Dynamics of an Exploited
15 Central California Population of White Sturgeon (*Acipenser*
16 *transmontanus*). *Acipenser*. Edited by P. Williot, 277-293. CEMAGREF,
17 Bordeaux, France.
- 18 Kolar, C.S., Courtneay, W.R. Jr, and Nico, L.G. 2010. Managing undesired and
19 invading fishes. In Hubert, W.A. and Quist, M.C. (eds.). Inland fisheries
20 management in North America. Third Edition. Am. Fish. Soc., Bethesda,
21 MD. p 213-260.
- 22 Kondolf et al. (Kondolf, G.M., J. C. Vick, and T. M. Ramirez). 1996. Salmon
23 Spawning Habitat Rehabilitation in the Merced, Tuolumne, and Stanislaus
24 Rivers, California: An Evaluation of Project Planning and Performance.
25 Water Resources Center Report No. 90. University of California, Davis.
- 26 Kondolf et al. (Kondolf, G., R. Larsen, and J. Williams). 2000. Measuring and
27 Modeling the Hydraulic Environment for Assessing Instream Flows.
28 North American Journal of Fisheries Management 20: 1016-1028.
- 29 Kondolf et al. (Kondolf, G. M., A. Falzone, and K. S. Schneider). 2001.
30 Reconnaissance-level Assessment of Channel Change and Spawning
31 Habitat on the Stanislaus River downstream of Goodwin Dam.
- 32 Kormos et al. (Kormos, B., M, Palmer-Zwahlen, and A. Low. 2012. Recovery of
33 Coded-Wire Tags from Chinook Salmon in California's Central Valley
34 Escapement and Ocean Harvest in 2010. California Department of Fish
35 and Game Fisheries Branch Administrative Report 2012-02. March 2012.
36 44 pp.
- 37 Kuivila, K. M., and C. G. Foe. 1995. Concentrations, Transport and biological
38 Effects of dormant spray Pesticides in the San Francisco Estuary,
39 California. Environmental Toxicology and Chemistry 14: 1141-1150.
- 40 LACSD (Lake Arrowhead Community Services District). 2014a. Lake
41 Arrowhead. Site accessed May 19, 2014.
42 <http://www.lakearrowhead.com/activities.html>.

- 1 LACSD (Lake Arrowhead Community Services District). 2014c. Lake
2 Arrowhead, Fishing. Site accessed October 30, 2014.
3 <http://www.lakearrowhead.com/fishing.html>.
- 4 Lafayette Chamber of Commerce. 2014. Lafayette Reservoir. Site accessed
5 August 14, 2014. [http://www.lafayettechamber.org/community/lafayette-](http://www.lafayettechamber.org/community/lafayette-reservoir/)
6 [reservoir/](http://www.lafayettechamber.org/community/lafayette-reservoir/)
- 7 Lampman, R. T. 2011. Passage, Migration, Behavior, and Autoecology of Adult
8 Pacific Lamprey at Winchester Dam and Within the North Umpqua River
9 Basin, Oregon. Master's thesis. Oregon State University, Department of
10 Fisheries and Wildlife, Corvallis.
- 11 Larson, Z. S., and M. R. Belchik. 1998. A Preliminary Status Review of
12 Eulachon and Pacific Lamprey in the Klamath River Basin. Yurok Tribal
13 Fisheries Program, Klamath, California. April.
- 14 LARTF [Lower American River Task Force]. 2002. River Corridor Management
15 Plan (RCMP) for the Lower American River. 116 pages + 4 Appendices.
16 Available online:
17 [http://www.safca.org/Protection/NR_Documents/RCMP_5_Appendix.A.C](http://www.safca.org/Protection/NR_Documents/RCMP_5_Appendix.A.Chapter3.pdf)
18 [hapter3.pdf](http://www.safca.org/Protection/NR_Documents/RCMP_5_Appendix.A.Chapter3.pdf)
- 19 Lee, D. P. 1999. Water Level Fluctuation Criteria for Black Bass in California
20 Reservoirs. California Department of Fish and Game. Reservoir Research
21 and Management Project—Informational Leaflet No. 12. 12 pp.
- 22 Lee, D. P., and J. Chilton. 2007. Hatchery and genetic management plan for
23 Nimbus Fish Hatchery winter-run steelhead Program. Draft Report.
24 Prepared by DFG under Contract 03CS200006 Modification 0004 with
25 Bureau of Reclamation, Folsom, California, and Nimbus Fish Hatchery,
26 Rancho Cordova.
- 27 Lee, G. F. and Jones-Lee, A. 2003. Summary of Findings on the Causes and
28 Factors Influencing Low DO in the San Joaquin River Deep Water Ship
29 Channel near Stockton, CA. Report of G. Fred Lee & Associates, El
30 Macero, CA, March 2003. <http://www.gfredlee.com/psjriv2.htm>
- 31 Leet et al. (Leet, W. S., C. M. Dewees, R. Klingbeil, and E. J. Larson). 2001.
32 California's Living Marine Resources: a Status Report. Agriculture and
33 Natural Resources, University of California, Berkeley.
- 34 Lehman et al. (Lehman, P. W., G. Boyer, C. Hall, and K. Gehrts). 2005.
35 Distribution and Toxicity of a New Colonial *Microcystis aeruginosa*
36 Bloom in the San Francisco Bay Estuary, California. *Hydrobiologia*
37 (2005) 541: 87-99. DOI 10.1007/s10750-004-4670-0
- 38 Lehman et al. (Lehman, P. W., T. Sommer, and L. Rivard). 2008a. The Influence
39 of Floodplain Habitat on the Quantity of Riverine Phytoplankton Carbon
40 Produced During the Flood Season in San Francisco Estuary. *Aquatic*
41 *Ecology* 42: 363-378.

- 1 Lehman et al. (Lehman, P. W., G. Boyer, M. Satchwell, and S. Waller). 2008b.
2 The Influence of Environmental Conditions on the Seasonal Variation of
3 Microcystis Cell Density and Microcystins Concentration in San
4 Francisco estuary. *Hydrobiologia* Vol. 600, Issue 1, pp 187-204.
- 5 Lehman et al. (Lehman, P. W., S. J. Teh, G. L. Boyer, M. L. Nobriga, E. Bass, C.
6 Hogle). 2010. Initial Impacts of *Microcystis aeruginosa* Blooms on the
7 Aquatic Food Web in the San Francisco Estuary. *Hydrobiologia* (2010)
8 637: 229-248. DOI 10.1007/s10750-009-9999-y
- 9 Leidy, R. A. 2007. Ecology, Assemblage Structure, Distribution, and Status of
10 Fishes in Stream Tributary to the San Francisco Estuary, California. SFEI
11 Contribution #530. San Francisco Estuary Institute. Oakland, California.
- 12 Leidy et al. (Leidy, R.A., G.S. Becker, B.N. Harvey). 2005. Historical
13 Distribution and Current Status of Steelhead/Rainbow Trout
14 (*Oncorhynchus mykiss*) in Streams of the San Francisco Estuary,
15 California. Center for Ecosystem Management and Restoration, Oakland,
16 CA.
- 17 Lindberg, J. B. Baskerville-Bridges, and S. Doroshov. 2000. Update on Delta
18 Smelt Culture with an Emphasis on Larval Feeding Behavior. IEP
19 Newsletter. Vol. 13, Number 1. Winter.
- 20 Lindley, S. and Mohr, M.A. 2003. Modeling the effect of striped bass (*Morone*
21 *saxatilis*) on the population viability of Sacramento River winter-run
22 Chinook salmon (*Oncorhynchus tshawytscha*). *Fish. Bull.* 101:321-331.
- 23 Lindley, S. T., R. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A.
24 Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams.
25 2004. Population Structure of Threatened and Endangered Chinook
26 Salmon ESU in California's Central Valley Basin. NOAA-TM-NMFS-
27 SWFSC-360. NMFS Southwest Science Center, Santa Cruz, California.
- 28 Lindley et al. (Lindley, S. T., R. Schick, E. Mora, P. B. Adams, J. J. Anderson, S.
29 Greene, C. Hanson, B. P. May, D. R. McEwan, R. B. MacFarlane, C.
30 Swanson, and J. G. Williams). 2007. Framework for Assessing Viability
31 of Threatened and Endangered Chinook Salmon and steelhead in the
32 Sacramento-San Joaquin Basin. *San Francisco Estuary and Watershed*
33 *Science* 5: 26.
- 34 Lindley et al. (Lindley, S. T., M. L. Moser, D. L. Erickson, M. Belchik, D. W.
35 Welch, E. Rechisky, J. T. Kelly, J. Heublein, and A. P. Klimley). 2008.
36 Marine Migration of North American Green Sturgeon. *Transactions of the*
37 *American Fisheries Society* 137: 182-194.

- 1 Lindley et al. (Lindley, S. T., C. B. Grimes, M. S. Mohr, W. Peterson, J. Stein, J.
2 T. Anderson, L. W. Botsford, D. L. Bottom, C.A. Busack, T. K. Collier, J.
3 Ferguson, J. C. Garza, A. M. Grover, D. G. Hankin, R. G. Kope, P. W.
4 Lawson, A. Low, R. B. MacFarlane, K. Moore, M. Palmer-Zwahlen, F. B.
5 Schwing, J. Smith, C. Tracy, R. Webb, B. K. Wells, and T. H. Williams).
6 2009. What Caused the Sacramento River Fall Chinook Stock Collapse?
7 Pre-publication report to the Pacific Fishery Management Council.
- 8 Linville et al. (Linville, R. G., S. N. Luoma, L. Cutter, and G. A. Cutter). 2002.
9 Increased Selenium Threat as a Result of Invasion of the Exotic Bivalve
10 Potamocorbula amurensis into the San Francisco Bay-Delta. *Aquatic*
11 *Toxicology* 57: 51-64.
- 12 Loboschefskey et al. (Loboschefskey, E., G. Benigno, T. Sommer, K. Rose, T.
13 Ginn, A. Massoudieh, and F. Loge). 2012. Individual-level and
14 Population-level Historical Prey Demand of San Francisco Estuary Striped
15 Bass Using a Bioenergetics Model. *San Francisco Estuary and Watershed*
16 *Science*, 10(1).
- 17 Lund et al. (Lund, J., E. Hanak, W. Fleenor, R. Howitt, J. Mount, and P. Moyle).
18 2007. Envisioning Futures for the Sacramento San-Joaquin Delta. Public
19 Policy Institute of California.
- 20 MacFarlane, R. B. and E. C. Norton. 2002. Physiological Ecology of juvenile
21 Chinook Salmon (*Oncorhynchus tshawytscha*) at the Southern End of
22 Their Distribution, the San Francisco Estuary and Gulf of the Farallones,
23 California. *Fisheries Bulletin* 100:244–257.
- 24 Mac Nally, R., Thomson, J.R., Kimmerer, W.J., Feyrer, F., Newman, K.B., Sih,
25 A. et al. (2010). Analysis of pelagic species decline in the upper San
26 Francisco Estuary using multivariate autoregressive modeling (MAR).
27 *Ecol. Appl.*, 20, 1417–1430.
- 28 Magneson, M.D. 2013. The Influence of Lewiston Dam Releases on Water
29 Temperatures of the Trinity River and Lower Klamath River, CA, April to
30 October 2012. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
31 Office, Arcata Fisheries Data Series Report Number DS 2013-30, Arcata,
32 California.
- 33 Magneson, M.D. 2014. The Influence of Lewiston Dam Releases on Water
34 Temperatures of the Trinity River and Lower Klamath River, CA, April to
35 October 2013. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
36 Office, Arcata Fisheries Data Series Report Number DS 2014-36, Arcata,
37 California.
- 38 Manly et al. (Manly, B. F., J. D. Fullerton, A. N. Hendrix, K. P. Burnham). 2015.
39 Comments on Feyrer et al. Modeling the Effects of Future Outflow on the
40 Abiotic Habitat of an Imperiled Estuarine Fish. *Estuaries and Coasts*
41 38(5): 1815-1820.

- 1 Marston et al. (Marston, D., C. Mesick, A. Hubbard, D. Stanton, S. Fortmann-
2 Roe, S. Tsao, and T. Heyne). 2012. Delta Flow Factors Influencing Stray
3 Rate of Escaping Adult San Joaquin River fall-run Chinook Salmon
4 (*Oncorhynchus tshawytscha*). San Francisco Estuary and Watershed
5 Science, 10(4).
- 6 Martin et al. (Martin, C. D., P. D. Gaines, and R. R. Johnson). 2001. Estimating
7 the Abundance of Sacramento River Winter Chinook Salmon with
8 Comparisons to Adult Escapement. Red Bluff Research Pumping Plant
9 Report Series, Volume 5. U. S. Fish and Wildlife Service.
- 10 Matern et al. (Matern, S. A., P. B. Moyle, and L. C. Pierce). 2002. Native and
11 Alien Fishes in a California Estuarine Marsh: Twenty-one Years of
12 Changing Assemblages. Transactions of the American Fisheries Society,
13 131:5, 797-816, DOI: 10.1577/1548-
14 8659(2002)131<0797:NAAFIA>2.0.CO;2
- 15 Maunder, M. N. and R. B. Deriso. 2011. A state-space multistage life cycle
16 model to evaluate population impacts in the presence of density
17 dependence: illustrated with application to delta smelt (*Hyposmesus*
18 *transpacificus*). NRC Research Press.
- 19 McBain & Trush, Inc. (eds.), 2002. San Joaquin River Restoration Study
20 Background Report, prepared for Friant Water Users Authority, Lindsay,
21 CA, and Natural Resources Defense Council, San Francisco, CA.
- 22 McBain and Trush and Stillwater Sciences. 2006. Special Run Pool 9 and 7/11
23 Reach: Post-project Monitoring Report. Prepared for Tuolumne River
24 Technical Advisory Committee, Turlock and Modesto Irrigation Districts,
25 U.S. Fish and Wildlife Service Anadromous Fish Restoration Program,
26 California Bay-Delta Authority.
- 27 McCabe, G. T., and C. A. Tracy. 1994. Spawning and Early-life History of
28 White Sturgeon, *Acipenser transmontanus*, in the Lower Columbia River.
29 Fishery Bulletin 92: 760-772.
- 30 McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P.
31 Bjorkstedt. 2000. Viable salmonid populations and the recovery of
32 evolutionarily significant units. U.S. Department of Commerce, NOAA
33 Technical Memorandum. NMFS-NWFSC-42,156 p.
- 34 McEnroe, M., and J. J. Cech, Jr. 1985. Osmoregulation in Juvenile and Adult
35 White Sturgeon, *Acipenser transmontanus*. Environmental Biology of
36 Fishes 14: 23-30.
- 37 McEwan, D. 2001. Central Valley steelhead. Contributions to the Biology of
38 Central Valley Salmonids. Volume 1. California Department of Fish and
39 Game, Sacramento. Fish Bulletin 179.
- 40 McEwan, D., and T. A. Jackson. 1996. Steelhead Restoration and Management
41 Plan for California. California Department of Fish and Game, Inland
42 Fisheries Division, Sacramento.

- 1 McMichael, GA, JR Skalski and KA Deters. 2011. Survival of juvenile Chinook
2 salmon during barge transport. *North American Journal of Fisheries*
3 *Management* 31:1187-1196.
- 4 Meng, L., and P. B. Moyle. 1995. Status of Splittail in the Sacramento-San
5 Joaquin Estuary. *Transactions of the American Fisheries Society* 124:
6 538–549.
- 7 Merz et al. (Merz, J. E., S. Hamilton, P. S. Bergman, and B. Cavallo. 2011.
8 Spatial Perspective for Delta Smelt: a Summary of Contemporary Survey
9 Data. *California Fish and Game*, 97(4):164-189.
- 10 Merz et al. (Merz, J., B. Rook, C. Watry, and S. Zeug). 2012. Evaluation of the
11 2008-2010 Sailor Bar Gravel Placements on the Lower American River,
12 California. 2010-2011 Data Report. Prepared for City of Sacramento
13 Water Forum, and U.S. Bureau of Reclamation and U.S. Fish and Wildlife
14 Service, CVPIA Gravel Program. Contract 2010-1049.
- 15 Mesick, C. 2001. The Effects of San Joaquin River flows and Delta export Rates
16 during October on the Number of Adult San Joaquin Chinook Salmon that
17 Stray. *Contributions to the Biology of Central Valley Salmonids, Volume*
18 *2. Fish Bulletin* 179.
- 19 Mesick, C. 2002. Gravel Mining and Scour of Salmonid Spawning Habitat in the
20 Lower Stanislaus River. Prepared by Carl Mesick Consultants, El Dorado,
21 California.
- 22 Michel, C. J. 2010. River and Estuarine Survival and Migration of Yearling
23 Sacramento River Chinook Salmon (*Oncorhynchus tshawytscha*) Smolts
24 and the Influence Of Environment. Masters Thesis. University of
25 California Santa Cruz.
- 26 Michel, C.J., A. J. Ammann, S. T. Lindley, P. T. Sandstrom, E. D. Chapman, M.
27 J. Thomas, G. P. Singer, A. P. Klimley, and R. B. MacFarlane. 2015.
28 Chinook salmon outmigration survival in wet and dry years in California's
29 Sacramento River. *Canadian Journal of Fisheries and Aquatic Sciences*.
30 Published on the web 18 June 2015, 10.1139/cjfas-2014-0528.
- 31 Miller et al. (Miller, W. J., B. F. J. Manly, D. D. Murphy, D. Fullerton, and R. R.
32 Ramey). 2012. An Investigation of Factors Affecting the Decline of
33 Delta Smelt (*Hypomesus transpacificus*) in the Sacramento-San Joaquin
34 Estuary. *Reviews in Fisheries Science* 20: 1-19.
- 35 Monsen et al. (Monsen, N. E., J. E. Cloern, and J. R. Burau). 2007. Effects of
36 Flow Diversions on Water and Habitat Quality: Examples from
37 California's Highly Manipulated Sacramento-San Joaquin Delta. *San*
38 *Francisco Estuary and Watershed Science*, 5(3)
- 39 Mount et al. (Mount, J., W. Bennett, J. Durand, W. Fleenor, E. Hanak, J. Lund,
40 and P. B. Moyle). 2012. Aquatic Ecosystem Stressors in the Sacramento-
41 San Joaquin Delta. Public Policy Institute of California, San Francisco.

- 1 Moyle, P. B. 2002. Inland Fishes of California. Second edition. University of
2 California Press, Berkeley.
- 3 Moyle, P. B. 2008. The Future of Fish in Response to Large-Scale Change in the
4 San Francisco Estuary, California. Mitigating impacts of natural hazards
5 on fishery ecosystems. Symposium 64. Edited by K. D. McLaughlin.
6 American Fisheries Society, Bethesda, Maryland.
- 7 Moyle, P. B., and W. A. Bennett. 2008. The Future of the Delta Ecosystem and
8 Its Fish. Technical Appendix D. Comparing futures for the Sacramento–
9 San Joaquin Delta. Public Policy Institute of California.
- 10 Moyle, P.B., and W.A. Bennett. 2010. Re: Striped bass predation on listed
11 fishes: can a control program be justified. Letter to Jim Kellogg, President,
12 Fish and Game Commission. Dated August 26, 2010.
- 13 Moyle et al. (Moyle, P. B., B. Herbold, D. E. Stevens, and L. W. Miller). 1992.
14 Life History and Status of Delta Smelt in the Sacramento–San Joaquin
15 Estuary, California. Transactions of the American Fisheries Society 121:
16 67–77.
- 17 Moyle et al. (Moyle, P. B., P. K. Crain, K. Whitener, and J. F. Mount). 2003.
18 Alien Fishes in Natural Streams: Fish Distribution, Assemblage Structure,
19 and Conservation in the Cosumnes River, California, USA.
20 Environmental Biology of Fishes 68: 143-162.
- 21 Moyle et al. (Moyle, P. B., R. D. Baxter, T. Sommer, T.C. Foin, and S. A.
22 Matern). 2004. Biology and Population Dynamics of Sacramento Splittail
23 (*Pogonichthys macrolepidotus*) in the San Francisco Estuary: a Review.
24 San Francisco Estuary and Watershed Science 2: Article 3.
- 25 Moyle et al. (Moyle, P. B., L. R. Brown, S. D. Chase, and R. M. Quinones).
26 2009. Status and Conservation of Lampreys in California. American
27 Fisheries Society Symposium 72: 279-292.
- 28 Moyle et al. (Moyle, P., W. Bennett, J. Durand, W. Fleenor, B. Gray, E. Hanak, J.
29 Lund, and J. Mount). 2012. Where the Wild Things Aren't: Making the
30 Delta a Better Place For Native Species. Public Policy Institute of
31 California, San Francisco, California. Available at:
32 http://www.ppic.org/content/pubs/report/R_612PMR.pdf.
- 33 Mueller-Solger et al. (Mueller-Solger, A. B., A. D. Jassby, and D. C. Muller-
34 Navarra). 2002. Nutritional Quality of Food Resources for Zooplankton
35 (*Daphnia*) in a Tidal Freshwater System (Sacramento–San Joaquin River
36 Delta). Limnol. Oceanogr., 47(5), 2002, 1468–1476.
- 37 Muir, WD, DM Marsh, BP Sandford, SG Smith and JG Williams. 2006. Post-
38 hydropower system delayed mortality of transported Snake River stream-
39 type Chinook salmon: unraveling the mystery. Transactions of the
40 American Fisheries Society 135:1523-1534.

- 1 Murphy, D. D. and S. A. Hamilton. 2013. Eastward Migration or Marshward
2 Dispersal: Exercising Survey Data to Elicit an Understanding of Seasonal
3 Movement of Delta Smelt. San Francisco Estuary and Watershed Science,
4 11(3). San Francisco Estuary and Watershed Science, John Muir Institute
5 of the Environment, UC Davis.
- 6 MWD (Metropolitan Water District of Southern California). 2014. Diamond
7 Valley Lake, Southwestern Riverside County Multi-Species Reserve. Site
8 accessed October 5, 2014. <http://www.dvlake.com/shiple01.html>
- 9 Myers et al. (Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T.
10 C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and
11 R. S. Waples). 1998. Status Review of Chinook Salmon from
12 Washington, Idaho, Oregon, and California. NOAA Technical
13 Memorandum NMFS-NWFSC-35. National Marine Fisheries Service,
14 Northwest Fisheries Science Center, Seattle, Washington.
- 15 Myrick, C. A., and J. J. Cech, Jr. 2004. Temperature Effects on Juvenile
16 Anadromous Salmonids in California's Central Valley: what don't we
17 know? Reviews in Fish Biology and Fisheries 141: 113-123.
- 18 National Research Council. 2010. A scientific assessment of alternatives for
19 reducing water management effects on threatened and endangered fishes
20 in California's Bay-Delta. The National Academies Press, Washington,
21 D.C.
- 22 Naughton et al. (Naughton, G. P., C. C. Caudill, M. L. Keefer, T. C. Bjornn, L. C.
23 Stuehrenberg, and C. A. Perry). 2005. Late-season Mortality during
24 Migration of Radio-Tagged Adult Sockeye Salmon (*Oncorhynchus nerka*)
25 in the Columbia River. Canadian Journal of Fisheries and Aquatic
26 Sciences 62: 30-47.
- 27 NCRWQCB et al. (California North Coast Regional Water Quality Control Board
28 and Bureau of Reclamation). 2009. Channel Rehabilitation and Sediment
29 Management for Remaining Phase 1 and Phase 2 Sites, Draft Master
30 Environmental Impact Report and Environmental Assessment. June.
- 31 NCRWQCB et al. (California North Coast Regional Water Quality Control
32 Board, Bureau of Reclamation, Bureau of Land Management). 2013.
33 Trinity River Channel Rehabilitation Sites: Douglas City (River Mile
34 93.6-94.6) and Lorenz Gulch (River Mile 89.4-90.2), Final Environmental
35 Assessment/Initial Study. May.
- 36 Newcomb, J. and L. Pierce. 2010. Low Dissolved Oxygen Levels in the Stockton
37 Deep Water Shipping Channel, Adverse Effects on Salmon and Steelhead
38 and Potential Beneficial Effects of Raising Dissolved Oxygen Levels with
39 the Aeration Facility. Fish Passage Improvement Program Flood Safe
40 Environmental Stewardship and Statewide Resources Office Department
41 of Water Resources. 28 pp.

- 1 Newman, K. B. 2003. Modeling Paired Release-recovery Data in the Presence of
 2 Survival and Capture Heterogeneity with Application to Marked Juvenile
 3 Salmon. *Statistical Modeling* 3: 157-177.
- 4 Newman, K. B. 2008. An Evaluation of four Sacramento-San Joaquin River
 5 Delta Juvenile Salmon Studies. Prepared for CALFED Science Program.
 6 Project No. SCI-06-G06-299. March.
- 7 Newman, K. B., and P. L. Brandes. 2010. Hierarchical Modeling of Juvenile
 8 Chinook Salmon Survival as a Function of Sacramento–San Joaquin Delta
 9 Water Exports. *North American Journal of Fisheries Management*
 10 30:157-169.
- 11 Newman, K. B., and J. Rice. 2002. Modeling the Survival of Chinook Salmon
 12 Smolts Outmigrating Through the Lower Sacramento River system.
 13 *Journal of the American Statistical Association* 97: 983-993.
- 14 NID (Nevada Irrigation District). 2005. Raw Water Master Plan Update, Phase I:
 15 Technical Analysis, Volume I, Final Report. September.
- 16 NID (Nevada Irrigation District). 2008. Yuba-Bear Hydroelectric Project FERC
 17 Project No. 2266 Relicensing Pre-Application Document (PAD) Public
 18 Information. April.
- 19 NID (Nevada Irrigation District). 2009. Combie Reservoir Water Supply and
 20 Maintenance Project Preliminary Biological Evaluation for CEQA Initial
 21 Study. July.
- 22 Nielsen et al. (Nielsen, J. L., S. A. Pavey, T. Wiacek, and I. Williams). 2005.
 23 Genetics of Central Valley *O. mykiss* populations: Drainage and
 24 Watershed Scale Analysis. *San Francisco Estuary and Watershed*
 25 *Science* 3 (2).
- 26 Nixon, S. W. 1988. Physical Energy Inputs and the Comparative Ecology of
 27 Lake and Marine Ecosystems. *Limnology and Oceanography*, Part II 33:
 28 1005–1025.
- 29 NMFS (National Marine Fisheries Service). 1993. Designated Critical Habitat;
 30 Sacramento River winter-run Chinook Salmon. *Federal Register* 58:
 31 33212-33219.
- 32 NMFS (National Marine Fisheries Service). 1999. Designated Critical Habitat;
 33 Central California Coast and Southern Oregon/Northern California Coasts
 34 Coho Salmon. *Federal Register* 64: 24049.24062.
- 35 NMFS (National Marine Fisheries Service). 2000. Biological Opinion for the
 36 Trinity River Mainstem Fishery Restoration EIS and its effects on
 37 Southern Oregon/Northern California Coast Coho Salmon, Sacramento
 38 River winter-run Chinook Salmon, Central Valley spring-run Chinook
 39 Salmon, and Central Valley Steelhead.

- 1 NMFS (National Marine Fisheries Service). 2000. Endangered Species Act-
2 Reinitiated Section 7 Consultation Biological Opinion and Incidental Take
3 Statement Effects of the Pacific coast salmon plan on California Central
4 Valley spring-run chinook, and California coastal chinook salmon. NMFS,
5 Page(s): 31
- 6 NMFS (National Marine Fisheries Service). 2010. Endangered Species Act
7 Section 7 Consultation Biological Opinion: Authorization of ocean salmon
8 fisheries pursuant to the Pacific Coast Salmon Fishery Management Plan
9 and additional protective measures as it affects Sacramento River winter
10 Chinook salmon. NMFS, Page(s): 97
- 11 NMFS (National Marine Fisheries Service). 2004. Biological Opinion on the
12 Long-term Central Valley Project and State Water Project Operations,
13 Criteria, and Plan.
- 14 NMFS (National Marine Fisheries Service). 2005a. Endangered and Threatened
15 Species: Final Listing Determinations for 16 ESUs of West Coast salmon,
16 and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.
17 Federal Register 70: 37160-37204.
- 18 NMFS (National Marine Fisheries Service). 2005b. Endangered and Threatened
19 Wildlife and Plants: Proposed Threatened Status for Southern Distinct
20 Population Segment of North American Green Sturgeon. Federal Register
21 70: 17386-17401.
- 22 NMFS (National Marine Fisheries Service). 2005c. Green Sturgeon (*Acipenser*
23 *medirostris*) Status Review Update.
- 24 NMFS (National Marine Fisheries Service). 2008. Recovery Plan for Southern
25 Resident Killer Whales (*Orcinus orca*).
- 26 NMFS (National Marine Fisheries Service). 2009a. Biological and Conference
27 Opinion on the Long-Term Operations of the Central Valley Project and
28 State Water Project.
- 29 NMFS (National Marine Fisheries Service). 2009b. Endangered and Threatened
30 Wildlife and Plants; Final Rulemaking to Designate Critical Habitat for
31 the Threatened Southern Distinct Population Segment of North American
32 Green Sturgeon. Federal Register 74: 52300-52351.
- 33 NMFS (National Marine Fisheries Service). 2009c. Biological Opinion: Effects
34 of the Pacific Coast Salmon Plan on the Southern Resident killer whale
35 (*Orcinus orca*) Distinct Population Segment. National Marine Fisheries
36 Service, Northwest Region. May 5, 2009. As cited in NMFS *Endangered*
37 *Species Act Section 7 Consultation Authroization of Ocean Salmon*
38 *Biological Opinion Pursuant to the Pacific Coast Salmon Fisheries*
39 *Management Plan and Additional Protective Measures as it Affects*
40 *Sacramento River Winter-run Chinook Salmon, April 30, 2010.*

- 1 NMFS (National Marine Fisheries Service). 2011a. Endangered and Threatened
 2 Species; Designation of Critical Habitat for the Southern Distinct
 3 Population Segment of Eulachon. Federal Register 76: 65324.
- 4 NMFS (National Marine Fisheries Service). 2011b. Critical Habitat for the
 5 Southern Distinct Population Segment of Eulachon, Final Section 4(b)(2)
 6 Report. NMFS Northwest Region, Protected Resources Division.
 7 Portland, OR.
- 8 NMFS (National Marine Fisheries Service). 2012a. Biological Opinion on
 9 Continued Operation and Maintenance of Englebright Dam and Reservoir,
 10 Daguerre Point Dam, and Recreational Facilities on and Around
 11 Englebright Reservoir. NMFS, Southwest Region, Long Beach,
 12 California.
- 13 NMFS (National Marine Fisheries Service). 2012b. Final implementation of the
 14 2010 Reasonable and Prudent Alternative Sacramento River winter-run
 15 Chinook management framework for the Pacific Coast Salmon Fishery
 16 Management Plan. Memorandum for Sacramento River winter Chinook
 17 ocean salmon fishery. April 30, 2012.
- 18 NMFS (National Marine Fisheries Service). 2014a. Final Recovery Plan for the
 19 Southern Oregon/Northern California Coast Evolutionarily Significant
 20 Unit of Coho Salmon (*Oncorhynchus kisutch*). National Marine Fisheries
 21 Service. Arcata, CA.
- 22 NMFS (National Marine Fisheries Service). 2014b. Recovery Plan for the
 23 Evolutionarily Significant Units of Sacramento River winter-run Chinook
 24 Salmon and Central Valley spring-run Chinook Salmon and the Distinct
 25 Population Segment of California Central Valley steelhead. California
 26 Central Valley Area Office. March 2014. 430 p.
- 27 NMFS (National Marine Fisheries Service). 2015. Eulachon (*Thaleichthys*
 28 *pacificus*). Site accessed June 18, 2015.
 29 http://www.nmfs.noaa.gov/pr/species/fish/pacific_eulachon.htm
- 30 Nobriga, M. L. 2002. Larval Delta Smelt Composition and Feeding Incidence:
 31 Environmental and Ontogenetic Influences. California Fish and Game 88:
 32 149-164.
- 33 Nobriga, M. L. 2009. Bioenergetic Modeling Evidence for a Context-dependent
 34 Role of Food Limitation in California's Sacramento-San Joaquin Delta.
 35 California Fish and Game 95(3): 111-121.
- 36 Nobriga, M. and P. Cadrett. 2001. Differences among Hatchery and Wild
 37 steelhead: Evidence from Delta Fish Monitoring Programs. IEP
 38 Newsletter Vol. 14, No. 3. Summer.
- 39 Nobriga, M. L., and F. Feyrer. 2007. Shallow-Water Piscivore-Prey Dynamics in
 40 California's Sacramento-San Joaquin Delta. San Francisco Estuary and
 41 Watershed Science 5(2): Article 4.

- 1 Nobriga, M.L., and F. Feyrer. 2008. Diet composition in San Francisco Estuary
2 striped bass: Does trophic adaptability have its limits? *Environmental*
3 *Biology Fish* 83: 495 -503.
- 4 Nobriga et al. (Nobriga, M. L., Z. Matica, and Z. P. Hymanson). 2004.
5 Evaluating Entrainment Vulnerability to Agricultural Irrigation
6 Diversions: a Comparison among Open-Water Fishes. Early life history
7 of fishes in the San Francisco Estuary and watershed. Edited by F. Feyrer,
8 L. R. Brown, R. L. Brown, and J. J. Orsi, 281-295. *American Fisheries*
9 *Society, Symposium 39, Bethesda, Maryland.*
- 10 Nobriga et al. (Nobriga, M. L., F. Feyrer, R. D. Baxter, and M. Chotkowski).
11 2005. Fish Community Ecology in an Altered River Delta: Spatial
12 Patterns in Species Composition, Life History Strategies and Biomass.
13 *Estuaries: 776-785.*
- 14 Nobriga et al. (Nobriga, M. L., T. R. Sommer, F. Feyrer, and K. Fleming). 2008.
15 Long-term Trends in Summertime Habitat Suitability for Delta Smelt,
16 *Hypomesus transpacificus*. *San Francisco Estuary and Watershed Science*
17 6: Article 1.
- 18 NRC (National Research Council). 2004. *Endangered and Threatened Fishes in*
19 *the Klamath River Basin: Causes of Decline and Strategies for Recovery.*
20 *The National Academies Press, Washington, D.C.*
- 21 NRC (National Research Council). 2012. *Sustainable Water and Environmental*
22 *Management in the California Bay-Delta. Prepared by the Committee on*
23 *Sustainable Water and Environmental Management in the California*
24 *Bay-Delta. The National Academies Press, Washington, D.C.*
- 25 OEHHA (Office of Environmental Health Hazard Assessment). 2005. *Health*
26 *Advisory: Safe Eating Guidelines for Fish from Trinity Lake, Lewiston*
27 *Lake, Carrville Pond, Trinity River Upstream from Trinity Lake, and the*
28 *East Fork Trinity River (Trinity County) – A Fact Sheet. California*
29 *Environmental Protection Agency, Sacramento, California.*
- 30 OEHHA (Office of Environmental Health Hazard Assessment). 2009. *Health*
31 *Advisory: Safe Eating Guidelines for Fish from San Pablo Reservoir*
32 *(Contra Costa County). California Environmental Protection Agency,*
33 *Sacramento, California.*
- 34 OEHHA (Office of Environmental Health Hazard Assessment). 2013a. *Health*
35 *Advisory and Guidelines for Eating Fish from Pyramid Lake (Los Angeles*
36 *County).*
- 37 OEHHA (Office of Environmental Health Hazard Assessment). 2013b. *Health*
38 *Advisory and Guidelines for Eating Fish from Silverwood Lake (San*
39 *Bernardino County).*
- 40 Painter et al. (Painter, R. L., L. Wixom, and L. Meinz). 1979. *American Shad*
41 *Management Plan for the Sacramento River Drainage. Anadromous Fish*
42 *Conservation Act Project AFS-17, Job 5. CDFG, Sacramento.*

- 1 Palmer-Zwahlen, M. and B. Kormos. 2013. Recovery of Coded-Wire Tags from
2 Chinook salmon in California's Central Valley Escapement and Ocean
3 Harvest in 2011. Fisheries Branch Administrative Report 2013-02.
- 4 Parker et al. (Parker, A. E., R. C. Dugdale, and F. P. Wilderson). 2012. Elevated
5 Ammonium Concentrations from Wastewater Discharge Depress Primary
6 Productivity in the Sacramento River and the Northern San Francisco
7 Estuary. *Marine Pollution Bulletin* 64: 574-86.
- 8 Perry, R. W. 2010. Survival and migration dynamics of juvenile Chinook Salmon
9 (*Oncorhynchus tshawytscha*) in the Sacramento-San Joaquin River Delta.
10 Doctoral dissertation. University of Washington, Seattle.
- 11 Perry, R. W., and J. R. Skalski. 2008. Migration and Survival of Juvenile
12 Chinook Salmon Through the Sacramento-San Joaquin River Delta
13 During the Winter of 2006-2007.
- 14 Perry, R. W., P. L. Brandes, P. T. Sandstrom, A. Ammann, B. MacFarlane, A. P.
15 Klimley, and J. R. Skalski. 2010. Estimating survival and migration route
16 probabilities of juvenile Chinook Salmon in the Sacramento-San Joaquin
17 River Delta. *North American Journal of Fisheries Management* 30:142-
18 156.
- 19 Perry et al. (Perry, R. W., Romine, J. G., Brewer, S. J., LaCivita, P. E., Brostoff,
20 W. N., and Chapman, E.D). 2012. Survival and Migration Route
21 Probabilities of Juvenile Chinook Salmon in the Sacramento-San Joaquin
22 River Delta During the Winter of 2009-10: U.S. Geological Survey Open-
23 File Report 2012-1200, 30 p.
- 24 Perry, R. W., P. L. Brandes, J. R. Burau, P. T. Sandstrom, and J. R. Skalski. 2015.
25 Effect of Tides, River Flow, and Gate Operations on Entrainment of
26 Juvenile Salmon into the Interior Sacramento-San Joaquin River Delta.
27 *Transactions of the American Fisheries Society* 144:445-455.
- 28 Petersen Lewis, R. S. 2009. Yurok and Karuk traditional Ecological Knowledge:
29 Insights into Pacific Lamprey Populations of the Lower Klamath Basin.
30 *American Fisheries Society Symposium* 72: 1-39.
- 31 Pickard et al. (Pickard, A., A. Grover, and F. Hall). 1982. An Evaluation of
32 Predator Composition at Three Locations on the Sacramento River.
33 Technical Report No. 2. Interagency Ecological Study Program for the
34 Sacramento-San Joaquin Estuary.
- 35 Pinnix, W.D., and S. Quinn. 2009. Juvenile Salmonid Monitoring on the
36 Mainstem Trinity River at Willow Creek, California, 2006-2007. U.S.
37 Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata
38 Fisheries Data Series Report Number DS 2009-16, Arcata, California.

- 1 Pinnix et al. (Pinnix, W.D., A. Heacock, and P. Petros). 2013. Juvenile Salmonid
2 Monitoring on the Mainstem Trinity River, California, 2011. U. S. Fish
3 and Wildlife Service, Arcata Fish and Wildlife Office, Yurok Tribal
4 Fisheries Program, and Hoopa Valley Tribal Fisheries Department. Arcata
5 Fisheries Data Series Report Number DS2013-29, Arcata, California.
- 6 Polis, G.A. and Strong, D.R. 1996. Food web complexity and community
7 dynamics. *Am. Nat.* 147: 813-846.
- 8 Porter, R. 2010. Report on the predation index, predator control fisheries, and
9 program evaluation for the Columbia River Basin Experimental Northern
10 Pikeminnow Management Program. Annual Report. US Department of
11 Energy, Bonneville Power Administration, Portland, Oregon.
- 12 Porter, R. 2012. Report on the predation index, predator control fisheries, and
13 program evaluation for the Columbia River Basin Experimental Northern
14 Pikeminnow Management Program. Annual Report. US Department of
15 Energy, Bonneville Power Administration, Portland, Oregon.
- 16 PSFMC (Pacific States Marine Fisheries Commission). 2014. Juvenile Salmonid
17 Emigration Monitoring in the Lower American River, California January –
18 June 2013. Unpublished report prepared for the U.S. Fish and Wildlife
19 Service and California Department of Fish and Wildlife, Sacramento,
20 California. 54 pp.
- 21 Pyper et al. (Pyper, B., J. B. Lando, and C. Justice). 2006. Analysis of Weir
22 Counts and Spawning Surveys of Adult Chinook Salmon in the Stanislaus
23 River. September.
- 24 Pyper et al. (Pyper, B.J., S.P. Cramer, R.P. Ericksen, and R. M. Sitts. 2012.
25 Implications of Mark- Selective Fishing for Ocean Harvests and
26 Escapements of Sacramento River Fall Chinook Salmon Populations,
27 Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem
28 Science, 4:1, 373-390 Available:
29 <http://dx.doi.org/10.1080/19425120.2012.679575>
- 30 Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout.
31 Seattle, WA: University of Washington Press.
- 32 Radtke, L. D. 1966. Distribution of Smelt, Juvenile Sturgeon, and Starry
33 Flounder in the Sacramento-San Joaquin Delta with Observations on Food
34 of Sturgeon. Edited by S. L. Turner and D. W. Kelley. *Ecological Studies*
35 of the Sacramento-San Joaquin Delta, Part II. California Department of
36 Fish and Game Fish Bulletin 136: 115-129.
- 37 Rechisky et al. 2012 Trap and Haul from Cramer
- 38 Reclamation (Bureau of Reclamation). 2003. Ecosystem Restoration
39 Opportunities in the Upper Sacramento River Region.
- 40 Reclamation (Bureau of Reclamation). 2005. Lake Natoma Temperature Curtain
41 and Channel Modification Study, 2001–2002. Hydraulic Laboratory
42 Report HL-2005-02.

- 1 Reclamation (Bureau of Reclamation). 2007. Folsom General Plan/Resource
 2 Management Plan: Folsom Lake Recreation Area and Folsom
 3 Powerhouse State Historic Park.
- 4 Reclamation (Bureau of Reclamation). 2008a. Biological Assessment on the
 5 Continued Long-Term Operations of the Central Valley Project and the
 6 State Water Project.
- 7 Reclamation (U.S. Bureau of Reclamation). 2008b. Plan Formulation Report,
 8 Upper San Joaquin River Basin Storage Investigation. October.
- 9 Reclamation (Bureau of Reclamation). 2009. Whiskeytown Dam Hydraulics and
 10 Hydrology. June 4. Site accessed January 26, 2015
 11 <http://www.usbr.gov/projects/>
- 12 Reclamation (Bureau of Reclamation). 2010a. CVPIA Sacramento River
 13 Spawning Gravel Addition Project at Keswick Dam. Categorical
 14 Exclusion Checklist. October 5.
- 15 Reclamation (Bureau of Reclamation). 2010b. New Melones Lake Area Final
 16 Resource Management Plan and Environmental Impact Statement.
 17 February 2010.
- 18 Reclamation (Bureau of Reclamation). 2010c. Cachuma Lake Final Resource
 19 Management Plan/Environmental Impact Statement. May 2010.
- 20 Reclamation (Bureau of Reclamation). 2012a. Adaptive Management of Fall
 21 Outflow for Delta Smelt Protection and Water Supply Reliability.
 22 Revised Milestone Draft.
- 23 Reclamation (Bureau of Reclamation). 2012b. Stanislaus River Focus Group
 24 Meeting October 10, 2012, Handouts.
- 25 Reclamation (Bureau of Reclamation). 2013a. Draft CVPIA Fiscal Year 2014
 26 Work Plan. Clear Creek Restoration – CVPIA Section 3406(b)(12).
 27 April 28.
- 28 Reclamation (Bureau of Reclamation). 2013b. Shasta Lake Water Resources
 29 Investigation, California. Draft Environmental Impact Statement. June.
- 30 Reclamation (Bureau of Reclamation). 2013c. Shasta Lake Water Resources
 31 Investigation, California. Draft Water Quality Technical Report. June
- 32 Reclamation (Bureau of Reclamation). 2014a. Draft Resource Management Plan
 33 and Draft Environmental Impact Statement, Contra Loma Reservoir and
 34 Recreation Area. May.
- 35 Reclamation (Bureau of Reclamation). 2014b. Battle Creek Salmon and
 36 Steelhead Restoration Project. Site accessed September 19, 2014.
 37 <http://www.usbr.gov/mp/battlecreek/about.html>
- 38 Reclamation (Bureau of Reclamation). 2014c. Habitat Assessment Final Report:
 39 Shasta Dam Fish Passage Evaluation. United States Department of the
 40 Interior, Mid-Pacific Region.

- 1 Reclamation (Bureau of Reclamation). 2014d. *Long-Term Water Transfers*
2 *Environmental Impact Statement/Environmental Impact Report, Public*
3 *Draft*. September.
- 4 Reclamation (Bureau of Reclamation). 2014e. *Appendix L: Biological Review*
5 *for Endangered Species Act Compliance for Extended Water Transfer*
6 *Period*. Final Environmental Assessment/Initial Study, Water Transfers
7 for the San Luis & Delta-Mendota Water Authority. April.
- 8 Reclamation and CSP (Bureau of Reclamation and California Department of
9 Parks and Recreation. 2010. Millerton Lake Final Resource Management
10 Plan/General Plan Final Environmental Impact Statement/ Environmental
11 Impact Report. April.
- 12 Reclamation and CSP (Bureau of Reclamation and California Department of
13 Parks and Recreation). 2013. San Luis Reservoir State Recreation Area
14 Final Resource Management Plan/General Plan and Final Environmental
15 Impact Statement/ Environmental Impact Report. June.
- 16 Reclamation and DFG (Bureau of Reclamation and California Department of Fish
17 and Game). 2011. Final Environmental Impact Statement/Environmental
18 Impact Report for the Nimbus Hatchery Fish Passage Project.
- 19 Reclamation and DWR (Bureau of Reclamation and California Department of
20 Water Resources). 2010. Appendix E. Fisheries Management Plan: A
21 Framework for Adaptive Management in the San Joaquin River
22 Restoration Program. November.
- 23 Reclamation and DWR (Bureau of Reclamation and California Department of
24 Water Resources). 2011. San Joaquin River Restoration Program Draft
25 Program Environmental Impact Statement/Environmental Impact Report.
26 April.
- 27 Reclamation and DWR (Bureau of Reclamation and California Department of
28 Water Resources). 2015. Biological Review for Endangered Species Act
29 Compliance with the WY 2015 Drought Contingency Plan April through
30 September Project Description. Prepared for State Water Resources
31 Control Board. Available online:
32 [http://www.waterboards.ca.gov/waterrights/water_issues/programs/drough](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/apr2015_req032415.pdf)
33 [t/docs/tucp/2015/apr2015_req032415.pdf](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/apr2015_req032415.pdf)
- 34 Reclamation and Trinity County (Bureau of Reclamation and Trinity County).
35 2006. Indian Creek rehabilitation site: Trinity River Mile 93.7 to 96.5.
36 Revised Environmental Assessment/Recirculated Partial Draft
37 Environmental Impact Report. November 14.
- 38 Reclamation et al. (Bureau of Reclamation, Department of Water Resources, U.S.
39 Fish and Wildlife Service, National Marine Fisheries Service, and
40 California Department of Fish and Game [now known as Department of
41 Fish and Wildlife]). 2003. Environmental Water Account Draft
42 Environmental Impact Statement / Environmental Impact Report.

- 1 Reclamation et al. (Bureau of Reclamation, U.S. Fish and Wildlife Service,
2 National Marine Fisheries Service, California Department of Fish and
3 Game [now known as Department of Fish and Wildlife], and Water
4 Forum). 2006. Lower American River flow management standard. Draft
5 Report.
- 6 Reed et al. (Reed, D., J. Hollibaugh, J. Korman, E. Peebles, K. Rose, P. Smith,
7 and P. Montagna). 2014. Workshop on Delta Outflows and Related
8 Stressors Panel Summary Report. Delta Stewardship Council/Delta
9 Science Program.
- 10 Reis-Santos et al. (Reis-Santos, P., S. D. McCormick, and J. M. Wilson). 2008.
11 Ionoregulatory Changes during Metamorphosis and Salinity Exposure of
12 Juvenile Sea Lamprey (*Petromyzon marinus* L.). *The Journal of*
13 *Experimental Biology* 211: 978-988.
- 14 Ricker, W.E. 1981. Changes in the average size and average age of Pacific
15 salmon. *Can J Fish Aquat Sci* 38: 1636–1656. doi: 10.1139/f81-213
- 16 Riverside County (County of Riverside). 2014. Lake Skinner. Site accessed
17 March 9, 2014. [http://www.rivcoparks.org/parks/lake-skinner/lake-](http://www.rivcoparks.org/parks/lake-skinner/lake-skinner-home)
18 [skinner-home](http://www.rivcoparks.org/parks/lake-skinner/lake-skinner-home).
- 19 Roberts, J. 2007. Timing, Composition, and Abundance of Juvenile Anadromous
20 Salmonid Emigration in the Sacramento River near Knights Landing,
21 October 2001-July 2002. California Department of Fish and Game, North
22 Central Region Fisheries Program.
- 23 Robinson, T. C., and J. M Bayer. 2005. Upstream Migration of Pacific Lampreys
24 in the John Day River, Oregon: Behavior, Timing, and Habitat Use.
25 *Northwest Science* 79: 106-119.
- 26 Rose et al. (Rose, K. A., W. J. Kimmerer, K. P. Edwards, and W. A. Bennett).
27 2013a. Individual-Based Modeling of Delta Smelt Population Dynamics
28 in the Upper San Francisco Estuary: I. Model Description and Baseline
29 Results. *Transactions of the American Fisheries Society*, 142:5,
30 1238-1259.
- 31 Rose et al. (Rose, K. A., W. J. Kimmerer, K. P. Edwards, and W. A. Bennett).
32 2013b. Individual-Based Modeling of Delta Smelt Population Dynamics
33 in the Upper San Francisco Estuary: II. Alternative Baselines and Good
34 versus Bad Years. *Transactions of the American Fisheries Society*, 142:5,
35 1260-1272.
- 36 Rosenfield, J. A., and R. D. Baxter. 2007. Population Dynamics and Distribution
37 Patterns of Longfin Smelt in the San Francisco Estuary. *Transactions*
38 *American Fisheries Society* 136: 1577-1592.
- 39 Rutter, C. 1908. The fishes of the Sacramento-San Joaquin basin, with a study of
40 their Distribution and Variation. Document No. 637.

- 1 Saiki, M. K. 1984. Environmental Conditions and Fish Faunas in Low Elevation
2 Rivers on the Irrigated San Joaquin Valley floor, California. California
3 Fish and Game 70: 145-157.
- 4 Saiki et al. (Saiki, M. K., M. R. Jennings, and R. H. Wiedmeyer). 1992. Toxicity
5 of Agricultural Subsurface Drainwater from the San Joaquin Valley,
6 California, to Juvenile Chinook Salmon and Striped Bass. Transactions of
7 American Fisheries Society 121: 73-93.
- 8 SBCWD (San Benito County Water District). 2012. Initial Study, Zebra Mussel
9 Eradication Project: San Justo Reservoir, Hollister Conduit, & San Benito
10 County Water District Subsystems. January.
- 11 Schaffter, R. 1997. White Sturgeon Spawning Migrations and Location of
12 Spawning Habitat in the Sacramento River, California. California
13 Department of Fish and Game 83: 1-20.
- 14 Scheiff, T., and P. Zedonis. 2010. The Influence of Lewiston Dam Releases on
15 Water Temperatures of the Trinity and Klamath Rivers, CA. April to
16 October, 2009. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
17 Office, Arcata Fisheries Data Series Report Number DS 2010-17, Arcata,
18 California.
- 19 Scheiff, T. and P. Zedonis. 2011. The Influence of Lewiston Dam Releases on
20 Water Temperatures of the Trinity and Klamath Rivers, CA. April to
21 October, 2010. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
22 Office, Arcata Fisheries Data Series Report Number DS 2011-22, Arcata,
23 California.
- 24 Scheiff, T., and P. Zedonis. 2012. The Influence of Lewiston Dam Releases on
25 Water Temperatures of the Trinity and Klamath Rivers, CA. April to
26 October, 2012. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
27 Office, Arcata Fisheries Data Series Report Number DS 2012-30, Arcata,
28 California.
- 29 Scheiff et al. (Scheiff, A. J., J. S. Lang, and W. D. Pinnix). 2001. Juvenile
30 Salmonid Monitoring on the Mainstem Klamath River at Big Bar and
31 Mainstem Trinity River at Willow Creek 1997-2000. Annual report of the
32 Klamath River Fisheries Assessment Program. U.S. Fish and Wildlife
33 Service, Arcata Fish and Wildlife Office, Arcata, California.
- 34 Schick et al. (Schick, R. S., A. L. Edsall, and S. T. Lindley). 2005. Historical and
35 Current Distribution of Pacific Salmonids in the Central Valley, CA.
36 Technical Memorandum 369. National Marine Fisheries Service, Santa
37 Cruz, California.
- 38 Schneider, K. S., G. M. Kondolf, and A. Falzone. 2003. Channel-floodplain
39 Disconnection on the Stanislaus River: a Hydrologic and Geomorphic
40 Perspective. Edited by P. M. Faber, 163-168. California Riparian
41 Systems: Processes and Floodplain Management, Ecology, and
42 restoration. Riparian Habitat and Floodplains Conference Proceedings,
43 Riparian Habitat Joint Venture, Sacramento, California.

- 1 Schoellhamer, D. H. 2011. Sudden Clearing of Estuarine Waters upon Crossing
 2 the Threshold from Transport to Supply Regulation of Sediment Transport
 3 as an Erodible Sediment Pool Is Depleted: San Francisco Bay, 1999.
 4 Estuaries and Coasts. DOI 10.1007/s12237-011-9382-x.
- 5 Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Fish. Res.
 6 Board Can., Bull. No. 184. 966 pp.
- 7 SCVWD (Santa Clara Valley Water District). 2010. Urban Water Management
 8 Plan.
- 9 SDCWA and USACE (San Diego County Water Authority and U.S. Army Corps
 10 of Engineers). 2008. Final Environmental Impact Report/Environmental
 11 Impact Statement for the Carryover Storage and San Vicente Dam Raise
 12 Project. April 2008.
- 13 SDFish. 2014. Dixon Lake. Sdfish.com Site accessed October 30, 2014.
 14 <http://sdfish.com/lakes/dixon-lake>
- 15 SDFish. 2015. Lake Jennings. Sdfish.com Site accessed May 11, 2015.
 16 <http://sdfish.com/lakes/lake-jennings>
- 17 Seeholtz et al. (Seesholtz, A., B. J. Cavallo, J. Kindopp, and R. Kurth). 2004.
 18 Juvenile Fishes of the Lower Feather River: Distribution, Emigration
 19 Patterns, and Associations with Environmental Variables. Early Life
 20 History of Fishes in the San Francisco Estuary and Watershed. Edited by
 21 F. Feyrer, L. R. Brown, R. L. Brown, and J. J. Orsi, 141-166. American
 22 Fisheries Society, Symposium 39, Bethesda, Maryland.
- 23 Seeholtz et al. (Seesholtz, A., M.J. Manuel, and J.P. Van Eenennaam). (2014).
 24 First Documented Spawning and Associated Habitat Conditions for Green
 25 Sturgeon in the Feather River, California. Environmental Biology of
 26 Fishes DOI: 10.1007/s10641-014-0325-9: 1-8.
- 27 SJTA (San Joaquin Tributaries Authority). 2012. Review of Scientific
 28 Information Pertaining to SWRCB’s February 2012 Technical Report on
 29 the Scientific Basis for Alternative San Joaquin River Flow Objectives.
 30 Prepared for State Water Resources Control Board Phase II
 31 Comprehensive Review Workshops, Workshop 2, “Bay-Delta Fisheries”
 32 to be held October 1-2, 2012. Prepared by Doug Demko, Michael
 33 Hellmair, Matt Peterson, Shaara Ainsley, Michele Palmer, and Andrea
 34 Fuller.
- 35 Siegel et al. (Siegel, S., C. Enright, C. Toms, C. Enos, and J. Sutherland). 2010.
 36 Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model.
 37 Chapter 1: Physical Processes. Suisun Marsh Habitat Management,
 38 Restoration and Preservation Plan. Final Review Draft. Prepared by
 39 WWR and DWR.
- 40 SJRGA (San Joaquin River Group Authority). 2010. 2009 Annual Technical
 41 Report on Implementation and Monitoring of the San Joaquin River
 42 Agreement and the Vernalis Adaptive Management Plan (VAMP).

- 1 SJRGA (San Joaquin River Group Authority). 2011. 2010 Annual Technical
2 Report on Implementation and Monitoring of the San Joaquin River
3 Agreement and the Vernalis Adaptive Management Plan (VAMP).
- 4 SJRGA (San Joaquin River Group Authority). 2013. 2011 Annual Technical
5 Report on Implementation and Monitoring of the San Joaquin River
6 Agreement and the Vernalis Adaptive Management Plan (VAMP).
- 7 Skinner, J. E. 1962. An Historical Review of the Fish and Wildlife Resources of
8 the San Francisco Bay Area. (Water Projects Branch Report No. 1.)
9 California Department of Fish and Game. Sacramento, CA.
- 10 Smelt Working Group. 2015. Smelt Working Group Meeting Notes. June 8.
- 11 Snider, B., and R. Titus. 2000a. Lower American River Emigration Survey
12 October 1996–September 1997. California Department of Fish and Game,
13 Habitat Conservation Division, Stream Evaluation Program.
- 14 Snider, B., and R. G. Titus. 1998. Evaluation of Juvenile Anadromous Salmonid
15 Emigration in the Sacramento River near Knights Landing, November
16 1995-July 1996. California Department of Fish and Game, Environmental
17 Services Division, Stream Evaluation Program.
- 18 Snider, B., and R. G. Titus. 2000b. Timing, Composition, and Abundance of
19 Juvenile Anadromous Salmonid Emigration in the Sacramento River near
20 Knights Landing, October 1996-September 1997. California Department
21 of Fish and Game, Habitat Conservation Division, Stream Evaluation
22 Program Technical Report No. 00-04.
- 23 Snider, B., and R. G. Titus. 2000c. Timing, Composition, and Abundance of
24 Juvenile Anadromous Salmonid Emigration in the Sacramento River near
25 Knights Landing, October 1997-September 1998. California Department
26 of Fish and Game, Habitat Conservation Division, Stream Evaluation
27 Program Technical Report No. 00-05
- 28 Snider, B., and R. G. Titus. 2000d. Timing, Composition, and Abundance of
29 Juvenile Anadromous Salmonid Emigration in the Sacramento River near
30 Knights Landing, October 1998-September 1999. California Department
31 of Fish and Game, Habitat Conservation Division, Native Anadromous
32 Fish and Watershed Branch, Stream Evaluation Program Technical Report
33 No. 00-6
- 34 Snider, B., and R. Titus. 2002. Lower American River Emigration Survey
35 October 1998–September 1999. California Department of Fish and Game,
36 Habitat Conservation Division, Stream Evaluation Program.
- 37 Snider et al. (Snider, B., R. Titus, and K. Vyberberg). 2001. Evaluation of
38 Effects of Flow Fluctuations on the Anadromous Fish Populations in the
39 Lower American River. California Department of Fish and Game Stream
40 Evaluation Program.
- 41 SOG (Stanislaus Operations Group). 2011. Annual Report of Activities, October
42 1, 2010 to September 30, 2011. October.

- 1 SOG (Stanislaus Operations Group). 2012. Annual Report of Activities, October
2 1, 2011 to September 30, 2012. October.
- 3 Sommer, T. and F. Mejia. 2013. A Place to Call Home: A Synthesis of Delta
4 Smelt Habitat in the Upper San Francisco Estuary. San Francisco Estuary
5 and Watershed Science, 11(2). San Francisco Estuary and Watershed
6 Science, John Muir Institute of the Environment, UC Davis.
- 7 Sommer et al. (Sommer, T. R., R. Baxter, and B. Herbold). 1997. Resilience of
8 Splittail in the Sacramento–San Joaquin Estuary. Transactions of the
9 American Fisheries Society 126: 961–976.
- 10 Sommer et al. (Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. Moyle, W.
11 Kimmerer, and L. Schemel). 2001a. California's Yolo Bypass: Evidence
12 that Flood Control can be Compatible with Fisheries, Wetlands, Wildlife,
13 and Agriculture. Fisheries 26: 6-16.
- 14 Sommer et al. (Sommer, T.R., D. McEwan and R. Brown). 2001b. Factors
15 affecting chinook salmon spawning in the lower Feather River. California
16 Department of Fish and Game Fish Bulletin 179:269-297
- 17 Sommer et al. (Sommer, T. R., W. C. Harrell, M. L. Nobriga, and R. Kurth).
18 2003. Floodplain as Habitat for Native Fish: Lessons from California's
19 Yolo Bypass. California Riparian Systems: Processes and Floodplain
20 Management, Ecology, and Restoration. 2001 Riparian Habitat and
21 Floodplains Conference Proceedings. Edited by P. M. Faber, 81–87.
22 Riparian Habitat Joint Venture, Sacramento, California.
- 23 Sommer et al. (Sommer, T. R., W. C. Harrell, A. Mueller-Solger, B. Tom, and W.
24 Kimmerer). 2004. Effects of Flow Variation on Channel and Floodplain
25 Biota and Habitats of the Sacramento River, California, USA. Aquatic
26 Conservation: Marine and Freshwater Ecosystems 14:247-261.
- 27 Sommer et al. (Sommer, T, W. Harrell, and M. Nobriga). 2005. Habitat Use and
28 Stranding Risk of Juvenile Chinook Salmon on a Seasonal Floodplain.
29 North American Journal of Fisheries Management 25: 1493-1504.
- 30 Sommer et al. (Sommer, T. R., C. Armor, R. Baxter, R. Breuer, L. Brown, M.
31 Chotkowski, S. Culberson, F. Feyrer, M. Gingras, B. Herbold, W.
32 Kimmerer, A. Mueller-Solger, M. Nobriga, and K. Souza). 2007a. The
33 Collapse of Pelagic Fishes in the upper San Francisco Estuary. Fisheries
34 32: 270-277.
- 35 Sommer et al. (Sommer, T., R. Baxter, and F. Feyrer). 2007b. Splittail revisited:
36 how recent population trends and restoration activities led to the
37 "delisting" of this native minnow. Pages 25-38 in M.J. Brouder and J.A.
38 Scheuer, editors. Status, distribution, and conservation of freshwater fishes
39 of western North America. American Fisheries Society Symposium 53.
40 Bethesda, Maryland.

- 1 Sommer et al. (Sommer, T. R., W. C. Harrell, Z. Matica, and F. Feyrer). 2008.
2 Habitat Associations and Behavior of Adult and Juvenile Splittail
3 (Cyprinidae: Pogonichthys macrolepidotus) in a Managed Seasonal
4 Floodplain Wetland. San Francisco Estuary and Watershed Science 5(2):
5 Article 3. <http://www.escholarship.org/uc/item/85r15611>
- 6 Sommer et al. (Sommer, T., F. Mejia, M. Nobriga, F. Feyrer, and L. Grimaldo).
7 2011. The Spawning Migration of Delta Smelt in the Upper San
8 Francisco Estuary. San Francisco Estuary and Watershed Science: 9(2).
- 9 Sommer et al. (T.R. Sommer, W.C. Harrell, and F. Feyrer. 2014. Large-bodied
10 fish migration and residency in a flood basin of the Sacramento River,
11 California, USA. Ecology of Freshwater Fish 2014: 23: 414–423
- 12 Sonke, C. and A. Fuller. 2012. Outmigrant Trapping of Juvenile Salmon in the
13 Lower Tuolumne River, 2012. Prepared for Turlock and Modesto
14 Irrigation Districts by FISHBIO, Oakdale, CA.
- 15 S.P. Cramer and Associates, Inc. 1998. Evaluation of Juvenile Chinook
16 Behavior, Migration Rate and Location of Mortality in the Stanislaus
17 River Through the Use of Radio Tracking. Final report prepared for the
18 Tri-dam Project. December.
- 19 Speegle, J., J. Kirsch, and J. Ingram. 2013. Annual report: Juvenile Fish
20 Monitoring During the 2010 and 2011 Field Seasons within the San
21 Francisco Estuary, California. Stockton Fish and Wildlife Office.
- 22 SRFG (Stanislaus River Fish Group). 2003. A Plan to Restore Anadromous Fish
23 Habitat in the Lower Stanislaus River. Review Draft.
- 24 SRFG (Stanislaus River Fish Group). 2004. A Summary of Fisheries Research in
25 the Lower Stanislaus River. Working Draft. March 10.
- 26 SRTTG (Sacramento River Temperature Task Group). 2012. Annual Report of
27 Activities: 1 October 2011 through 30 September 2012.
- 28 Staley, J. R. 1976. American River steelhead, *Salmo gairdnerii gairdnerii*,
29 management, 1956-1974. Anadromous Fisheries Branch Administrative
30 Report 76–2. California Department of Fish and Game.
- 31 Stevens 1966. Food habits of striped bass (*Roccus caxatilis*) in the Sacramento-
32 San Joaquin Delta. Pages 68-96 in J.L. Turner and D.W. Kelley, eds.
33 Ecological studies of the Sacramento-San Joaquin Estuary, part II: fishes
34 of the Delta. CDFG Fish. Bull. 136.
- 35 Stevens, D. E., and L. W. Miller. 1970. Distribution of Sturgeon Larvae in the
36 Sacramento-San Joaquin River system. California Fish and Game 56:
37 80-86.
- 38 Stevens et al. (Stevens, D. E., D. W. Kohlhorst, L. W. Miller, and D. W. Kelley).
39 1985. The Decline of Striped Bass in the Sacramento-San Joaquin
40 Estuary, California. Transactions of the American Fisheries Society 114:
41 12-30.

- 1 Stewart et al. (Stewart, A. R., S. N. Luoma, C. E. Schlekot, M. A. Doblin, and K.
2 A Hieb). 2004. Food Web Pathway Determines How Selenium Affects
3 Aquatic Ecosystems: A San Francisco Bay Case Study. *Environ. Sci.*
4 *Technol.* 2004, 38, 4519-4526.
- 5 Stillwater Sciences. 2007. The Merced River Alliance Project Interim Biological
6 Monitoring and Assessment Report. Prepared for East Merced Resource
7 Conservation District, Merced, California, and State Water Resources
8 Control Board.
- 9 Strange, J. S. 2010. Upper Thermal Limits to Migration in Adult Chinook
10 Salmon: evidence from the Klamath River basin. *Transactions of the*
11 *American Fisheries Society* 139: 1091–1108.
- 12 Suisun Ecological Workgroup. 2001. Suisun Ecological Workgroup Final Report
13 to the State Water Resources Control Board.
- 14 Swanson et al. (Swanson, C., P. S. Young, and J. J. Cech Jr). 1998. Swimming
15 Performance of Delta Smelt: Maximum Performance and Behavioral and
16 Kinematic Limitations of Swimming at Submaximal Velocities. *Journal*
17 *of Experimental Biology* 201: 333-345.
- 18 Sweetwater Authority. 2013. Sweetwater Reservoir Wetlands Habitat Recovery
19 Project Initial Study/Mitigated Negative Declaration. December.
- 20 SWRCB (State Water Resources Control Board). 1995. Water Quality Control
21 Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.
22 Sacramento, California.
- 23 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control*
24 *Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.*
25 December 13.
- 26 SWRCB (State Water Resources Control Board). 2010a. Staff Report for 2010
27 Integrated Report Clean Water Act Sections 303(d) and 305(b). April.
28 Site accessed December 2, 2013.
- 29 SWRCB (State Water Resources Control Board). 2013. *Comprehensive*
30 *(Phase 2) Review and Update to the Bay-Delta Plan, DRAFT Bay-Delta*
31 *Plan Workshops Summary Report.* January
- 32 SWRCB (State Water Resources Control Board). 2015. *Response from U.S.*
33 *Bureau of Reclamation on New Melones Operations.* E-mail from Ronald
34 Milligan (Reclamation) to Tom Howard (SWRCB) with Attachments.
35 Dated April 8, 2015. Available online at
36 [http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml)
37 [t/tucp/index.shtml](http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml)
- 38 SWRI (Surface Water Resources, Inc.). 2001. Aquatic Resources of the Lower
39 American River: Baseline Report. Draft Report. Prepared for the Lower
40 American River Fisheries and Instream Habitat (FISH) Working Group.

- 1 TCCA (Tehama-Colusa Canal Authority). 2008. Fishery Resources,
2 Appendix B. Fish passage improvement project at the Red Bluff
3 Diversion Dam EIS/EIR. Prepared by CH2M HILL, State Clearinghouse
4 No. 2002-042-075.
- 5 Teh et al. (Teh, S., I. Flores, M. Kawaguchi, S. Lesmeister, and C. the). 2011.
6 Full Life-Cycle Bioassay Approach to Assess Chronic Exposure of
7 Pseudodiaptomus forbesi to Ammonia/Ammonium. Submitted to: Chris
8 Foe and Mark Gowdy, State Water Board / UC Davis Agreement No. 06-
9 447-300 SUBTASK No. 14. August 31.
- 10 TID/MID (Turlock Irrigation District/Modesto Irrigation District). 1992. Lower
11 Tuolumne River Predation Study Report. Appendix 22 to Turlock
12 Irrigation District and Modesto Irrigation District Pursuant to Article 39 of
13 the License for the Don Pedro Project, No. 2299 Vol. VII. Prepared by T.
14 Ford, Turlock and Modesto Irrigation Districts and EA Engineering,
15 Science, and Technology, Lafayette, California.
- 16 TID/MID (Turlock Irrigation District/Modesto Irrigation District). 2013.
17 Predation Study W&AR-17. Initial Study Report Don Pedro Project,
18 FERC No. 2299. Prepared by FISHBIO, Oakdale, CA.
- 19 TNC (The Nature Conservancy). 2007a. Sacramento River Ecological Flows
20 Study. Gravel Study Final Report.
- 21 TNC (The Nature Conservancy). 2007b. Linking Biological Responses to River
22 Processes: Implications for Conservation and Management of the
23 Sacramento River—a Focal Species Approach. Final Report.
- 24 Thomson et al. (Thomson, J. R., W. J. Kimmerer, L. R. Brown, K. B. Newman, R.
25 MacNally, W. A. Bennett, F. Feyrer, and E. Fleishman). 2010. Bayesian
26 Change Point Analysis of Abundance Trends for Pelagic Fishes in the
27 Upper San Francisco Estuary. *Ecological Applications*, 20(5), 2010, pp.
28 1431–1448
- 29 Toft et al. (Toft, J.D., C.A. Simenstad, J.R. Cordell, and L.F. Grimaldo). 2003.
30 The Effects of Introduced Water Hyacinth on Habitat Structure,
31 Invertebrate Assemblages, and Fish Diets. *Estuaries* 26(3): 746–758.
- 32 Tri Dam Project. 2003. Letter from Steve Felte, General Manager, to interested
33 agencies Re: Request for Preliminary Input on the Proposed Goodwin
34 Hydroelectric Project. Dated 8, August, 2003.
- 35 TRRP (Trinity River Restoration Program). 2014. Review of the Trinity River
36 Restoration Program Following Phase 1, With Emphasis on the Program’s
37 Channel Rehabilitation Strategy. April.
- 38 TRTAC (Tuolumne River Technical Advisory Committee), Turlock and Modesto
39 Irrigation Districts, USFWS Anadromous Fish Restoration Program, and
40 California Bay-Delta Authority. 2006. Lower Tuolumne River Predation
41 Assessment Final Report. Prepared by Stillwater Sciences, Berkeley, CA
42 and McBain & Trush, Arcata, CA.

- 1 Trush et al. (Trush, W. J., S. McBain, and L. Leopold). 2000. Attributes of an
 2 Alluvial River and Their Relation to Water Policy and Management.
 3 Proceedings of the National Academy of Sciences 97: 11858-11863.
- 4 Tucker et al. (Tucker, M.E., C.M. Williams, and R.R. Johnson). 1998.
 5 Abundance, Food Habits and Life History Aspects of Sacramento
 6 Squawfish and Striped Bass at the Red Bluff Diversion Complex,
 7 including the Research Pumping Plant, Sacramento River, California,
 8 1994-1996. Red Bluff Research Pumping Plant Report Series, Volume 4.
 9 U. S. Fish and Wildlife Service, Red Bluff, California.
- 10 Tucker et al. (Tucker, M. E., C. D. Martin, and P. D. Gaines). 2003. Spatial and
 11 Temporal Distribution of Sacramento Pikeminnow and Striped Bass at the
 12 Red Bluff Diversion Complex, including the Research Pumping Plant,
 13 Sacramento River, California: January, 1997 to August, 1998. Red Bluff
 14 Research Pumping Plant Report Series. U. S. Fish and Wildlife Service,
 15 Red Bluff, California.
- 16 USACE (U.S. Army Corps of Engineers), Bureau of Reclamation, Sacramento
 17 Area Flood Control Agency, and California Central Valley Flood
 18 Protection Board. 2012. Folsom Dam Modification Project Approach
 19 Channel, Draft Supplemental Environmental Impact Statement/
 20 Environmental Impact Report. July.
- 21 USACE (U.S. Army Corps of Engineers). 2013. Biological Assessment for the
 22 U.S. Army Corps of Engineers Ongoing Operation and Maintenance of
 23 Englebright Dam and Reservoir on the Yuba River. October.
- 24 USFWS (U. S. Fish and Wildlife Service). 1983. Final Environmental Impact
 25 Statement: Trinity River Basin Fish and Wildlife Management Program.
 26 INT/FES 83-53.
- 27 USFWS (U. S. Fish and Wildlife Service). 1994a. Endangered and Threatened
 28 Wildlife and Plants; Critical Habitat Determination for the Delta Smelt.
 29 Federal Register 59: 65256-65278.
- 30 USFWS (U. S. Fish and Wildlife Service). 1994b. Rehabilitation of the
 31 Mainstem Trinity River Background Report. 1994.
- 32 USFWS (U.S. Fish and Wildlife Service). 1995. Working paper: Habitat
 33 Restoration Actions to Double Natural Production of Anadromous Fish in
 34 the Central Valley of California. Volume 2. May 9, 1995.
- 35 USFWS (U. S. Fish and Wildlife Service). 1997. Klamath River (Iron Gate Dam
 36 to Seiad Creek), Life Stage Periodicities for Chinook, Coho, and
 37 steelhead. July.
- 38 USFWS (U.S. Fish and Wildlife Service). 1999. Trinity River Flow Evaluation
 39 Final Report.
- 40 USFWS (U.S. Fish and Wildlife Service). 2000. Trinity River Mainstem Fishery
 41 Restoration Environmental Impact Statement/Environmental Impact
 42 Report.

- 1 USFWS (U. S. Fish and Wildlife Service). 2001a. Final Restoration Plan for the
2 Anadromous Fish Restoration Program: a Plan to Increase Natural
3 Production of Anadromous Fish in the Central Valley of California.
- 4 USFWS (U. S. Fish and Wildlife Service). 2001b. Abundance and Survival of
5 Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary: 1997
6 and 1998. Annual Progress Report Sacramento-San Joaquin Estuary.
- 7 USFWS (U. S. Fish and Wildlife Service). 2002b. Stanislaus River Anadromous
8 Fish Surveys 2000-2001. Snorkel Survey. Anadromous Fish Restoration
9 Program.
- 10 USFWS (U. S. Fish and Wildlife Service). 2003a. Flow-habitat Relationships for
11 steelhead and fall-run, late-fall, and winter-run Chinook Salmon Spawning
12 in the Sacramento River between Keswick Dam and Battle Creek.
- 13 USFWS (U. S. Fish and Wildlife Service). 2003b. Abundance and Survival of
14 Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary: 1999.
15 Annual Progress Report.
- 16 USFWS (U. S. Fish and Wildlife Service). 2005a. Flow-habitat Relationships for
17 fall-run Chinook Salmon Spawning in the Sacramento River between
18 Battle Creek and Clear Creek.
- 19 USFWS (U. S. Fish and Wildlife Service). 2005b. Flow-habitat Relationships for
20 Chinook Salmon Rearing in the Sacramento River between Keswick Dam
21 and Battle Creek.
- 22 USFWS (U. S. Fish and Wildlife Service). 2006. Relationships between Flow
23 Fluctuations and Redd Dewatering and Juvenile Stranding for Chinook
24 Salmon and steelhead in the Sacramento River between Keswick Dam and
25 Battle Creek.
- 26 USFWS (U. S. Fish and Wildlife Service). 2007. Central Valley Steelhead and
27 late fall-run Chinook Salmon Redd Surveys on Clear Creek, California.
- 28 USFWS (U. S. Fish and Wildlife Service). 2007. Flow-habitat Relationships for
29 Spring Chinook Salmon and steelhead/Rainbow Trout Spawning in Clear
30 Creek between Whiskeytown Dam and Clear Creek Road.
- 31 USFWS (U. S. Fish and Wildlife Service). 2008a. Biological Opinion on the
32 Coordinated Operations of the Central Valley Project and State Water
33 Project in California.
- 34 USFWS (U. S. Fish and Wildlife Service). 2008b. Juvenile Salmonid Monitoring
35 in Clear Creek, California from July 2002 through September 2003.
- 36 USFWS (U. S. Fish and Wildlife Service). 2010. Endangered and Threatened
37 Wildlife and Plants; 12-Month Finding on a Petition to List the
38 Sacramento Splittail as Endangered or Threatened. Federal Register 75:
39 62070-62095.

- 1 USFWS (U.S. Fish and Wildlife Service). 2011a. Flow-habitat Relationships for
 2 fall-run Chinook Salmon and steelhead/Rainbow Trout Spawning in Clear
 3 Creek between Clear Creek Road and the Sacramento River.
- 4 USFWS (U.S. Fish and Wildlife Service). 2011b. Flow-habitat Relationships for
 5 spring-run Chinook Salmon and steelhead/Rainbow Trout Rearing in
 6 Clear Creek between Whiskeytown Dam and Clear Creek Road.
- 7 USFWS (U. S. Fish and Wildlife Service). 2011a. Formal Endangered Species
 8 Act Consultation on the Proposed Coordinated Operations of the Central
 9 Valley Project and State Water Project. First Draft Biological Opinion.
 10 Reference No. 81410-2011-F-0043.
- 11 USFWS (U. S. Fish and Wildlife Service). 2011b. Biological Assessment of
 12 Artificial Propagation at Coleman National Fish Hatchery and Livingston
 13 Stone National Fish Hatchery: Program Description and Incidental Take
 14 of Chinook Salmon and steelhead. July.
- 15 USFWS (U. S. Fish and Wildlife Service). 2012. California Hatchery Review
 16 Project, Appendix VIII. Coleman National Fish Hatchery Steelhead
 17 Program Report.
- 18 USFWS (U.S. Fish and Wildlife Service). 2013a. Flow-habitat Relationships for
 19 spring-run and fall-run Chinook Salmon and steelhead/Rainbow Trout
 20 Rearing in Clear Creek Clear Creek Road and the Sacramento River.
- 21 USFWS (U.S. Fish and Wildlife Service). 2015. Clear Creek Habitat Synthesis
 22 Report.
- 23 USFWS et al. (U.S. Fish and Wildlife Service, Bureau of Reclamation, Hoopa
 24 Valley Tribe, and Trinity County). 1999. Trinity River Mainstem Fishery
 25 Restoration Environmental Impact Statement/Report. October.
- 26 USFWS et al. (U.S. Fish and Wildlife Service), Bureau of Reclamation, Hoopa
 27 Valley Tribe, and Trinity County. 2004. Trinity River Fishery
 28 Restoration. Supplemental Environmental Impact
 29 Statement/Environmental Impact Report. April.
- 30 USFWS et al. (U.S. Fish and Wildlife Service and Bureau of Reclamation). 2008.
 31 Implementation of the Central Valley Project Improvement Act, Annual
 32 Report for Fiscal Year 2006. January.
- 33 Van Eenennaam, J. P., M. A. H. Webb, X. Deng, S. I. Doroshov, R. B. Mayfield,
 34 J. J. Cech, D. C. Hillemeier, and T. E. Willson. 2001. Artificial Spawning
 35 and Larval Rearing of Klamath River Green Sturgeon. Transactions of the
 36 American Fisheries Society 130: 159-165.
- 37 Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S. I. Doroshov. 2005.
 38 Effect of Incubation Temperature on Green Sturgeon Embryos, *Acipenser*
 39 *medirostris*. Environmental Biology of Fishes 72: 145-154.

- 1 Van Eenennaam et al. (Van Eenennaam, J. P., J. Linares, S. I. Doroshov, D. C.
2 Hillemeier, T. E. Willson, and A. A. Nova). 2006. Reproductive
3 Conditions of the Klamath River Green Sturgeon. Transactions of the
4 American Fisheries Society 135: 151-163.
- 5 Van Nieuwenhuyse, E. E. 2007. Response of Summer Chlorophyll
6 Concentration to Reduced Total Phosphorus Concentration in the Rhine
7 River (Netherlands) and the Sacramento-San Joaquin Delta (California,
8 USA). *Can. J. Fish. Aquat. Sci.* 64: 1529-1542.
- 9 Vincik, R. F., R. G. Titus, and B. Snider. 2006. Timing, Composition, and
10 Abundance of Juvenile Anadromous Salmonid Emigration in the
11 Sacramento River near Knights Landing, September 1999-September
12 2000. California Department of Fish and Game, Sacramento Valley-
13 Central Sierra Region, Lower Sacramento River Juvenile Salmonid
14 Emigration Program.
- 15 Vogel, D. A. 2004. Juvenile Chinook Salmon Radio-telemetry Studies in the
16 Northern and Central Sacramento-San Joaquin Delta, 2002-2003. Report
17 to the National Fish and Wildlife Foundation, Southwest Region.
- 18 Vogel, D. A. 2008. Evaluation of Adult Sturgeon Migration at the Glenn-Colusa
19 Irrigation District Gradient Facility on the Sacramento River.
- 20 Vogel, D. A. 2011. Insights into the Problems, Progress, and Potential Solutions
21 for Sacramento River Basin Native Anadromous Fish Restoration.
22 Prepared for Northern California Water Association and Sacramento
23 Valley Water Users.
- 24 Vogel, D. 2013. Evaluation of Fish Entrainment in 12 Unscreened Sacramento
25 River Diversions. Final Report. Prepared for CVPIA Anadromous Fish
26 Screen Program (U.S. Fish and Wildlife Service and U.S. Bureau of
27 Reclamation) and Ecosystem Restoration Program (California Department
28 of Fish and Wildlife, U.S. Fish and Wildlife Service, and NOAA
29 Fisheries).
- 30 Vogel, D. A., and K. R. Marine. 1991. Guide to the Upper Sacramento River
31 Chinook Salmon Life History. Bureau of Reclamation Central Valley
32 Project.
- 33 Wagner, R. W., M. Stacey, L. R. Brown, and M. Dettinger. 2011. Statistical
34 Models of Temperature in the Sacramento–San Joaquin Delta under
35 Climate-Change Scenarios and Ecological Implications. *Estuaries and
36 Coasts* (2011) 34:544–556. DOI 10.1007/s12237-010-9369-z.
- 37 Wallace, M. 2004. Natural vs. Hatchery Proportions of Juvenile Salmonids
38 Migrating Through the Klamath River Estuary and Monitor Natural and
39 Hatchery Juvenile Salmonid Emigration from the Klamath River Basin.
40 July 1, 1998 through June 30, 2003. Final Performance Report. Federal
41 Aid in Sport Fish Restoration Act, Project No. F-51-R-6.

- 1 Water Forum. 2004. Draft Policy Document: Lower American River Flow
2 Management Standard.
- 3 Water Forum. 2005a. Impacts on Lower American River Salmonids and
4 Recommendations Associated with Folsom Reservoir Operations to Meet
5 Delta Water Quality Objectives and Demands. Draft Report. January.
- 6 Water Forum. 2005b. Addendum to the Report Titled “Impacts on Lower
7 American River Salmonids and Recommendations Associated with
8 Folsom Reservoir Operations to Meet Delta Water Quality Objectives and
9 Demands.”
- 10 Water Forum. 2005c. Lower American River, State of the River Report. April.
11 Available online: [http://www.waterforum.org/wp-](http://www.waterforum.org/wp-content/uploads/2015/09/State-of-the-River-2005.pdf)
12 [content/uploads/2015/09/State-of-the-River-2005.pdf](http://www.waterforum.org/wp-content/uploads/2015/09/State-of-the-River-2005.pdf)
- 13 Watry, C. B., A. Gray, R. Cuthbert, B. Pyper, and K. Arendt. 2007. Out-migrant
14 Abundance Estimates and Coded Wire Tagging Pilot Study for Juvenile
15 Chinook Salmon at Caswell Memorial State Park in the Lower Stanislaus
16 River, California. 2007 Annual Data Report. Prepared for U.S. Fish and
17 Wildlife Service Anadromous Fish Restoration Program.
- 18 Watry, C. B., A. Gray, K. Jones, K. Sellheim, and J. Merz. 2012. Juvenile
19 Salmonid Out-migration Monitoring at Caswell Memorial State Park in
20 the Lower Stanislaus River, California. 2010-2011 Biannual Report.
21 Prepared for U.S. Fish and Wildlife Service’s Comprehensive Assessment
22 and Monitoring Program. Grant No. 813326G008. 48 pp.
- 23 Wertheimer A.C., Heard, W.R., Maselko, J.M., and Smoker, W.W. 2004
24 Relationship of size at return with environmental variation, hatchery
25 production, and productivity of wild pink salmon in Prince William
26 Sound, Alaska: does size matter? *Rev Fish Biol Fisheries* 14: 321–334.
27 doi: 10.1007/s11160-004-2942-4
- 28 Weston, D. P., J. You, and M. J. Lydy. 2004. Distribution and Toxicity of
29 Sediment-Associated Pesticides in Agriculture-Dominated Water Bodies
30 of California’s Central Valley. *Environmental Science and Technology*
31 38: 2752-2759.
- 32 Whipple, A. A., R. M. Grossinger, D. Rankin, B. Stanford, and R. A. Askevold.
33 2012. Sacramento-San Joaquin Delta Historical Ecology Investigation:
34 Exploring Pattern and Process. Prepared for the California Department of
35 Fish and Game and Ecosystem Restoration Program. Historical Ecology
36 Program Publication 672, San Francisco Estuary Institute-Aquatic Science
37 Center, Richmond, California.
- 38 Wilkerson, F. P., R. C. Dugdale, V. E. Hogue, and A. Marchi. 2006.
39 Phytoplankton Blooms and Nitrogen Productivity in San Francisco Bay.
40 *Estuaries and Coasts* 29: 401-416.

- 1 Williams, J. G. 2001. Chinook Salmon in the Lower American River, California's
2 Largest Urban Stream. Contributions to the biology of Central Valley
3 salmonids, Volume 2. Edited by R. L. Brown. California Department of
4 Fish and Game Fish Bulletin 179: 1-38.
- 5 Williams, J. G. 2006. Central Valley Salmon: a Perspective on Chinook and
6 steelhead in the Central Valley of California. San Francisco Estuary and
7 Watershed Science 4.
- 8 Williams, G. J. 2010. Life History Conceptual Model for Chinook Salmon and
9 steelhead. DRERIP Delta Conceptual Model. Sacramento (CA): Delta
10 Regional Ecosystem Restoration Implementation Plan.
- 11 Williams, J.G., S.G. Smith, R.W. Zabel, W.D. Muir, M.D. Scheuerell, B.P.
12 Sandford, D.M. Marsh, R. McNatt, and S. Achord. 2004. Effects of the
13 federal Columbia River power system on salmon populations. NOAA
14 Technical Memorandum, NMFS-NWFSC 63 (2004).
- 15 Williams, T. H., J. C. Garza, N. Hetrick, S. T. Lindley, M. S. Mohr, J. M. Myers,
16 M. R. O'Farrell, R. M. Quinones, and D. J. Teel. 2011. Upper Klamath
17 and Trinity River Chinook Salmon Biological Review Team report.
18 National Marine Fisheries Service, Southwest Region.
- 19 Winans, G. A., D. Viele, A. Grover, M. Palmer-Zwahlen, D. Teel, and D. Van
20 Doornik. 2001. An update on genetic stock identification of Chinook
21 salmon in the Pacific Northwest: test fisheries in California. Reviews in
22 Fisheries Science 9:213–237.
- 23 Winder, M., and A. D. Jassby. 2011. Shifts in Zooplankton Community
24 Structure: Implications for Food Web Processes in the Upper San
25 Francisco Estuary. Estuaries and Coasts (2011) 34:675–690 DOI
26 10.1007/s12237-010-9342-x.
- 27 Wright, S. A., and D. H. Schoellhamer 2004. Trends in the Sediment Yield of the
28 Sacramento River, California, 1957 – 2001. San Francisco Estuary and
29 Watershed Science, 2(2).
- 30 YCWA (Yuba County Water Agency). 2009. Green Sturgeon Downstream of
31 Englebright Dam. Preliminary Information Package, Public Information.
32 Yuba River Development Project, FERC Project No. 2246.
- 33 Yoshiyama, R. M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 1996.
34 Historical and Present Distribution of Chinook Salmon in the Central
35 Valley Drainage of California in Sierra Nevada Ecosystem Project. Final
36 Report to Congress. Volume III: Assessments, commissioned reports,
37 and background information. University of California, Davis, Centers for
38 Water and Wildland Resources.

- 1 Yoshiyama, R. M, E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001.
2 Historical and Present Distribution of Chinook Salmon in the Central
3 Valley Drainage of California. Contributions to the Biology of Central
4 Valley Salmonids, Volume 1. Edited by R. L. Brown. California
5 Department of Fish and Game Fish Bulletin 179: 71-177.
- 6 YTFP (Yurok Tribal Fisheries Program). 1998. Yurok Elder Interviews: Eulachon
7 and Lamprey. Internal Report.
- 8 Zedonis, P. 2003. Lewiston Dam Releases and Their Influence on Water
9 Temperatures of the Trinity River, CA, WY 2002. Report AFWO-F-04-
10 03. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office,
11 Arcata, CA 95521. 16 pp.
- 12 Zedonis, P. 2004. Lewiston Dam Releases and their Influence on Water
13 Temperatures of the Trinity and Klamath Rivers, CA, April to October,
14 2003. Report AFWO-F01-04. U.S. Fish and Wildlife Service, Arcata Fish
15 and Wildlife Office, Arcata, CA 95521. 34 pp.
- 16 Zedonis, P. 2005. The influence of Lewiston Dam Releases on Water
17 Temperatures of the Trinity and Klamath Rivers, CA, April to October,
18 2004. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office,
19 Arcata Fisheries Technical Report Number TR2005-03, Arcata,
20 California. 31 pp.
- 21 Zedonis, P. 2009. The Influence of Lewiston Dam Releases on Water
22 Temperatures of the Trinity and Klamath Rivers, CA, April to October,
23 2008. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office,
24 Arcata Fisheries Data Series Report Number DS 2009-15, Arcata,
25 California. 24 pp.
- 26 Zedonis, P., and R. Turner. 2006. The Influence of Lewiston Dam Releases on
27 Water Temperatures of the Trinity and Klamath Rivers, CA, April to
28 October, 2005. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
29 Office, Arcata Fisheries Data Series Report Number DS2006-08, Arcata,
30 California. 29 pp.
- 31 Zedonis, P., and R. Turner. 2007. The Influence of Lewiston Dam Releases on
32 Water Temperatures of the Trinity and Klamath Rivers, CA, April to
33 October, 2006. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
34 Office, Arcata Fisheries Data Series Report Number DS 2007-01, Arcata,
35 California.
- 36 Zedonis, P., and R. Turner. 2008. The Influence of Lewiston Dam Releases on
37 Water Temperatures of the Trinity and Klamath Rivers, CA, April to
38 October, 2007. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife
39 Office, Arcata Fisheries Data Series Report Number DS 2008-01, Arcata,
40 California.

- 1 Zeug, S.C. and B.J. Cavallo. 2012. Influence of estuary conditions on the
2 recovery rate of coded-wire-tagged Chinook salmon (*Oncorhynchus*
3 *tshawytscha*) in an ocean fishery. Ecology of Freshwater Fish Vol. 22,
4 Num. 1, Page(s): 157-168.
- 5 Zeug S.C., and B.J. Cavallo. 2014. Controls on the Entrainment of Juvenile
6 Chinook Salmon (*Oncorhynchus tshawytscha*) into Large Water
7 Diversions and Estimates of Population-Level Loss. PLoS ONE 9(7):
8 e101479. doi:10.1371/journal.pone.0101479.
- 9 Zeug, S. C., K. Sellheim, C. Watry, J. D. Wikert, and J. Merz. 2014. Response of
10 juvenile Chinook salmon to managed flow: lessons learned from a
11 population at the southern extent of their range in North America.
12 Fisheries Management and Ecology 21:155-168.
- 13 Zimmerman, C., G. Edwards, and K. Perry. 2008. Maternal Origin and
14 Migratory History of *Oncorhynchus mykiss* Captured in Rivers of the
15 Central Valley, California. Contract P0385300. Prepared for California
16 Department of Fish and Game.
- 17 Zimmerman, C. E., G. W. Edwards, and K. Perry. 2009. Maternal Origin and
18 Migratory History of steelhead and Rainbow Trout Captured in Rivers of
19 the Central Valley, California. Transactions of the American Fisheries
20 Society 138: 280-291.

Chapter 10**1 Terrestrial Biological Resources****2 10.1 Introduction**

3 This chapter describes terrestrial biological resources in the study area; and
4 potential changes that could occur as a result of implementing the alternatives
5 evaluated in this Environmental Impact Statement (EIS). Implementation of the
6 alternatives could affect terrestrial biological resources through potential changes
7 in operation of the Central Valley Project (CVP) and State Water Project (SWP)
8 and ecosystem restoration.

**9 10.2 Regulatory Environment and Compliance
10 Requirements**

11 Potential actions that could be implemented under the alternatives evaluated in
12 this EIS could affect terrestrial biological resources in areas: along the shorelines
13 and in the waters of reservoirs that store CVP and SWP water supplies, along
14 rivers and waterways (including bypasses) impacted by changes in the operations
15 of CVP or SWP reservoirs, within agricultural areas served by CVP and SWP
16 water supplies, and modified to provide wetland habitat. Actions located on
17 public agency lands; or implemented, funded, or approved by Federal and state
18 agencies would need to be compliant with appropriate Federal and state agency
19 policies and regulations, as summarized in Chapter 4, Approach to
20 Environmental Analyses.

21 10.3 Affected Environment

22 This section describes terrestrial biological resources that could potentially be
23 affected by implementing the alternatives considered in this EIS. Changes in
24 terrestrial biological resources due to changes in CVP and SWP operations may
25 occur in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast,
26 and Southern California regions.

27 Terrestrial biological resources occur throughout the study area. However, the
28 analysis in this EIS is focused on terrestrial biological resources that could be
29 directly or indirectly affected by the implementation of the alternatives analyzed
30 in this EIS. The areas that could be affected are related to specific areas: 1) along
31 the shorelines of reservoirs that store CVP and SWP water supplies, 2) along
32 rivers downstream of CVP or SWP reservoirs, 3) areas with wetland habitat
33 restoration in the Yolo Bypass and Suisun Marsh, 4) wildlife refuges that receive
34 CVP water supplies, 5) riparian corridors within the Delta, and 6) within
35 agricultural acreage that is irrigated with CVP and SWP water supplies.

1 Therefore, the following description of the affected environment is limited to
2 these areas.

3 **10.3.1 Overview of Species with Special Status**

4 Species with special status are defined as species that are legally protected or
5 otherwise considered sensitive by Federal, state, or local resource agencies,
6 including:

- 7 • Species listed by the Federal government as threatened or endangered,
- 8 • Species listed by the State of California as threatened, endangered, or rare
9 (rare status is for plants only),
- 10 • Species that are formally proposed for Federal listing or are candidates for
11 Federal listing as threatened or endangered,
- 12 • Species that are candidates for State listing as threatened or endangered,
- 13 • Species that meet the definitions of rare, threatened, or endangered under
14 California Environmental Quality Act,
- 15 • Species identified by the U.S. Fish and Wildlife Service (USFWS) as Birds of
16 Conservation Concern,
- 17 • Species considered sensitive by the U.S. Bureau of Land Management (BLM)
18 or U.S. Forest Service (USFS),
- 19 • Species identified by California Department of Fish and Wildlife (CDFW) as
20 species of special concern, species designated by California statute as fully
21 protected (e.g., California Fish and Game Code, sections 3511 [birds],
22 4700 [mammals], and 5050 [reptiles and amphibians] and 5515 [fish]) or bird
23 species on the CDFW Watch List, and
- 24 • Species, subspecies, and varieties of plants considered by CDFW and
25 California Native Plant Society (CNPS) to be rare, threatened, or endangered
26 in California. The CNPS Inventory of Rare and Endangered Plants of
27 California assigns California Rare Plant Ranks (CRPR) categories for plant
28 species of concern. Only plant species in CRPR categories 1 and 2 are
29 considered special status plant species in this document:
 - 30 – CRPR 1A—Plants presumed to be extinct in California.
 - 31 – CRPR 1B—Plants that are rare, threatened, or endangered in California
32 and elsewhere.
 - 33 – CRPR 2—Plants that are rare, threatened, or endangered in California but
34 more common elsewhere.

35 A listing of wildlife and plant species with special status that occur or may occur
36 in portions of the study area and are affected by the long-term coordinated
37 operation of the CVP and SWP is provided in Appendix 10A. Relevant
38 documents used to assemble these resource lists include the list of Federal
39 endangered and threatened species that occur in or may be affected by projects in

1 the counties within the study area generated on-line from the USFWS Sacramento
2 Fish and Wildlife Office.

3 To supplement the U.S. Fish and Wildlife lists, the California Natural Diversity
4 Database (CNDDDB) was queried (DFG 2012) for regions where recent
5 documentation was lacking. This included the Stanislaus River corridor between
6 New Melones Dam and the San Joaquin River confluence, and the Trinity River
7 Region, including Trinity Lake, Lewiston Reservoir, Whiskeytown Lake, and
8 Clear Creek between Carr Powerhouse and the Sacramento River confluence.

9 **10.3.1.1 Critical Habitat**

10 Critical habitat refers to areas designated by the USFWS for the conservation of
11 species listed as threatened or endangered under the Endangered Species Act of
12 1973, as amended through the 108th Congress (ESA). When a species is proposed
13 for listing under the ESA, the USFWS considers whether there are certain areas
14 essential to the conservation of the species. Critical habitat is defined in
15 Section 3, Provision 5 of the ESA as follows.

16 *(5)(A) The term “critical habitat” for a threatened or endangered species*
17 *means -*

18 *(i) the specific areas within the geographical area occupied by*
19 *a species at the time it is listed in accordance with the Act, on*
20 *which are found those physical or biological features*
21 *(I) essential to the conservation of the species, and (II) which*
22 *may require special management considerations or protection;*
23 *and*

24 *(ii) specific areas outside the geographical area occupied by a*
25 *species at the time it is listed in accordance with the provisions*
26 *of section 4 of this Act, upon a determination by the Secretary*
27 *that such areas are essential for the conservation of the*
28 *species.*

29 Any Federal action (permit, license, or funding) in critical habitat requires that
30 Federal agency to consult with the USFWS where the action has potential to
31 adversely modify the habitat for terrestrial species.

32 The federally listed wildlife and plant species considered in this EIS that have
33 designated critical habitat areas that could be affected by modification of CVP
34 and SWP operations are presented in Table 10.1 below. There are occurrences of
35 critical habitat of other species not included in Table 10.1 or other locations of
36 critical habitat of the species listed in Table 10.1 which are not included below
37 because those occurrences are not located within the CVP or SWP service areas
38 or in areas that could be affected by modification of CVP and SWP operations,
39 such as lands located at high elevations within national forests where CVP and
40 SWP water is not delivered.

1
2**Table 10.1 Terrestrial Species with Designated Critical Habitat in Portions of the Study Area that Could Be Affected by Changes in CVP and SWP Operations**

Species	Regions*	Counties
Least Bell's Vireo	Central Coast and Southern California	Riverside, San Bernardino, San Diego, Santa Barbara, Ventura
Buena Vista Lake Shrew	Central Valley	Kern
Fresno Kangaroo Rat	Central Valley	Fresno
California Tiger Salamander	Central Valley	Alameda, Kern, Kings, Madera, Merced, San Benito, San Joaquin, Santa Barbara, Solano, Stanislaus, Tulare, Yolo
California Red-legged Frog	Central Valley, San Francisco Bay Area, Central Coast, Southern California	Alameda, Butte, Contra Costa, El Dorado, Kern, Kings, Los Angeles, Merced, Nevada, Placer, San Benito, San Joaquin, Santa Barbara, Santa Clara, Solano, Stanislaus, Ventura, Yuba
Alameda Whipsnake	Central Valley and San Francisco Bay Area	Alameda, San Joaquin, Santa Clara
Valley Elderberry Longhorn Beetle	Central Valley	Sacramento
Conservancy Fairy Shrimp	Central Valley	Butte, Merced, Solano, Stanislaus, Tehama, Ventura
Longhorn Fairy Shrimp	Central Valley	Alameda, Contra Costa, Merced
Vernal Pool Fairy Shrimp	Central Valley and San Francisco Bay Area	Alameda, Butte, Contra Costa, Fresno, Glenn, Madera, Merced, Placer, Sacramento, San Benito, San Joaquin, Santa Barbara, Shasta, Solano, Stanislaus, Tehama, Tulare, Ventura, Yuba
Vernal Pool Tadpole Shrimp	Central Valley	Alameda, Colusa, Kings, Madera, Merced, Sacramento, Shasta, Solano, Stanislaus, Tehama, Tulare, Yolo, Yuba
Butte County Meadowfoam	Central Valley	Butte, Tehama
Colusa Grass	Central Valley	Merced, Stanislaus, Yolo
Hairy Orcutt Grass	Central Valley	Butte, Fresno, Madera, Merced, Stanislaus, Tehama
San Joaquin Hairy Orcutt Grass	Central Valley	Fresno, Madera, Merced, Tulare
Slender Orcutt Grass	Central Valley	Plumas, Sacramento, Shasta, Tehama

Species	Regions*	Counties
Sacramento Orcutt Grass	Central Valley	Sacramento
Solano Grass	Central Valley	Yolo
Contra Costa Goldfields	Central Valley	Solano
Contra Costa Wallflower	Central Valley and San Francisco Bay Area	Contra Costa, Sacramento
Fleshy Owl's-Clover	Central Valley	Madera, Merced, Sacramento, San Joaquin, Stanislaus
Greene's Tuctoria	Central Valley	Madera, Merced, Shasta, Stanislaus, Tehama
Hoover's Spurge	Central Valley	Butte, Merced, Tehama, Tulare
Keck's Checker-Mallow	Central Valley	Fresno
Soft Bird's-Beak	Central Valley and San Francisco Bay Area	Contra Costa, Solano
Suisun Thistle	Central Valley	Solano

1 Source: USFWS 2014a - 2014aj

2 Note:

3 * Only includes critical habitat within lands served by CVP or SWP water or in areas that
 4 could be affected by modification of CVP and SWP operations. Therefore, does not
 5 include lands where CVP and SWP water is not delivered or not affected by CVP and
 6 SWP operations.

7 **10.3.2 Trinity River Region**

8 The Trinity River Region includes the area along the Trinity River from Trinity
 9 Lake to the confluence with the Klamath River; and along the lower Klamath
 10 River from the confluence with the Trinity River to the Pacific Ocean. The
 11 Trinity River Region includes Trinity Lake, Lewiston Reservoir, the Trinity River
 12 between Lewiston Reservoir and the confluence with the Klamath River, and
 13 along the lower Klamath River.

14 The Trinity River includes the mainstem, North Fork Trinity River, South Fork
 15 Trinity River, New River, and numerous smaller streams (NCRWQCB et al.
 16 2009; USFWS et al. 1999). The mainstem of the Trinity River flows 170 miles to
 17 the west from the headwaters to the confluence with the Klamath River. As
 18 described in Chapter 5, Surface Water Resources and Water Supplies, the CVP
 19 Trinity Lake and Lewiston Reservoir are located upstream of the confluences of
 20 the Trinity River and the North Fork, South Fork, and New River. Flows on the
 21 North Fork, South Fork, and New River are not affected by CVP facilities. The
 22 Trinity River flows approximately 112 miles from Lewiston Reservoir to the
 23 Klamath River through Trinity and Humboldt counties and the Hoopa Indian
 24 Reservation within Trinity and Humboldt counties. The Trinity River is the
 25 largest tributary to the Klamath River (DOI and DFG 2012).

1 The lower Klamath River flows 43.5 miles from the confluence with the Trinity
2 River to the Pacific Ocean (USFWS et al. 1999). Downstream of the Trinity
3 River confluence, the Klamath River flows through Humboldt and Del Norte
4 counties and through the Hoopa Indian Reservation, Yurok Indian Reservation,
5 and Resighini Indian Reservation within Humboldt and Del Norte counties (DOI
6 and DFG 2012). There are no dams located in the Klamath River watershed
7 downstream of the confluence with the Trinity River. The Klamath River estuary
8 extends from approximately 5 miles upstream of the Pacific Ocean. This area is
9 generally under tidal effects and salt water can occur up to 4 miles from the
10 coastline during high tides in summer and fall when Klamath River flows are low.

11 As described in subsection 10.3.2, Overview of Species with Special Status, a
12 listing of wildlife and plant species with special status that occur or may occur in
13 portions of the study area affected by the long-term coordinated operation of the
14 CVP and SWP is provided in Appendix 10A.

15 **10.3.2.1 Trinity Lake and Lewiston Reservoir**

16 The dominant vegetation community in the Trinity River watershed upstream of
17 Trinity Lake and Lewiston Reservoir includes mixed conifer, with ponderosa
18 pine, sugar pine, and Douglas-fir as the dominant species. Some south-facing
19 slopes are dominated by oak and brush. Mixed hardwood communities occur at
20 lower elevations, and include species such as madrone, big-leaf maple, and a
21 variety of oaks. The shrub community at lower elevations includes a number of
22 chaparral species such as manzanita, bitterbrush, and deerbrush. South-facing
23 slopes around Trinity Lake contain shrub fields that provide winter range for the
24 Weaverville deer herd (USFS 2005; STNF 2014)

25 Along the margins of Trinity Lake and Lewiston Reservoir, vegetation is
26 consistent with species associated with a reservoir environment and standing
27 water, including floating species, rooted aquatic species, and emergent wetland
28 species. Emergent wetland and riparian vegetation is constrained by fluctuating
29 water levels and steep banks (NCRWQCB et al. 2009; USFWS et al. 1999).

30 The reservoirs attract resting and foraging waterfowl and other species that favor
31 standing or slow moving water. Impounded water in the reservoirs also provides
32 foraging habitat for eagles and other raptors that prey on fish (e.g., ospreys) and
33 waterfowl.

34 Recently, ten pairs of mating bald eagles were observed at Trinity Lake and three
35 pairs at Lewiston Lake (USFS 2012).

36 **10.3.2.2 Trinity River from Lewiston Reservoir to Klamath River**

37 Current terrestrial habitat along the Trinity River is different than habitat prior to
38 construction of Trinity and Lewiston dams. The ongoing Trinity River
39 Restoration Program is restoring portions of the habitat. The following
40 description reflects recent habitat changes along the mainstem of the Trinity River
41 between Lewiston Reservoir and the confluence of the Klamath River.

1 **10.3.2.2.1 Trinity River Restoration Program**

2 The hydrologic and geomorphic changes following construction of the Trinity and
3 Lewiston dams changed the character of the river channel substantially and
4 allowed riparian vegetation to encroach on areas that had previously been scoured
5 by flood flows (USFWS et al. 1999). This resulted in the formation of a riparian
6 berm that armored and anchored the river banks and prevented meandering of the
7 river channel. The berm reduced the potential for encroachment and maturation
8 of woody vegetation along the stabilized channel. In addition, the extent of
9 wetlands probably declined following dam construction due, in part, to reduced
10 flows and elimination of river meanders.

11 The ongoing Trinity River Restoration Program includes specific minimum
12 instream flows, as described in Chapter 5, Surface Water Resources and Water
13 Supplies; mechanical channel rehabilitation; fine and coarse sediment
14 management; watershed restoration; infrastructure improvement; and adaptive
15 management components (NCRWQCB et al. 2009; USFWS et al. 1999). The
16 mechanical channel rehabilitation includes removal of fossilized riparian berms
17 that had been anchored by extensive woody vegetation root systems and
18 consolidated sand deposits, and thereby, had confined the river. Following
19 removal of the berms, the areas had been re-vegetated to support native
20 vegetation, re-establish alternate point bars, and re-establish complex fish habitat
21 similar to conditions prior to construction of the dams. Sediment management
22 activities include introduction of coarse sediment at locations to support spawning
23 and other aquatic life stages; and relocation of sand outside of the floodway. In
24 areas closer to Lewiston Dam with limited gravel supply, gravel/cobble point bars
25 are being rebuilt to increase gravel storage and improve channel dynamics.
26 Riparian vegetation planted on the restored floodplains and flows will be
27 managed to encourage natural riparian growth on the floodplain and limit
28 encroachment on the newly formed gravel bars. Improvement projects have been
29 completed and others are under construction or in the planning phases. The
30 restoration actions are occurring between Lewiston Dam and the North Fork.

31 **10.3.2.2.2 Terrestrial Habitat**

32 Between the North Fork and the South Fork, the Trinity River channel is
33 restricted by steep canyon walls that limit riparian vegetation to a narrow band
34 (NCRWQCB et al. 2009; USFWS et al. 1999). Between the South Fork and the
35 confluence with the Klamath River, there are confined reaches with little riparian
36 vegetation, alternating with vegetation similar to the pre-dam conditions in the
37 upper reach below Lewiston dam.

38 Many wildlife species that inhabited river and riparian habitats prior to dam
39 construction still occur along the Trinity River. Species that prefer early-
40 successional stages or require greater riverine structural diversity are likely to be
41 less abundant under current conditions (NCRWQCB et al. 2009; USFWS et al.
42 1999). For example, western pond turtle declined since completion of the dams in
43 response to diminishing instream habitat. In contrast, species such as northern

1 goshawk and black salamander that favor mature, late-successional riparian
2 habitats increased with more upland habitat along the riparian corridor.

3 Current habitats along the Trinity River include annual grassland, fresh emergent
4 wetland, montane riparian, valley-foothill riparian, and riverine habitats
5 (NCRWQCB et al. 2009, 2013). The annual grassland species include grasses
6 (e.g., wild oat, soft brome, ripgut brome, cheatgrass, and barley); forbs
7 (e.g., broadleaf filaree, California poppy, true clover, and bur clover); and native
8 perennial species (e.g., Creeping Wildrye). The annual grassland habitat supports
9 Mourning Dove, Savannah Sparrow, White-Crowned Sparrow, American Kestrel,
10 Red-Tailed Hawk, coyote, California Ground Squirrel, Botta's Pocket Gopher,
11 California Kangaroo Rat, Deer Mouse, Gopher Snake, Western Fence Lizard,
12 Western Skink, Western Rattlesnake, and Yellow-Bellied Racer. The fresh
13 emergent wetland species occur along the backwater areas, depressions, and along
14 the river edges, including American Tule, Narrow-Leaved Cattail, Dense Sedge,
15 Perennial Ryegrass, Himalayan Blackberry, and Narrow-Leaved Willow.
16 Wildlife species along the fresh emergent wetland include Western Toad, Pacific
17 Chorus Frog, Bullfrog, Green Heron, Mallard, and Red-Winged Blackbird. The
18 montane riparian habitat adjacent to the river include trees, including bigleaf
19 maple, white alder, oregon ash, black cottonwood, and Goodding's black willow;
20 and understory species, including mugwort, virgin's bower, American dogwood,
21 oregon golden-aster, dalmatian toadflax, white sweet clover, musk monkeyflower,
22 straggly gooseberry, California grape, and California blackberry. The valley-
23 foothill riparian habitat occur along alluvial fans, slightly dissected terraces, and
24 floodplains; and include cottonwood, California sycamore, valley oak, white
25 alder, boxelder, Oregon ash, wild grape, wild rose, California blackberry, blue
26 elderberry, poison oak, buttonbush, willow, sedge, rushes, grasses, and miner's
27 lettuce. Riparian woodlands along the montane riparian habitat support breeding,
28 foraging, and roosting habitat for tree swallow, bushtit, White-Breasted Nuthatch,
29 Nuttall's Woodpecker, Downy Woodpecker, Spotted Towhee, and Song Sparrow;
30 cover for amphibians, including Western Toad and Pacific Chorus Frog; and
31 habitat for deer mouse, raccoon, and Virginia Opossum. The riverine habitat
32 supports amphibians and reptiles, including Western Toad, Pacific Chorus Frog,
33 bullfrog, and Western Pond Turtle; birds, including mallard, Great Blue Heron,
34 Osprey, and Belted Kingfisher; and mammals, including river otter, beaver, Big
35 Brown Bat, and Yuma Myotis (bat).

36 The lands upslope of the Trinity River are characterized by mixed chaparral,
37 montane hardwood-conifer, blue oak-foothill pine, foothill pine, and Klamath
38 mixed conifer (NCRWQCB et al. 2009, 2013). The trees include Pacific
39 madrone, bigleaf maple, canyon live oak, black oak, blue oak, ponderosa pine,
40 Douglas fir, and incense cedar. Shrubs include greenleaf manzanita, buckbrush,
41 cascara, snowberry, and poison oak. Underlying herbaceous vegetation includes
42 ripgut brome, blue wild rye, silver bush lupine, purple sanicle, false hedge-
43 parsley, The habitats support numerous birds, including Northern Flicker,
44 Stellar's Jay, Hairy Woodpecker, Acorn Woodpecker, Wrentit, Bewick's Wren,
45 California Quail, Mountain Quail, Blue Grouse, Sharp-Shinned Hawk, Red-Tailed
46 Hawk, and Great Horned Owl; mammals including Black-Tailed Deer, Gray Fox,

1 coyote, Black-Tailed Jackrabbit, Raccoon, Virginia Opossum, Spotted Skunk,
 2 Gray Squirrel, Allen's Chipmunk, Deer Mouse, and Pallid Bat; and reptiles and
 3 amphibians, including California Kingsnake, Western Rattlesnake, Sharp-Tailed
 4 Snake, Western Fence Lizard, Southern Alligator Lizard, and Ensatina.

5 Inundation of lands by Trinity Lake, Lewiston Reservoir, and Whiskeytown Lake
 6 inundated approximately 20,500 acres of habitat for an estimated 8,500 black-
 7 tailed deer (USFWS 1975). The CDFW established a deer herd management plan
 8 for the Critical Winter Range for the Weaverville deer herd. A portion of the
 9 winter range is located along the Trinity River (NCRWQCB et al. 2009).

10 **10.3.2.3 Lower Klamath River Watershed from Trinity River to the** 11 **Pacific Ocean**

12 The Klamath River from the confluence with the Trinity River to the Pacific
 13 Ocean is characterized by a forested river canyon with riparian vegetation
 14 occurring along the channel. There is a greater diversity of riparian vegetation
 15 along the lower Klamath River below the mouth of the Trinity River, partly as a
 16 result of a more natural hydrograph on the Klamath River than exists on the
 17 Trinity River. Plant species composition changes as the Klamath River nears the
 18 Pacific Ocean; because the river slows, temperatures increase, and the tides
 19 affect salinity.

20 Grazing, timber harvest, and roads have degraded riparian conditions along the
 21 lower Klamath River (Yurok Tribe 2000). Riparian areas are dominated by
 22 deciduous trees including red alder. Red alder is a typical hardwood in riparian
 23 zones, tanoak is a typical hardwood on mid to upper slopes, and Pacific madrone
 24 occurs in small stands on drier sites (Green Diamond Resource Company 2006).

25 The broad lower Klamath River meanders within the floodplain and supports
 26 wetland habitats similar to those that existed pre-dam along the Trinity River.
 27 Wetland habitats along the lower Klamath River are dominated by cattails, tules,
 28 and a variety of rushes and sedges. As the river nears the ocean, salt-tolerant
 29 plants such as cord grass and pickleweed increase in abundance as the salinity
 30 increases (USFWS et al. 1999). Wildlife species in the lower Klamath River
 31 watershed are similar to those found in the Trinity River watershed.

32 **10.3.3 Central Valley Region**

33 The Central Valley Region extends from above Shasta Lake to the Tehachapi
 34 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and
 35 Suisun Marsh.

36 The Central Valley Region includes portions of the Sacramento Valley and San
 37 Joaquin Valley; including the Delta, Suisun Marsh, and the Yolo Bypass. The
 38 areas where terrestrial biological resources could potentially be affected include
 39 the fluctuation zones associated with reservoirs; river margins influenced by the
 40 magnitude, duration, and frequency of flows; and agricultural lands and refuges
 41 served by CVP and SWP water supplies.

1 The Central Valley Region is predominantly made up of lowlands and plains
2 surrounded by foothills and tall mountains of the Coast Ranges to the west, the
3 Cascade Range to the north, the Sierra Nevada Mountains to the east, and the
4 Tehachapi Mountains to the south. Communities of various sizes and an
5 extensive network of roadways are located throughout the valley.

6 Land use within the Sacramento Valley and San Joaquin Valley is dominated by
7 agriculture and urban development. Grassland and oak woodland habitats occur
8 in the foothills, particularly in the mid-elevation eastern margin of the Sacramento
9 and San Joaquin valleys. Coniferous forests, mixed hardwood/coniferous forests,
10 and oak woodlands generally represent the dominant vegetation surrounding CVP
11 and SWP reservoirs. Riparian vegetation is generally constrained to narrow
12 ribbons immediately adjacent to creeks and rivers. Many of the wetlands and
13 riparian areas that once occurred in the Central Valley have been eliminated as a
14 consequence of land use conversion to agriculture and urbanization.

15 **10.3.3.1 Overview of Terrestrial Communities**

16 This section describes the terrestrial communities in the Central Valley Region
17 that could be affected directly or indirectly by operations of the CVP and SWP.
18 These communities are broadly described for lakes/reservoirs (including open
19 water and drawdown areas); rivers (including open water and riparian and
20 floodplain areas); wetlands; and agricultural lands that could be affected by
21 changes in water deliveries and ecosystem restoration activities. Other
22 communities are described for areas that could be affected by restoration activities
23 related to the proposed action and alternatives.

24 **10.3.3.1.1 Lake/Reservoir Communities**

25 Reservoirs that store CVP and SWP water supplies provide habitat used by some
26 terrestrial species, either within the open water area of the reservoirs or along the
27 margins and in the drawdown areas.

28 *Open Water Areas*

29 As described in Chapter 5, Surface Water Resources and Water Supplies, water
30 surface elevations in reservoirs that store CVP and SWP water supplies change
31 seasonally and annually due to hydrologic and operational variables. The open
32 water areas of these reservoirs are used as foraging and resting sites by waterfowl
33 and other birds, and by semi-aquatic mammals such as river otter and beaver.
34 Bald Eagles and Ospreys nest in forests at the margins of these reservoirs, and
35 frequently use the reservoirs to forage for fish.

36 *Margin and Drawdown Areas*

37 The CVP and SWP reservoirs in the Central Valley are generally located in
38 canyons where the surrounding slopes are dominated by upland vegetation such
39 as woodland, forest, and chaparral. The water surface elevations in these
40 reservoirs fluctuate within the inundation area, as described in Chapter 5, Surface
41 Water Resources and Water Supplies, between maximum allowed storage
42 elevations and minimum elevations defined by the lowest elevation on the intake
43 structure. Along the water surface edge of the inundation area, the soils are

1 usually shallow. Soil is frequently lost to wave action and periodic inundation,
 2 followed by severe desiccation when the water elevation declines, which
 3 generally results in a barren drawdown zone around the perimeter of the
 4 reservoirs. Natural regeneration of vegetation within the drawdown zone is
 5 generally prevented by the timing of seed release when reservoir levels are high in
 6 the spring, lack of sediment replenishment necessary for seedling establishment in
 7 the spring, and high temperatures combined with low soil moisture levels of
 8 exposed soils in the summer.

9 Lack of vegetative cover within the drawdown zone can limit wildlife use of this
 10 area. Rapidly rising reservoir levels can potentially result in direct mortality of
 11 some sedentary wildlife species or life stages within the drawdown zone of
 12 reservoirs. As reservoir levels drop, energy expenditures can increase for
 13 piscivorous (fish-eating) birds foraging in the reservoirs as these species must
 14 travel greater distances to forage (DWR 2004a).

15 **10.3.3.1.2 Riverine Communities**

16 The rivers and streams influenced by the long-term coordinated operation of the
 17 CVP and SWP support habitats for plants and wildlife. The primary components
 18 of the riverine environment that support plants and wildlife, including open water
 19 areas and adjacent riparian and floodplain communities (including bypasses that
 20 are inundated at high flows), are described below.

21 *Open Water Areas*

22 The riverine environment downstream of reservoirs is managed generally for
 23 water supply and flood control purposes. As such, the extent of open water in the
 24 rivers varies somewhat predictably, although not substantially, within and among
 25 years. In the wetter years when bypasses and floodplains are inundated, vast
 26 areas of open water become available during the flood season, generally in the
 27 late winter and early spring. Open water portions of riverine systems provide
 28 foraging habitat for fish eating birds and waterfowl. Gull, Tern, Osprey, and Bald
 29 Eagle forage over open water. Near shore and shoreline areas provide foraging
 30 habitat for birds such as waterfowl, heron, egret, shorebirds, and belted kingfisher.
 31 Many species of insectivorous birds such as swallows, swifts, and flycatchers
 32 forage over open water areas of lakes and streams. Mammals known to associate
 33 with open water and shoreline habitats include river otter, American mink,
 34 muskrat, and beaver.

35 *Riparian and Floodplain Areas*

36 The riparian and floodplain communities that could be affected by CVP and SWP
 37 operations refers primarily to the vegetation and associated wildlife community
 38 supported and influenced by proximity to the waterway, including areas
 39 frequently flooded by rising water levels in the rivers (floodplains). The extent of
 40 riparian vegetation within the Central Valley has been reduced over time due to a
 41 variety of actions, including local, state, and Federal construction and operation of
 42 flood control facilities isolated historic floodplains; agricultural and land use
 43 development that occurred following development of flood control projects;
 44 regulation of flows from dams that has reduced the magnitude and frequency of

1 larger flow events, increased recession rates, and increased summertime flows;
2 and construction and maintenance of active ship channels by the U.S. Army Corps
3 of Engineers (USACE) (DWR 2012). Currently, levee and bank protection
4 structures associated with the flood protection system are present along more than
5 2,600 miles of rivers in the Central Valley, including the Delta (DWR 2009a).

6 Characteristic riparian tree species in the Central Valley include willows,
7 cottonwoods, California sycamore, and valley oaks. Typical understory plants
8 include elderberry, blackberries, and poison oak. On the valley floor in the deep
9 alluvial soils, the structure and species composition of the plant communities
10 change with distance from the river, with the denser stands of willow and
11 cottonwood at the water's edge transitioning into stands of valley oaks on the less
12 frequently inundated terraces. In other areas, the riparian zone does not support a
13 canopy of large trees and instead is dominated by shrub species (sometime
14 referred to as riparian scrub).

15 Riparian and floodplain vegetation supports wildlife habitats because of its high
16 floristic and structural diversity, high biomass and high food abundance, and
17 proximity to water. In addition to providing breeding, foraging, and roosting
18 habitat for an array of animals, riparian and floodplain vegetation also provides
19 movement corridors for some species, connecting a variety of habitats throughout
20 the region. The Sacramento and San Joaquin valleys lack substantial areas of
21 natural habitat that support native biodiversity or corridors between the areas of
22 natural habitat; therefore, riparian and floodplain corridors play a critical role in
23 connecting wildlife among the few remaining natural areas (CalTrans and
24 DFG 2010).

25 Typical wildlife species associated with the riparian and floodplain communities
26 include mammals such as striped skunk, raccoon, and gray fox. Riparian bird
27 species include Red-Shouldered Hawk, Wood Duck, Great Blue Heron, Black-
28 Crowned Night Heron, and many neotropical migratory birds, including Yellow
29 Warbler and Western Yellow-Billed Cuckoo. Amphibians and reptiles include
30 Pacific Tree Frog, Pacific Gopher Snake, Garter Snake, and Western Pond Turtle.
31 Special status species that associate with riparian and floodplain habitats include
32 Bank Swallow (state listed), Western Yellow-Billed Cuckoo (Federally and state
33 listed), and the Valley Elderberry Longhorn Beetle (Federally listed).

34 River flows and associated hydrologic and geomorphic processes are important
35 for maintaining riparian and floodplain ecosystems. Most aspects of a flow
36 regime (e.g., the magnitude, frequency, timing, duration, and sediment load)
37 affect a variety of riparian and floodplain habitat processes. Two processes that
38 create riparian and floodplain ecosystems are disturbance and plant recruitment.
39 The interaction of these processes across the landscape is primarily responsible
40 for the pattern and distribution of riparian and floodplain habitat structure and
41 condition, and for the composition and abundance of riparian-associated species.

42 High flow events and associated scour, deposition, and prolonged inundation can
43 create exposed substrate for plant establishment or openings in existing riparian
44 and floodplain communities. Early successional species, like cottonwoods and

1 willows that recruit into these openings, become more abundant in the landscape
2 as vegetation grows within disturbed areas. As a result, structural and species
3 diversity within riparian and floodplain vegetation could increase, as could overall
4 wildlife habitat values. Without disturbance, larger trees and species less tolerant
5 of frequent disturbance begin to dominate riparian woodlands.

6 The recruitment of cottonwoods and willows especially depends on geomorphic
7 processes that create bare mineral soil through erosion and deposition of sediment
8 along river channels and on floodplains, and on flow events that result in
9 floodplain inundation. Receding flood flows that expose moist mineral soil create
10 ideal conditions for germination of cottonwood and willow seedlings. After
11 germination occurs, the water surface must decline gradually to enable seedling
12 establishment. Riparian and floodplain communities also undergo natural
13 disturbance cycles when flood flows remove streamside vegetation and
14 redistribute sediments and seeds, thereby maintaining habitat diversity for
15 terrestrial species that associate with riparian and floodplain corridors.

16 Both prolonged drought and prolonged inundation, however, can lead to plant
17 death and loss of riparian plants (Kozlowski and Pallardy 2002). Riparian plants
18 have high moisture requirements during the active growing season (spring
19 through fall), and dry soil conditions can reduce growth and injure or kill plants.
20 On the other hand, prolonged inundation creates anaerobic conditions that, during
21 the active growing season, also can reduce growth, injure, or kill plants.

22 The continuation of riparian and floodplain communities is anticipated to change
23 along levees within the federally authorized levee systems that have maintenance
24 agreements with the USACE (including Delta levees along the Sacramento and
25 San Joaquin rivers) and other levees that are eligible for the federal Rehabilitation
26 and Inspection Program (Public Law 84-99). As described in Section 3.3.2.2 of
27 Chapter 3, Description of Alternatives, the vegetation management policies of the
28 USACE were changed in 2009 and 2010. Historically, the USACE allowed brush
29 and small trees to be located on the waterside of federal flood management
30 project levees if the vegetation would preserve, protect, and/or enhance natural
31 resources, and/or protect rights of Native Americans, while maintaining the
32 safety, structural integrity, and functionality of the levee (DWR 2011). After
33 Hurricane Katrina in 2005, the USACE issued a policy and draft policy guidance
34 to remove substantial vegetation from these levees throughout the nation (USACE
35 2009). In 2010, the USACE issued a draft policy guidance letter, *Draft Process
36 for Requesting a Variance from Vegetation Standards for Levees and
37 Floodwalls—75 Federal Register 6364-68* (USACE 2010) that included
38 procedures for State and local agencies to request variances on a site-specific
39 basis. DWR has been in negotiations with USACE to remove vegetation on the
40 upper third of the waterside slope, top, and landside of the levees, and continue to
41 allow vegetation on the lower two-thirds of the waterside slope of the levee and
42 along benches above the water surface (DSC 2011). The effects of these changes
43 have not become widespread at this time. Future conditions under these
44 requirements are further described under the description of the No Action

1 Alternative in this chapter (see Section 10.4.2.1.3, Changes in River and Delta
2 Floodplains).

3 **10.3.3.1.3 Wetlands, Marshes, and Wet Meadows**

4 Wetlands in the Central Valley can be characterized as perennial or seasonal with
5 perennial wetlands further classified as tidal or non-tidal. Natural, non-tidal
6 perennial wetlands are scattered along the Sacramento and San Joaquin rivers,
7 typically in areas with slow moving backwaters. Management of wetlands,
8 marshes, and wet meadows can include irrigation of open areas to support native
9 herbaceous plants or cultivated species; periodic or continuous flooding to
10 provide feeding and roosting sites for many wetland-associated birds; and either
11 limited or no tilling or disturbance of the managed areas.

12 Managed seasonal wetlands on the west side of the Sacramento River generally
13 occur between Willows and Dunnigan along the Colusa Basin Drain. Substantial
14 portions of these managed wetland habitats occur at the flood bypasses, including
15 the Yolo Bypass Wildlife Area and Fremont Weir, as a part of the Sacramento
16 National Wildlife Refuge Complex, and around the Thermalito Afterbay
17 (Reclamation 2010a). Both tidal and nontidal, perennial wetlands are found in the
18 Delta and Suisun Marsh.

19 *Perennial Non-tidal (Freshwater) Wetlands and Marshes*

20 In the Sacramento and San Joaquin valleys and foothills, perennial non-tidal
21 wetland habitats include freshwater emergent wetlands and wet meadows.
22 Freshwater emergent wetlands, or marshes, are dominated by large, perennial
23 herbaceous plants, particularly tules and cattails, which are generally restricted to
24 shallow water. In marshes, vegetation structure and the number of species are
25 strongly influenced by disturbance, changes in water levels, and the range of
26 elevations present at a site. Wet meadows are similar to perennial freshwater
27 wetlands in many regards; however, they are dominated by a greater variety of
28 perennial plants such as rushes, sedges, and grasses than are found in freshwater
29 wetlands. Perennial freshwater wetlands also provide ecological functions related
30 to water quality and hydrology. These areas generally qualify as jurisdictional
31 wetlands subject to U.S. Army Corps of Engineers jurisdiction under Sections 401
32 and 404 of the federal Clean Water Act.

33 Perennial freshwater wetlands are among the most productive wildlife habitat in
34 California (CDFW 1988a). In the Sacramento and San Joaquin valleys and
35 foothills, these wetlands support several sensitive amphibians, reptiles, birds, and
36 mammals. Perennial freshwater wetlands also provide food, cover, and water for
37 numerous species of wildlife. Wetlands in the Sacramento and San Joaquin
38 valleys and foothills are especially important to migratory birds and wintering
39 waterfowl.

40 *Seasonal Wetlands*

41 Natural seasonal wetlands occur in topographic depressions and swales that are
42 seasonally saturated and exhibit hydric soils that support hydrophytic plant
43 species. Natural seasonal wetlands are generally dominated by hydrophytic plants

1 during the winter and spring months. Characteristic plant species in seasonal
 2 wetlands consist of both native and nonnative species. Native species include
 3 coyote thistle, toad rush, hyssop loosestrife, and foothill meadowfoam. Natural
 4 seasonal wetlands provide food, cover, and water for numerous common and
 5 special status species of wildlife that rely on wetlands for all or part of their life
 6 cycle. Like perennial wetlands, seasonal wetlands have been substantially
 7 reduced from their historical extent.

8 Numerous managed seasonal wetlands occur within the Sacramento Colusa,
 9 Sutter, Tisdale, and Yolo Bypasses and around the Thermalito Afterbay
 10 (Reclamation 2010a).

11 Managed marsh areas are intentionally flooded and managed during specific
 12 seasonal periods to enhance habitat values for specific wildlife species (CALFED
 13 2000). Managed marsh areas are distributed largely in the northern, central, and
 14 western portions of the Delta, as well as in Suisun Marsh and the Yolo Bypass,
 15 Stone Lakes National Wildlife Refuge, Cosumnes River Preserve, and
 16 Suisun Marsh.

17 *Perennial Tidal Wetlands and Open Water*

18 In the Central Valley, tidal wetlands and open water are primarily found in the
 19 Delta and Suisun Marsh. Tidal wetlands are influenced by tidal movement of salt
 20 water from San Francisco Bay and inflow of freshwater from the Delta and
 21 smaller local watersheds. Tidal open water in the Delta is mainly freshwater
 22 habitat, with brackish and saline conditions occurring in the western Delta at
 23 times of high tides and low flows into the western Delta. It is freshwater in the
 24 Yolo Bypass and mainly brackish and saline in Suisun Marsh. Tidal mudflats
 25 occur as mostly unvegetated sediment deposits in the intertidal zone between the
 26 tidal wetland communities at its upper edge and the tidal perennial aquatic
 27 community at its lower edge. Tidal brackish wetlands exist from near Collinsville
 28 westward to the Carquinez Strait. Suisun Marsh is the largest contiguous brackish
 29 water marsh remaining on the North America west coast (Reclamation et al.
 30 2011). Tidal freshwater marshes occur at the shallow, slow-moving or stagnant
 31 edges of freshwater waterways in the intertidal zone and are subject to frequent
 32 long duration flooding.

33 Salinity levels vary throughout the year and are influenced largely by inflow from
 34 the Delta (Reclamation et al. 2011). Tidal water in the Delta is mainly freshwater,
 35 with brackish and saline conditions occurring in the western Delta at times of high
 36 tides and low flows into the western Delta. Tidal marshes associated with the
 37 lower Yolo Bypass are freshwater, whereas they are mainly brackish and saline in
 38 Suisun Marsh where tidal brackish marshes exist from near Collinsville westward
 39 to the Carquinez Strait.

40 **10.3.3.1.4 Agricultural Lands**

41 Agricultural land uses and farming practices in the Central Valley provide
 42 habitats and resources for a variety of terrestrial species, including several Federal
 43 and state special status species. Agricultural lands are primarily found within the

1 Sacramento and San Joaquin valleys on the rich alluvial soils of the riverine
2 floodplains. The distribution of seasonal crops varies annually and seasonally,
3 depending on market forces and crop-rotation patterns. Some of the principal
4 crop types and their value to wildlife are described below.

5 Crops in the Sacramento and San Joaquin valleys include grain and seed crops
6 (e.g., barley and wheat), forage crops (e.g., hay and alfalfa), row crops
7 (e.g., tomatoes, lettuce, sugar beets), cotton, orchards (e.g., almonds, walnuts,
8 peaches, plums), and vineyards. There are also areas of irrigated pastureland
9 throughout the Sacramento and San Joaquin valleys.

10 Grain and seed crops include wheat, barley, corn, and other annual grasses that
11 are grown in dense stands. Most of the value for wildlife occurs during the early
12 growing period because the later dense growth makes it difficult for wildlife to
13 move through these fields. Following harvesting, waste grain is available to
14 waterfowl and other birds, such as sandhill crane. Row crop and silage fields
15 generally provide lesser value to wildlife than native cover types, but can support
16 abundant populations of small mammals, such as California vole and western
17 harvest mouse. These species attract predators such as snakes and raptors. Other
18 reptile and bird species prey on the abundant insect populations found in row crop
19 and silage fields.

20 Species generally associated with field and row crops include the Red-Winged
21 Blackbird, Western Meadowlark, California Vole, Black-Tailed Jackrabbit,
22 Western Harvest Mouse, Botta's Pocket Gopher, Raccoon, Striped Skunk, and
23 Virginia Opossum. Croplands also provide foraging habitat for many raptors
24 including Swainson's Hawk, Northern Harrier, Red-Tailed Hawk, and
25 White-Tailed Kite.

26 Alfalfa is irrigated and intensively mowed such that vegetation structure varies
27 with the growing, harvesting, and fallowing cycle. As a result, alfalfa supports
28 some of the highest biodiversity amongst crops in California, second only to rice
29 in agricultural habitat biodiversity (Hartman and Kyle 2010), with many species
30 using alfalfa to forage, nest, rest, and hide. A wide range of species, including
31 songbirds, swallows, bats, and many types of waterfowl and migratory birds feed
32 on insects in alfalfa fields. Mammals such as gophers, mice, and rabbits feed
33 directly on alfalfa. Larger herbivorous mammals, such as deer, antelope, and elk,
34 frequent alfalfa fields, especially during dry or cold seasons. Hawks, eagles,
35 migratory birds, coyotes, and mountain lions feed on the birds and rodents that
36 feed on the alfalfa. Scavengers such as coyotes and vultures feed on carrion
37 (Putnam et al. 2001).

38 Rice cultivation is also widespread in the Sacramento Valley. Rice fields provide
39 surrogate wetland habitats and many wetland wildlife species use rice fields,
40 especially waterfowl and shorebirds, and wading birds that forage on aquatic
41 invertebrates and vertebrates such as crayfish and small fish. Foraging
42 opportunities are provided by fish that become entrained in the irrigation canals
43 that supply water to the rice fields and the crayfish that are found along canal
44 banks and berms of the rice fields. Other wildlife species that use flooded rice

1 fields include Giant Garter Snake and bullfrog. Ring-necked pheasant and
2 Sandhill Cranes among others forage on post-harvest waste grain. The practice of
3 flooding rice fields in winter to allow for decomposition of rice stubble, as
4 opposed to burning, enhances the wildlife value of rice fields. Winter flooding
5 provides loafing and foraging opportunities for a variety of birds, including
6 waterfowl, cranes, herons, and egrets.

7 Orchards and vineyards, typically dominated by a single tree species, are grown in
8 fertile areas that once supported diverse and productive habitats for wildlife.

9 Orchards and vineyards generally provide relatively low wildlife value; however,
10 some species of birds and mammals have adapted to orchard and vineyard
11 habitats. Many have become "agricultural pests" which result in crop losses.

12 Deer and rabbits browse on the trees while other wildlife such as squirrels and
13 numerous birds feed on fruit or nuts. Cover crops grown under the trees provide a
14 food source for wildlife that feed on seeds or herbaceous vegetation. Wildlife

15 species reported to feed on nuts (almonds and walnuts) include Northern Flicker,
16 Western Scrub-Jay, American Crow, Plain Titmouse, Brewer's Blackbird, House
17 Finch, Gray Squirrel and California Ground Squirrel (DFG 1999a, 1999b, 1999c).

18 Other fruit crops such as apples, cherries, figs, pears and prunes are also eaten by
19 these same species and others such as Band-Tailed Pigeon, Yellow-Billed

20 Magpie, Western Bluebird, American Robin, Varied Thrush, Northern

21 Mockingbird, Cedar Waxwing, Yellow-Rumped Warbler, Black-Headed

22 Grosbeak, Bullock's Oriole, Desert Cottontail, Gray Squirrel, coyote, black bear,

23 raccoon, and Mule Deer. Evergreen orchards (citrus, olives, avocado) do not
24 provide the food for wildlife that many of the deciduous fruit and nut trees

25 provide. Mourning Dove and California Quail use orchard habitats for cover and

26 nesting sites. Carnivores such as fox, bobcat, and coyote frequently use avocado

27 orchards (Nogeire et al. 2013). Irrigated pastures are managed grasslands with a

28 low structure of native herbaceous plants, cultivated species, or a mixture of both.

29 Pastures are not typically tilled or disturbed frequently and provide breeding

30 opportunities for ground-nesting birds, including waterfowl, Ring-Necked

31 Pheasant, and Sandhill Crane if adequate residual vegetation is present. Flood

32 irrigation of pastures provides feeding and roosting sites for many wetland-

33 associated birds, including shorebirds, wading birds, gulls, waterfowl, and raptors.

34 Large mammals such as deer, and elk graze in pastures when there is adequate

35 escape cover adjacent to the open pasture. Burrowing species using irrigated

36 pastures include California Ground Squirrel, Pocket Gophers, and Burrowing

37 Owls. Pastures provide foraging habitat for grassland-foraging wildlife, such as

38 coyote and fox, and raptors like the Northern Harrier, American Kestrel, and

39 Red-Tailed Hawk.

40 In addition to the crop lands, the network of irrigation canals, drains, and

41 reservoirs that convey water in the agricultural areas provide habitat for many

42 species of wildlife, including species with special status. These conveyance

43 features, particularly those that contain water throughout the growing season,

44 typically support some of the plants and animals characteristic of riverine systems

45 and riparian areas. While water flows through many of these facilities

46 intermittently, these features can provide habitat for species, such as Giant Garter

1 Snake. Giant Garter Snake is frequently associated with the water conveyance
2 systems that support rice cultivation.

3 **10.3.3.1.5 Invasive Species**

4 Invasive plants and wildlife are species that are not native to the region, persist
5 without human assistance, and have serious impacts on the environment. They
6 are termed “invasive” because they displace native species and alter habitat
7 functions and values. Many invasive plant species are considered “noxious
8 weeds” by governmental agencies such as the U.S. Department of Agriculture and
9 California Department of Food and Agriculture. Numerous invasive plants have
10 been introduced into the study area, and many have become established. The
11 California Invasive Plant Council maintains a list of species that have been
12 designated as invasive in California (CalIPC 2006).

13 According to the California Department of Fish and Wildlife’s aquatic invasive
14 species management plan (DFG 2008), invasive species threaten the diversity or
15 abundance of native species through competition for resources, predation,
16 parasitism, hybridization with native populations, introduction of pathogens, or
17 physical or chemical alteration of the invaded habitat. Unlike the native riparian
18 flora, many invasive riparian species do not provide the food, shelter, and other
19 habitat components on which many native fish and wildlife species depend. In
20 addition to the ability to degrade wildlife habitat, many of these invasive trees and
21 shrubs have the potential to harm human health and the economy by adversely
22 affecting the ecosystem, flood protection systems, water delivery, recreation, and
23 agriculture.

24 Changes in CVP and SWP operations would affect the wetted edges at CVP and
25 SWP reservoirs, reservoirs that store CVP and SWP water supplies, and along the
26 rivers downstream of the CVP and SWP reservoirs. Therefore, only those
27 invasive plant species that are associated with the margins at these waterways
28 would be likely to cause adverse effects on terrestrial biological resources.
29 Examples of these species include tree-of-heaven, giant reed, purple loosestrife,
30 perennial pepperweed, tamarisk, and red sesbania. In addition to the potential
31 effects caused by changed water operations, invasive species have the potential to
32 be introduced as part of construction of habitat restoration, or to colonize areas
33 disturbed by restoration construction activities (e.g., yellow star thistle, perennial
34 pepperweed, Spanish broom, Himalaya blackberry).

35 **10.3.3.2 Sacramento Valley**

36 The Sacramento Valley portion of the Central Valley Region considered in this
37 EIS includes Shasta Lake, Keswick Reservoir, and the Sacramento River from
38 Keswick Reservoir to the Delta. The Sacramento Valley also includes the lower
39 Yuba River and the middle and lower portions of the Feather River and American
40 River watersheds that are influenced by CVP and SWP operations, respectively.

41 Historically, the Sacramento Valley contained a mosaic of riverine, wetland, and
42 riparian communities with terrestrial habitats consisting of perennial grassland
43 and oak woodlands. With development of the Sacramento Valley, native habitats

1 were converted to cultivated fields, pastures, residences, water impoundments,
2 and flood-control structures. As a result, native habitats generally are restricted in
3 their distribution and size and are highly fragmented.

4 A listing of wildlife and plant species with special status that occur or may occur
5 in portions of the study area affected by the long-term coordinated operation of
6 the CVP and SWP is provided in Appendix 10A.

7 The USFWS has approved a habitat conservation plan for the Natomas
8 Basin/Metropolitan Air Park near Sacramento. Six other habitat conservation
9 plans are being prepared in the Sacramento Valley, including programs for Butte
10 County, Yuba-Sutter counties, Placer County, Yolo County, South Sacramento
11 County, and Solano County.

12 **10.3.3.2.1 Shasta Lake and Keswick Reservoir**

13 The area in which Shasta Lake is situated is characterized by a variety of
14 vegetation and wildlife habitats typical of transitional mixed woodland and low-
15 elevation forest habitats (Reclamation 2013a). The majority of vegetation
16 communities and wildlife habitats around Shasta Lake are tree-dominated, and
17 include upland forests with associated mixed chaparral, riparian forests, and
18 woodlands. Other wildlife habitats around the lake include annual grasslands and
19 barren areas. Montane riparian, the dominant riparian vegetation type at and near
20 Shasta Lake, also occurs as thin stringers and patches along most stream corridors
21 tributary to Shasta Lake.

22 Wildlife species around Shasta Lake are those typically associated with
23 tree-dominated habitats and chaparral (Reclamation 2013a). Mammals in these
24 habitats include deer, rabbits, chipmunks, and squirrels. Mature trees provide
25 nesting habitat for raptors such as the bald eagle and osprey. Hollow trees and
26 logs provide denning sites for mammals such as the coyote and skunks, and
27 cavities in mature trees are used by cavity-dwelling species such as the Acorn
28 Woodpecker and California Myotis. Many amphibians and reptiles, including
29 *Ensatina*, Western Skink, and Western Fence Lizard, inhabit the detrital layer of
30 moist areas. Snakes, including the Western Rattlesnake and Sharp-Tailed Snake,
31 also are found in these habitats.

32 Recently, 38 pairs of mating Bald Eagles were observed at Shasta Lake
33 (USFS 2012).

34 Terrestrial resources around Keswick Reservoir are similar to those found at
35 lower elevations around Shasta Lake. Otters, Gray Fox, coyote, bobcat, Osprey,
36 and turtles occur along the Keswick Reservoir reach of the Sacramento River
37 (BLM 2006). Historically, vegetation in this area of the watershed was harvested
38 to provide fuel for mining smelters. Chaparral habitat, dominated by manzanita
39 with intermittent oak, pine, and fir trees occur on the foothills above the reservoir.
40 As described in Chapter 5, Surface Water Resources and Water Supplies, water
41 elevations in Keswick Reservoir are relatively stable throughout the year.

1 **10.3.3.2.2 Whiskeytown Lake and Clear Creek**

2 Riparian communities within the Whiskeytown Unit of the Whiskeytown-Shasta-
3 Trinity National Recreation Area, which includes Whiskeytown Reservoir,
4 include the following species: grey pine, willow, white alder, dogwoods, Oregon
5 ash, bigleaf maple, and Fremont and black cottonwood. Wild grape is also very
6 common; other riparian shrubs include snowberry, California blackberry, toyon,
7 buckeye, and button willow. Flowering herbaceous plants, cattails, sedges,
8 rushes, and ferns make up the riparian understory. The riparian habitats are
9 generally vigorous and well-vegetated, especially in the most favorable locations,
10 such as canyons and stream bottoms (NPS 1999).

11 Riparian vegetation is limited to a narrow band along the channel margins in the
12 confined canyon reaches of Clear Creek between Whiskeytown Dam and Clear
13 Creek Bridge, where the alluvial section of the creek begins. Downstream of
14 Clear Creek Bridge, where the valley widens, the channel becomes predominately
15 alluvial, and floodplains and terraces allow riparian vegetation to be more
16 extensive (CBDA 2004).

17 Fresh emergent wetlands occur throughout the entire reach of lower Clear Creek
18 from Whiskeytown Dam to the Sacramento River. These wetlands are more
19 prominent in the reach below Clear Creek Road Bridge where soils are deeper and
20 the valley becomes wider and is subject to periodic flooding. Valley-foothill
21 riparian is found primarily in the lower reaches of lower Clear Creek from Clear
22 Creek Road Bridge to the Sacramento River. In addition, smaller linear patches
23 occur scattered throughout the system up to Whiskeytown Dam (BLM and
24 NPS 2008).

25 Due to the diversity of habitats present within the watershed, the areas adjacent to
26 Whiskeytown Lake and lower Clear Creek support a diverse assemblage of
27 wildlife species. More than 200 vertebrate species are known to occur within the
28 Whiskeytown Unit of the Whiskeytown-Shasta-Trinity National Recreation Area,
29 including at least 35 mammal species, 150 bird species, and 25 reptile and
30 amphibian species (NPS 2014).

31 **10.3.3.2.3 Sacramento River: Keswick Reservoir to the Delta**

32 Release of flows from Shasta Dam changed the pre-dam flow patterns from high
33 flows in the mid-spring during snow melt to high flows in the summer months, as
34 described in Chapter 5, Surface Water Resources and Water Supplies.
35 Consequently, in most years, the current flow regime precludes or substantially
36 reduces opportunities for establishment of cottonwoods and willows; and the
37 structure and composition of riparian vegetation has undergone change
38 (Roberts et al. 2002). The extent of early-successional riparian communities
39 (e.g., cottonwood forest) has been decreasing, while the extent of mid-
40 successional communities (e.g., mixed riparian forest) has been increasing.
41 Generally, these effects diminish with distance downstream because of the
42 influence of inflows from tributaries, diversions, and flood bypasses
43 (Reclamation 2013a).

1 Much of the Sacramento River from Shasta Dam to Redding is deeply entrenched
2 in bedrock, which precludes development of extensive areas of riparian vegetation
3 (Reclamation 2013a). The upper banks along these steep-sided, bedrock-
4 constrained segments of the upper Sacramento River are characterized primarily
5 by upland communities, including woodlands and chaparral. Outside the river
6 corridor, other vegetation communities along the upper Sacramento River include
7 riparian scrub, annual grassland, and agricultural lands.

8 The river corridor between Redding and Red Bluff once supported extensive areas
9 of riparian vegetation (Reclamation 2013a). Agricultural and residential
10 development has permanently removed much of the native and natural habitat.
11 Riparian vegetation now occupies only a small portion of floodplains. Willow
12 and blackberry scrub and cottonwood- and willow-dominated riparian
13 communities are still present along active channels and on the lower flood
14 terraces, whereas valley oak–dominated communities occur on higher flood
15 terraces. Although riparian woodlands along the upper Sacramento River
16 typically occur in narrow or discontinuous patches, they provide value for wildlife
17 and support both common and special status species of birds, mammals, reptiles,
18 amphibians, and invertebrates.

19 Portions of the adjacent land along the Sacramento River from Red Bluff to
20 Hamilton City include substantial remnants of the pre-European Sacramento
21 Valley historical riparian forest (Reclamation 2013a). Along the Sacramento
22 River below Red Bluff, riparian vegetation is characterized by narrow linear
23 stands of trees and shrubs, in single- to multiple-story canopies. These patches of
24 riparian vegetation may be on or at the toe of levees. Riparian communities in
25 this region include woodlands and riparian scrub.

26 From Red Bluff to Colusa, the Sacramento River contains point bars, islands, high
27 and low terraces, instream woody cover, and early-successional riparian plant
28 growth, reflecting river meander and erosional processes (Reclamation 2013a).
29 Major physiographic features include floodplains, basins, terraces, active and
30 remnant channels, and oxbow sloughs. These features sustain a diverse riparian
31 community and support a wide range of wildlife species including raptors,
32 waterfowl, and migratory and resident avian species, plus a variety of mammals,
33 amphibians, and reptiles that inhabit both aquatic and upland habitats.

34 Downstream of Colusa, the Sacramento River channel changes from a dynamic
35 and active meandering one to a confined, narrow channel (Reclamation 2013a).
36 Surrounding agricultural lands encroach directly adjacent to the levees, which
37 have cut the river off from most of its riparian corridor, especially on the eastern
38 side of the river. Most of the levees in this reach are lined with riprap, allowing
39 the river no erodible substrate and limiting the extent of riparian vegetation and
40 riparian wildlife habitat.

41 **10.3.3.2.4 Feather River**

42 Antelope Lake, Lake Davis, and Frenchman Lake located in the Upper Feather
43 River; Lake Oroville and Thermalito Forebay and Afterbay; and the lower Feather
44 River are located within areas in the Feather River watershed that could be

1 affected by changes in CVP and/or SWP operations. Downstream of Lake
2 Oroville, the basin extends south and includes the drainage of the Yuba and
3 Bear Rivers.

4 *Upper Feather River Lakes*

5 The Upper Feather River Lakes, including Antelope Lake, Lake Davis, and
6 Frenchman Lake, are SWP facilities on the upper Feather River upstream of Lake
7 Oroville. These lakes are part of the Plumas National Forest and provide habitat
8 for raptor nesting and wintering areas, waterfowl nesting area, and deer
9 movement area (DWR 2013a; Plumas County 2012). Deer movement and
10 fawning areas also occur around Lake Davis.

11 *Lake Oroville and Thermalito Complex*

12 Lake Oroville is situated in the foothills on the western slope of the Sierra Nevada
13 Mountains, about a mile downstream of the confluence of its major tributaries.
14 Below the dam, a portion of the river flow is diverted at the Thermalito Diversion
15 Dam and routed to the Thermalito Forebay, which is an offstream reservoir with a
16 surface area up to 630 acres (DWR 2007a, 2007b). Downstream of the forebay,
17 water is stored in Thermalito Afterbay (up to 4,300 surface acres), which among
18 other purposes serves as a warming basin for agricultural water.

19 The majority of vegetation around Lake Oroville consists of a variety of native
20 vegetation associations, including mixed oak woodlands, foothill pine/mixed oak
21 woodlands, and oak/pine woodlands with a mosaic of chaparral (DWR 2004a,
22 2007a). Open areas within the woodlands consist of annual grassland species.
23 Native riparian habitats are restricted to narrow strips along tributaries, consisting
24 mostly of alder, willow, and occasional cottonwood and sycamore. There is
25 minimum wetland vegetation around Lake Oroville, and most is associated with
26 seeps and springs that are a natural part of the landscape above the high water
27 line. Emergent wetlands are generally absent within the drawdown zone of Lake
28 Oroville.

29 Lack of vegetative cover within the drawdown zone severely limits wildlife use of
30 this area. Thirty-six wildlife species were detected using habitats within the
31 drawdown zone on at least one occasion during field surveys (DWR 2004a).
32 Several of these species may use habitats within the drawdown zone for
33 reproduction including Belted Kingfisher, Canada Goose, Canyon Wren,
34 American Dipper, killdeer, mallard, Common Merganser, and Northern
35 Rough-Winged Swallow.

36 Riparian vegetation occurs around the north shore of Thermalito Forebay as a thin
37 strip of mixed riparian species (mostly willows), with an understory of emergent
38 wetland vegetation. Cottonwoods and willows occur in scattered areas around the
39 high water surface elevation of Thermalito Afterbay shoreline (FERC 2007).
40 Emergent wetlands ranging from thin strips to more extensive areas are found
41 around Thermalito Forebay and Thermalito Afterbay. Waterfowl brood ponds
42 constructed in inlets of Thermalito Afterbay support emergent vegetation along
43 much of their shores.

1 Species observed within the wetland margin of Thermalito Afterbay include Barn
 2 Swallow, Black Phoebe, White-Tailed Kite, Black-Tailed Jackrabbit,
 3 Brown-Headed Cowbird, bullfrog, Common Garter Snake, Common
 4 Yellowthroat, Gopher Snake, Northern Harrier, Pacific tree Frog, raccoon,
 5 red-Winged Blackbird, Ring-Necked Pheasant, Short-Eared Owl, Striped Skunk,
 6 Tree Swallow, Virginia Opossum, and Violet-Green Swallow (DWR 2004a).

7 In contrast to the drawdown area around the margin of Lake Oroville, the
 8 drawdown zone of Thermalito Afterbay supports a richer wildlife community and
 9 greater habitat diversity. Survey data collected as part of the relicensing process
 10 indicate that exposed mudflats seasonally provide habitat for a variety of
 11 migratory waterbirds including Black-Necked Stilt, Black Tern, California Gull,
 12 Caspian Tern, Forster's Tern, Greater Yellowlegs, Least Sandpiper, Long-Billed
 13 Dowitcher, Ring-Billed Gull, Semipalmated Sandpiper, Spotted Sandpiper, and
 14 White-Faced Ibis. Wading birds and other waterfowl have been observed on the
 15 mudflats as well as shallow flooded areas (DWR 2004a). Potentially suitable
 16 Giant Garter Snake habitat is present along portions of the afterbay and forebay
 17 margins. The existing waterfowl brood ponds provide a refuge for Giant Garter
 18 Snakes during periods of afterbay drawdown.

19 Several invasive plant species are found around Lake Oroville and downstream in
 20 and around the Thermalito Complex. Invasive species associated with riparian
 21 and wetland areas include purple loosestrife, giant reed, tree-of-heaven, and red
 22 sesbania. About 85 of the roughly 900 acres of wetlands and riparian areas along
 23 the margin of Thermalito Afterbay contain varying densities of purple loosestrife
 24 (DWR 2007a). Purple loosestrife adversely affects native vegetation.

25 *Feather River from Oroville Complex to the Sacramento River*

26 The Feather River from Oroville Dam to the confluence with the Sacramento
 27 River supports stands of riparian vegetation, which have been restricted over time
 28 by flood control levees and land clearing for agriculture and urbanization. As a
 29 consequence, the vegetation generally occurs in a narrow zone along much of the
 30 river in this reach. However, remnant riparian forest exist in areas where wide
 31 meander bends persist, such as at Abbott Lake and O'Connor Lake near the Lake
 32 of the Woods State Recreation Area (DWR 2004b). This area contains mixed
 33 riparian forests, including Fremont cottonwood, willow, boxelder, alder, and
 34 Oregon ash. The riparian strip along the river is bordered mostly by agricultural
 35 fields. Downstream of Yuba City near the confluence with the Sacramento River,
 36 valley oak and cottonwood riparian stands becomes more common.

37 As described above for the Sacramento River, riparian areas provide value for
 38 wildlife and support a wide range of species of birds, mammals, reptiles,
 39 amphibians, and invertebrates.

40 **10.3.3.2.5 Yuba River**

41 Portions of the Yuba River watershed along the North Yuba River between New
 42 Bullards Bar Reservoir and Englebright Lake and along the Lower Yuba River

1 between Englebright Lake and the Feather River could be affected by operation of
2 the Lower Yuba River Water Accord (DWR et al. 2007b).

3 New Bullards Bar Dam and Reservoir are owned and operated by the Yuba
4 County Water Agency to provide flood control, water storage, and hydroelectric
5 generation. The Harry L. Englebright Dam and Reservoir were constructed by
6 the California Debris Commission downstream of New Bullards Bar Reservoir to
7 trap and store sediment from historical hydraulic mining sites in the upper
8 watershed, and to provide recreation and hydroelectric generation opportunities
9 (USACE 2013). Following decommissioning of the California Debris
10 Commission in 1986, administration of Englebright Dam and Reservoir (Lake)
11 was assumed by the USACE. Portions of the watershed along the Middle Yuba
12 River between New Bullards Bar Reservoir and Englebright Reservoir are within
13 the Plumas and Tahoe national forests.

14 Vegetation communities adjacent to New Bullards Bar Reservoir include oak
15 woodlands, mixed conifer, and montane hardwood habitats which include live
16 oak, blue oak, foothill pine, California wild rose, and lupine (DWR et al. 2007).
17 The shoreline is generally barren. Bald Eagles have been observed near New
18 Bullards Bar Reservoir; and California Red-legged Frogs have been reported in a
19 tributary to the reservoir, Oregon Creek.

20 Vegetation communities at Englebright Reservoir are generally blue oak
21 woodland and montane chaparral with small areas of mixed chaparral and live oak
22 woodland (Yuba County 2011).

23 Vegetation along the lower Yuba River downstream of Englebright Dam is
24 characterized by a number of vegetation types including grasslands, woodlands,
25 and chaparral (USACE 2014). Within the Narrows, a steep gorge in the
26 Yuba River immediately below Englebright Dam, there is little vegetation; small,
27 isolated clumps of willow, mulefat, and other riparian species are widely scattered
28 along the mostly barren, rocky banks. Downstream of the Narrows, there are
29 extensive piles of cobble and gravel left from past gold and gravel mining
30 operations. Here there are narrow strips of riparian vegetation consisting of
31 Fremont cottonwood, willow, boxelder, and elderberry shrub. As described above
32 for the Sacramento River, these communities support a wide range of similar
33 wildlife species including raptors, waterfowl, and migratory and resident avian
34 species, plus a variety of mammals, amphibians, and reptiles that inhabit both
35 aquatic and upland habitats.

36 **10.3.3.2.6 Bear River**

37 The Bear River flows into the Feather River downstream of the confluence with
38 the Yuba River. As described in Chapter 5, Surface Water Resources and Water
39 Supplies, the Bear River includes Nevada Irrigation District's Rollins and Combie
40 reservoirs along the upper and middle reaches of the Bear River, and South Sutter
41 Water District's Camp Far West Reservoir along the lower reach of the Bear
42 River (FERC 2013; NID 2005).

1 Vegetation communities near the reservoirs and along the Bear River from
 2 Rollins Reservoir to the confluence with the Feather River occur in bands based
 3 on elevations (FERC 2013; NID 2005). Gray pine, ponderosa pine, hardwoods,
 4 and chaparral shrubs occur at the higher elevations with black cottonwood, white
 5 alder, and valley oak in the riparian zones. Incense cedar, Douglas fir, white fir,
 6 madrone, sugar pine, Brewer's oak, whiteleaf manzanita, greenleaf manzanita,
 7 wedgeleaf ceanothus, deerbrush, and poison oak at mid-elevations with white
 8 alders, maple, and willow along the riparian areas.

9 **10.3.3.2.7 American River**

10 The American River watershed encompasses approximately 2,100 square miles
 11 (Reclamation et al. 2006). The North, Middle, and South forks of the American
 12 River converge upstream of Folsom Lake. Lake Natoma is located downstream
 13 of Folsom Lake. Water continues to flow between Nimbus Dam and the
 14 confluence with the Sacramento River, as described in Chapter 5, Surface Water
 15 Resources and Water Supplies.

16 *Folsom Lake and Lake Natoma*

17 Folsom Lake, formed by Folsom Dam, has a surface area of about 11,500 acres,
 18 and 75 miles of shoreline (Reclamation 2005a). Lake Natoma, which serves as an
 19 afterbay downstream of Folsom Dam, has about 540 acres of surface area.

20 Vegetation communities associated with Folsom Lake include oak woodland and
 21 annual grassland. The oak woodland habitat is located on the upland banks and
 22 slopes of the reservoir, and is dominated by live oak, blue oak, and foothill pine
 23 with several species of understory shrubs and forbs. Annual grasslands occur
 24 around the reservoir, primarily at the southern end.

25 The oak woodlands and annual grasslands around the reservoir support a variety
 26 of birds. A number of raptors, including red-tailed hawk, Cooper's hawk, great
 27 horned owl, and long-eared owl use oak woodlands for nesting, foraging, and
 28 roosting. Mammal species likely to occur in woodland habitats include deer,
 29 coyote, bobcat, fox, Virginia Opossum, raccoon, rabbits, squirrels, and a variety
 30 of rodents. Amphibians and reptiles that may be found in oak woodlands include
 31 California Newt, Pacific Tree Frog, Western Fence Lizard, Gopher Snake,
 32 Common Kingsnake, and Western Rattlesnake. The adjacent grasslands are used
 33 by various bird species for foraging, including White-Crowned Sparrow, Lesser
 34 Goldfinch, Western Meadowlark, and several raptor species. Migratory
 35 waterfowl also are known to feed and rest in the grasslands associated with the
 36 north fork of Folsom Reservoir.

37 Seasonal wetland communities occur both inside and outside of the area
 38 influenced by the reservoir. These communities are exposed to wetland
 39 hydrology for a limited period of time and may not meet all criteria for wetlands.
 40 Within the reservoir drawdown zone, this seasonal vegetation is frequently
 41 inundated and may receive overland flow from upland areas. Outside of the
 42 drawdown zone, seasonally wet areas receive water from seeps, drainages, and
 43 precipitation (Reclamation et al. 2006). Small areas of permanent freshwater

1 marsh are found at the toe of the Mormon Island Auxiliary Dam. Water birds and
2 other wildlife depend on the freshwater marshes in these areas for foraging and/or
3 rearing habitat. These species include Pacific Tree Frog, Western Toad, Common
4 Garter Snake, beaver, raccoon, and muskrat.

5 Folsom Lake is surrounded by a relatively barren drawdown zone due to annual
6 fluctuations in water elevations. The majority of this zone is devoid of
7 vegetation, although scattered stands of woody vegetation occur in some areas of
8 the drawdown zone (Reclamation et al. 2006). The only contiguous riparian
9 vegetation occurs along Sweetwater Creek at the southern end of the reservoir.

10 Between Folsom Dam and Lake Natoma, the river channel is narrower and
11 flanked by steep, rocky cliffs (Reclamation 2005a). The land along the river
12 includes wooded canyon areas, sheer bluffs, and dredge tailings from the gold
13 mining era. Within Lake Natoma, the open water is bordered by narrow bands of
14 riparian woodland. Patches of permanent freshwater marsh exist in shallow coves
15 that are inundated when water rises in Lake Natoma (Reclamation 2005a).

16 *Lower American River between Lake Natoma and Confluence with the*
17 *Sacramento River*

18 Downstream of Lake Natoma, the lower American River flows to the confluence
19 with the Sacramento River. In the upper reaches of the lower American River, the
20 river channel is controlled by natural bluffs and terraces. Levees have been
21 constructed along the northern and southern banks for approximately 13 miles
22 upstream of the confluence with the Sacramento River (Reclamation et al. 2006).

23 Most of the lower American River is encompassed by the American River
24 Parkway, which preserves what remains of the historic riparian zone
25 (Reclamation et al. 2006). Vegetation communities along the lower
26 American River downstream of Nimbus Dam include freshwater emergent
27 wetland, riparian forest and scrub. Oak woodland and annual grassland are
28 present in the upper, drier areas farther away from the river. The current
29 distribution and structure of riparian communities along the river reflects the
30 human-induced changes caused by activities such as gravel extraction, dam
31 construction and operations, and levee construction and maintenance, as well as
32 by both historical and ongoing streamflow and sediment regimes, and
33 channel dynamics.

34 In general, willow and alder tend to occupy areas within the active channel of the
35 river that are repeatedly disturbed by river flows, with cottonwood-willow
36 thickets occupying the narrow belts along the active river channel (Reclamation et
37 al. 2006). Typical species in these thickets include Fremont cottonwood, willow,
38 poison oak, wild grape, blackberry, northern California black walnut, and
39 white alder.

40 Cottonwood forest is found on the steep, moist banks along much of the river
41 corridor (Reclamation et al. 2006). Valley oak woodlands occur on upper terraces
42 where fine sediment and adequate soil moisture provide a long growing season.
43 Live oak woodland occurs on the more arid and gravelly terraces that are isolated
44 from the fluvial dynamics and moisture of the river. Annual grassland occurs in

1 areas that have been disturbed by human activity and can be found in many areas
2 within the river corridor.

3 The cottonwood-dominated riparian forest and areas associated with backwater
4 and off-river ponds are highest in wildlife diversity and species richness relative
5 to other river corridor habitats (Reclamation et al. 2006). More than 220 species
6 of birds have been recorded along the lower American River and more than
7 60 species are known to nest in the riparian habitats. Typical species that can be
8 found along the river include Great Blue Heron, Mallard, Red-Tailed Hawk,
9 American Kestrel, California Quail, Killdeer, Belted Kingfisher, Western
10 Scrub-Jay, Swallows, and American Robin. Additionally, more than 30 species
11 of mammals reside along the river, including skunk, rabbit, raccoon, squirrel,
12 vole, muskrat, deer, fox, and coyote. Reptiles and amphibians that occupy
13 riparian habitats along the river include Western Toad, Pacific Tree Frog,
14 bullfrog, Western Pond Turtle, Western Fence Lizard, Common Garter Snake,
15 and Gopher Snake (Reclamation 2005a).

16 Backwater areas and off-river ponds are located throughout the length of the river,
17 but occur predominantly at the Sacramento Bar, Arden Bar, Rossmoor Bar, and
18 between Watt Avenue and Howe Avenue (Reclamation 2005a; Reclamation et al.
19 2006). Plant species that dominate these backwater areas include various species
20 of willow, sedge, cattail, bulrush, and rush. Riparian vegetation around these
21 ponded areas is composed of mixed-age willow, alder, and cottonwood. These
22 backwater ponds may be connected to the river by surface water during high
23 winter flood flows and by groundwater during other times of the year. Wildlife
24 species typical of these areas include: Pied-Billed Grebe, American Bittern, Green
25 Heron, Common Merganser, White-Tailed Kite, Wood Duck, Yellow Warbler,
26 Warbling Vireo, Dusky-Footed Woodrat, Western Gray Squirrel, Pacific Tree
27 Frog, and Western Toad.

28 Several non-native weed populations are rapidly expanding in the riparian
29 vegetation of the lower American River (County of Sacramento 2008). In
30 particular, red sesbania is expanding along shorelines of streams and ponds, along
31 with other invasive species such as Chinese tallowtree, giant reed, pampasgrass,
32 Spanish broom, Himalayan blackberry, and tamarisk, which can rapidly colonize
33 exposed bar surfaces and stream banks.

34 **10.3.3.2.8 Agricultural Lands in the Sacramento Valley**

35 The study area in the Sacramento Valley includes Shasta, Plumas, Tehama,
36 Glenn, Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, Sacramento,
37 Yolo, and Solano counties. As described in Chapter 12, Agricultural Resources,
38 field and forage crops dominate the irrigated acreage in Sacramento Valley with
39 over 1.4 million acres irrigated. Rice, irrigated pasture, and hay are the largest
40 acreages. Second to field and forage crops are orchard and vine crops, making up
41 roughly 21 percent of the total acreage. Almonds and walnuts are the largest
42 acreages in this category. In total, the Sacramento Valley contains nearly two
43 million agricultural acres. Typical terrestrial resources of these crops are
44 described in subsection 10.3.4.1.4, Agricultural Lands.

1 **10.3.3.2.9 Wildlife Refuges in the Sacramento Valley**

2 The Sacramento Valley supported three major landscape types: wetlands,
3 grassland-prairies, and riparian woodlands (Reclamation et al 2001a). These
4 habitats were hydrologically and biologically linked to the river systems. Prior to
5 their containment by the construction of dams and levees, the major rivers
6 meandered, forming oxbows and riparian habitat. Winter floods would inundate
7 and scour areas along these rivers, creating marshes and early-succession riparian
8 scrub. Expanses of seasonal wetlands were also created by winter flooding.
9 These seasonal wetlands formed habitat for overwintering and migrating
10 waterfowl. Habitat areas such as wetlands are now intensively managed to
11 support a wide range of birds and other wildlife within small and fragmented
12 areas. Remnant wetlands and agricultural lands in the Central Valley support
13 approximately 60 percent of the waterfowl wintering in the Pacific Flyway region
14 (includes Alaska, Arizona, California, Idaho, Nevada, Oregon, Utah, Washington,
15 and portions of Colorado, Montana, New Mexico, and Wyoming west of the
16 Continental Divide [PFC 2014]). In addition, another 20 percent of the Pacific
17 Flyway population passes through the Central Valley, using the wetlands for
18 foraging and resting on their migratory passage through the region. The
19 Sacramento Valley provides winter habitat for 44 percent of the Pacific Flyway
20 waterfowl. The wetland and associated habitat are also important to several
21 federally listed and proposed species, and other special status species such as the
22 American Peregrine Falcon, Bald Eagle, Aleutian Canada Goose, Giant Garter
23 Snake, and California Tiger Salamander.

24 The Sacramento National Wildlife Refuge (NWR) Complex is composed of five
25 national wildlife refuges (Sacramento, Delevan, Colusa, Sutter and Sacramento
26 River NWRs) and three state wildlife management areas (Willow Creek-Lurline,
27 Butte Sink and North Central Valley Wildlife Management Areas) (USFWS
28 2013a). The refuges of the Sacramento NWR Complex contain permanent ponds,
29 seasonal wetlands, irrigated moist soil impoundments, and uplands (Reclamation
30 et al 2001). Gray Lodge Wildlife Area is located adjacent to the Butte Sink, an
31 overflow area of Butte Creek and the Sacramento River. It consists of seasonal
32 wetlands and upland areas with permanent wetland and riparian habitats (DFG
33 2011a). The Gray Lodge Wildlife Area supports permanent and seasonal
34 wetlands, crops, and pasture (Reclamation et al. 2001).

35 Seasonally flooded marsh is the most prevalent and diverse of the wetland habitat
36 types (Reclamation et al 2001). Wetland units managed as seasonally flooded
37 marsh are typically flooded from early September through mid-April. Their
38 diversity is the product of a variety of water depths that result in an array of
39 vegetative species that, in combination, provide habitat for the greatest number of
40 wildlife species throughout the course of a year. Through the fall and winter,
41 seasonally flooded marshes are used by a wide range of waterfowl and smaller
42 numbers of egret, heron, ibis, and grebe, to name a few. In addition, raptors take
43 advantage of the water bird prey base. Water is removed in the spring; therefore,
44 shorebirds use the shallow depth and exposed mudflats on their northern
45 migration.

1 Moist soil impoundments, or seasonally flooded impoundments, are similar to
2 seasonally flooded marshes (Reclamation et al 2001). Moist soil impoundments
3 are typically irrigated during the summer to bolster plant growth and to enhance
4 seed production. Irrigation is usually performed in mid-summer to increase plant
5 biomass and seed production of watergrass, sprangletop, and smartweed plants.
6 During these irrigation periods, these units are often used by locally nesting
7 colonial water birds (egrets, herons).

8 Permanent ponds and summer water provide wetland habitat for year-round and
9 summer resident species (Reclamation et al 2001). Permanent ponds remain
10 flooded throughout the year, while units managed for summer water are flooded
11 through June or July. Characterized by both emergent and submergent aquatic
12 plants, permanent ponds and summer water units provide brood and molting areas
13 for waterfowl, secure roosting and nesting sites for wading birds and other over-
14 water nesters, and feeding areas for species like cormorants and pelicans.
15 Permanent wetland habitats are also important to a number of special status
16 species, such as the Giant Garter Snake, White-Faced Ibis, and Tricolored
17 Blackbird.

18 Valley-foothill riparian habitats are found along low- to mid-elevation streams
19 and waterways (Reclamation et al. 2001). Riparian habitats provide nesting,
20 roosting, and feeding areas for passerines, raptors, herons, egrets, waterfowl, and
21 small mammals. These areas also provide corridors for resident and migratory
22 wildlife. Riparian woodland habitats are characterized by even-aged, broad-
23 leafed, deciduous trees with open canopies that reflect flood-mediated episodic
24 events. Cottonwood, willow, alder, and oak are typical trees found in riparian
25 woodlands. Riparian scrub habitats are described as streamside thickets
26 dominated by one or more willow species, as well as other fast-growing shrubs
27 and vines.

28 **10.3.3.3 San Joaquin Valley**

29 The San Joaquin Valley portion of the Central Valley Region considered in this
30 EIS includes the San Joaquin River from Millerton Lake to the Delta; lower
31 Stanislaus River from New Melones Reservoir to the confluence with the San
32 Joaquin River; San Luis Reservoir; and agricultural areas and wildlife refuges that
33 use CVP and SWP water supplies.

34 Historically, the San Joaquin Valley was a large floodplain that supported vast
35 expanses of permanent and seasonal marshes, lakes, and riparian areas. Almost
36 70 percent of the valley has been converted to irrigated agriculture (Reclamation
37 2005b). Relict stands of alkali desert scrub are widely scattered throughout the
38 San Joaquin Valley, but are generally found in the Tulare Basin in the southern
39 San Joaquin Valley. Annual and perennial grasslands occur throughout the San
40 Joaquin Valley, mostly on level plains and the gently rolling foothills at
41 elevations immediately higher than the patches of alkali desert scrub. Ruderal
42 vegetation is typically associated with road and utility rights-of-way, borders of
43 fields, ditches, and abandoned fields.

1 As described in subsection 10.3.2, Overview of Species with Special Status, A
2 listing of wildlife and plant species with special status that occur or may occur in
3 portions of the study area affected by the long-term coordinated operation of the
4 CVP and SWP is provided in Appendix 10A.

5 The USFWS has approved a habitat conservation plan for San Joaquin County
6 Multi-species Habitat Conservation and Open Space Plan, Kern Water Bank, and
7 the Metropolitan Bakersfield.

8 **10.3.3.3.1 San Joaquin River**

9 Potential changes in CVP and SWP operations could affect terrestrial resources
10 associated with the San Joaquin River from Millerton Lake to the Delta.

11 *Millerton Lake*

12 Millerton Lake on the San Joaquin River is located in the western foothills of the
13 Sierra Nevada Mountains in an area that ranges from grasslands and rolling hills
14 near Friant Dam, to steep, craggy slopes in the upper reaches of the lake.

15 Vegetation around Millerton Lake consists of a number of terrestrial
16 communities, including annual grassland, oak woodland, foothill pine oak
17 woodland, and chaparral (Reclamation 2011; Reclamation and State Parks 2010).

18 The most dominant vegetation community near the water edge is the nonnative
19 grassland with blue oak woodland on the slopes above the lake and mixed riparian
20 woodlands along drainages to the lake (Reclamation 2011; Reclamation and State
21 Parks 2010). The dominant grassland species include broad-leaf filaree,
22 fiddleneck, Heermann tarweed, vinegar weed, and ripgut brome, soft chess,
23 zorro grass. The blue oak woodland also includes gray pine, buck brush, bush
24 lupine, holly-leaf redberry, and hoary coffeeberry. The mixed riparian woodland
25 species include interior live oak and gray pine with red willow, Fremont
26 cottonwood, California buckeye, edible fig, and Oregon ash with an understory of
27 California grape, button bush, Himalayan blackberry, sedges, and nonnative
28 spearmint. Aquatic plants occur along the drainages where the water is relatively
29 stagnant including mosquito fern, common duckweed, dotted duckmeat,
30 punctuate smartweed, tall flat sedge, and broad-leaf cattail. Much of the shoreline
31 is barren or characterized by nonnative grasslands with weedy species, such as
32 Bermuda grass and cocklebur, and sporadic Goodding's black willow.

33 Mule Deer, California Quail, wild turkey, and feral pig, all of which are game
34 species, occur in the area around Millerton Lake (Reclamation 2011; Reclamation
35 and State Parks 2010). The region provides winter range and migratory routes for
36 the San Joaquin deer herd. A number of special status bat species have potential
37 to occur in the area, and suitable roost sites may be found throughout the area.
38 Other special status species that may occur in the area include the ringtail,
39 American badger, and San Joaquin pocket mouse.

40 A relatively diverse community of reptile and amphibian species exists in and
41 around Millerton Lake (Reclamation 2011; Reclamation and State Parks 2010).
42 The presence of the nonnative bullfrog has changed, and continues to dramatically
43 alter, the extant reptile and amphibian community through predation and because

1 of its ability to out-compete native species. The Western Pond Turtle is known to
2 occur around the lake. The California Tiger Salamander has also been reported.
3 Limited areas of potential breeding habitat for California tiger salamander,
4 primarily stock ponds dominated by nonnative species, have been identified in the
5 San Joaquin River gorge upstream of the lake.

6 Bald eagles use roost trees near open water for foraging and are known to winter
7 around Millerton Lake (Reclamation 2011; Reclamation and State Parks 2010).
8 Several species associated with riparian habitats, including the least Bell's vireo
9 and willow flycatcher, occurred historically around the lake, but have not been
10 recently documented. A number of nonnative birds, including European Starling
11 and Brown-Headed Cowbird, influence the native bird community through
12 competition and nest parasitism.

13 A number of rare and listed plant species are known to occur around Millerton
14 Lake and the upper San Joaquin River (Reclamation 2011; Reclamation and State
15 Parks 2010). These include Ewan's larkspur, Michael's piperia, tree anemone,
16 and Madera leptosiphon. Two plant species which serve as hosts for special
17 status invertebrates, the elderberry and California pipevine, are also known to
18 occur in the area. California pipevine is the obligate host plant for the pipevine
19 swallowtail, a butterfly species and the elderberry shrub is the host plant of the
20 Valley Elderberry Longhorn Beetle.

21 *San Joaquin River from Friant Dam to the Confluence with the Merced River*

22 A multilayered riparian forest dominated by cottonwoods occurs on the active low
23 floodplain of the San Joaquin River along with older stands of cottonwood-
24 dominated riparian forest in areas that were formerly active floodplains prior to
25 the completion of Friant Dam and associated diversion channels, and the resulting
26 reduction in river flow (DWR and Reclamation 2002; Reclamation and DWR
27 2011). Other areas on the low floodplain are dominated by willow, with
28 occasional scattered cottonwood, ash, or white alder. California buttonbush is
29 often present and may even dominate the riverbank for stretches.

30 The intermediate terrace of the floodplain of the San Joaquin River is primarily a
31 mixed-species riparian forest (DWR and Reclamation 2002; Reclamation and
32 DWR 2011). Species dominance in this mixed riparian forest depends on site
33 conditions, such as availability of groundwater and frequency of flooding.
34 Typical dominant trees in the overstory and midstory include Fremont
35 cottonwood, boxelder, Goodding's black willow, Oregon ash, and California
36 sycamore. Immediately along the water's edge, white alder occurs in the upper
37 reaches of the San Joaquin River. Typical shrubs include red willow, arroyo
38 willow, and California buttonbush.

39 Tree-dominated habitats with an open-to-closed canopy are typically found on the
40 higher portions of the floodplain (DWR and Reclamation 2002; Reclamation and
41 DWR 2011). These areas are exposed to less flood-related disturbance than areas
42 lower on the floodplain. Valley oak is the dominant tree species while California
43 sycamore, Oregon ash, and Fremont cottonwood are present in small numbers.

1 Typical understory species include creeping wild rye, California wild rose,
2 Himalayan blackberry, California wild grape, and California blackberry.

3 Dense stands of willow shrubs frequently occur within the active floodplain of the
4 river in areas subject to more frequent scouring flows and often occupy stable
5 sand and gravel point bars immediately above the active channel (DWR and
6 Reclamation 2002; Reclamation and DWR 2011). Dominant species include
7 sandbar willow, arroyo willow, and red willow. Occasional emergent Fremont
8 cottonwood may also be present.

9 Other areas have vegetation consisting of woody shrubs and herbaceous species
10 dominated by different species depending on river reach. Some areas are
11 dominated by mugwort, together with stinging nettle and various tall weedy
12 herbs. Other areas are dominated either by blackberry (usually the introduced
13 Himalayan blackberry) or wild rose in dense thickets, with or without scattered
14 small emergent willows.

15 Areas with fine-textured, rich alluvium located outside the active channels but in
16 areas that are subject to periodic flooding contain a shrub-dominated community
17 characterized by widely spaced blue elderberry shrubs (DWR and Reclamation
18 2002; Reclamation and DWR 2011). The herbaceous understory is typically
19 dominated by nonnative grasses and forbs that are characteristic of annual
20 grassland communities, including ripgut brome, foxtail fescue, foxtail barley,
21 red-stemmed filaree, and horseweed.

22 Emergent wetlands typically occur in the river bottom immediately adjacent to the
23 low-flow channel (DWR and Reclamation 2002; Reclamation and DWR 2011).
24 Backwaters and sloughs where water is present through much of the year support
25 emergent marsh vegetation, such as tule and cattails. More ephemeral wetlands,
26 especially along the margins of the river and in swales adjacent to the river,
27 support native and nonnative herbaceous species.

28 Prevalent invasive species found in this portion of the San Joaquin River corridor
29 include red sesbania, tamarisk, giant reed, Chinese tallow, Tree-of-heaven, and
30 perennial pepperweed (Reclamation and DWR 2011). Water hyacinth, water
31 milfoil, Parrot's feather, curly-leaf pondweed, and sponge plant occur within the
32 streams, especially in areas with slow or ponded water.

33 The riparian forest trees and understory provide habitat for raptors, cavity-nesting
34 birds, and songbirds, including Red-Tailed Hawk, Red-Shouldered Hawk,
35 Swainson's Hawk, White-Tailed Hawk, Downy Woodpecker, Wood Duck,
36 Northern Flicker, Ash-Throated Flycatcher, Pacific-Slope Flycatcher, Olive Sided
37 Flycatcher, Tree Swallow, Oak Titmouse, White-Breasted Nuthatch, Western
38 Wood-Pewee, Warbling Vireo, Orange-Crowned Warbler, Yellow Warbler,
39 Bullock's Oriole, and Spotted Towhee (DWR and Reclamation 2002;
40 Reclamation and DWR 2011). Western Wood-Pewee, Bushtit, Bewick's Wren,
41 Lazuli Bunting, Blue Grosbeak, and American Goldfinch inhabit the riparian
42 scrub vegetation. Song Sparrow, Common Yellowthroat, Marsh Wren, and
43 Red-Winged Blackbird inhabit the emergent wetlands. Coyote, River Otter,
44 raccoon, Desert Cottontail, and Striped Skunk occur in the riparian forest and

1 shrub communities. Shorebirds, such as Killdeer; Mallard Duck; California Vole;
 2 Common Muskrat; Norway Rat; Pacific Chorus Frog; Western Pond Turtle; and
 3 Western Terrestrial Garter Snake occur near the river.

4 *San Joaquin River from Merced River to the Delta*

5 Downstream of the Merced River confluence, vegetation and wildlife resources
 6 along the San Joaquin River are similar to the upstream reaches described above
 7 (DWR and Reclamation 2002; Reclamation and DWR 2011). The reach of the
 8 San Joaquin River immediately downstream of the Merced River is more incised
 9 than areas further downstream and has a less developed riparian area with less
 10 understory vegetation. Between the Merced River and the Delta, agricultural land
 11 use has encroached on the riparian areas, leaving only a narrow band of riparian
 12 habitat. Near the confluence with tributary rivers, in cutoff oxbows, and in the
 13 San Joaquin River NWR, there are more extensive riparian habitat areas.
 14 Remnant cattail-dominated marshes and tules occur in these areas.

15 Wildlife species are similar to those found in the reaches upstream of the Merced
 16 River described above (DWR and Reclamation 2002; Reclamation and
 17 DWR 2011).

18 **10.3.3.3.2 Stanislaus River**

19 The upper Stanislaus River watershed has a drainage area of approximately
 20 980 square miles (Reclamation 2010b). The North, Middle, and South forks of
 21 the Stanislaus River converge upstream of the CVP New Melones Reservoir.
 22 Water from New Melones Reservoir flows into Tulloch Reservoir. Downstream
 23 of Tulloch Reservoir, the Stanislaus River flows to Goodwin Dam and then
 24 approximately 40 miles to the confluence with the San Joaquin River.

25 *New Melones Reservoir*

26 Several broad categories of vegetation have been described in other studies
 27 around the New Melones Reservoir, including blue oak woodland and blue
 28 oak-foothill pine woodland, grasslands, chaparral, wetlands, and serpentine-based
 29 communities (Reclamation 2010b). The montane hardwood and montane
 30 hardwood-conifer woodlands occur at higher elevations substantially above the
 31 reservoir open water, especially along the eastern portion of the New Melones
 32 Reservoir; and are not anticipated to be affected by changes in CVP and
 33 SWP operations.

34 Blue oak woodland vegetation occurs in the western and southwestern portion of
 35 New Melones Reservoir, especially on rocky slopes and along riparian corridors
 36 (Reclamation 2010b). Oak trees that are established along the shoreline during
 37 drier periods are frequently killed when the reservoir fills to the maximum
 38 elevation. The blue oak woodland community also includes ponderosa pine,
 39 California buckeye, manzanita, ceanothus, yerba santa, foothill pine, scrub oak,
 40 black oak, valley oak, interior live oak, coffeeberry, redberry, holly-leaved cherry,
 41 and needlegrass. The blue oak-foothill pine woodland occurs at higher elevations
 42 along the western and southern areas of the New Melones Reservoir, and includes
 43 understory species, including poison oak, woodland star, sugar cup, shooting star,

1 Chinese house, and gooseberry. The oak woodland supports woodpecker,
2 mourning doves, wild turkey, California quail, mule deer, black-tailed deer,
3 western grey squirrel, gray fox, raccoon, feral pig, striped skunk, mountain lion,
4 and bobcat. The transition chaparral zones between the oak woodlands and
5 grasslands support California Thrasher, quail, wrentit, bobcat, Deer Mouse, feral
6 pig, and Fence Lizard.

7 Annual grasslands occur along adjacent plains and foothills on the western and
8 southern portions of New Melones Reservoir (Reclamation 2010b). The annual
9 plant species, including wild oats, soft chess, ripgut, fiddleneck, longbeak stork's
10 bill, and redstem stork's bill. Perennial grass species include triple-awned grass,
11 wheat grass, bent grass, wild-rye, melic grass, needle-grass, and muhly. The area
12 also includes foothill pine, blue oak, California poppy, and lupines. Grasslands
13 support Meadowlark, Horned Lark, sparrow, quail, mouse, and vole. Raptors that
14 forage in the grasslands include White-Tailed Kite, Northern Harrier, Great
15 Horned Owl, Red-Tailed Hawk, and Swainson's Hawk.

16 Little riparian vegetation exists along the shoreline of New Melones Reservoir
17 because fluctuating water levels limit the establishment of riparian vegetation
18 (Reclamation 2010b). Riparian vegetation is generally found in the upstream
19 reaches of some of the perennial drainages that flow into the reservoir. Wetland
20 vegetation is found in some locations along the edges of the lake and in moist
21 canyons. There are many riparian communities, seeps, and wet meadows in the
22 upper reaches of streams that are tributaries of the lake. Species in the valley and
23 foothill riparian woodlands include boxelder, Fremont cottonwood, willows,
24 white alder, and big-leaf maple. The wet meadow species include short-hair
25 sedge, gentian-aster, few-flowered spikerush, carpet clover, bentgrass, pull-up
26 muhly, beaked sedge, Nebraska sedge, Kentucky bluegrass, longstalk clover, and
27 tufted hairgrass.

28 The open water of New Melones Lake, along with associated shoreline
29 vegetation, provides foraging and resting habitat for a variety of waterfowl and
30 shorebirds (Reclamation 2010b). Several fish-eating bird species, such as grebe,
31 forage in the open water; other species, such as ducks, herons, and egrets, dabble
32 along the shoreline foraging on seeds and small fish in shallow areas. Trees along
33 the shoreline provide nesting areas for osprey. Riparian areas along larger
34 tributaries to New Melones Reservoir provide food, cover, water, and nesting
35 habitat for a variety of wildlife species and serve as travel corridors for species
36 such as black-tailed deer.

37 Limestone caves are located in portions of the upper reaches of New Melones
38 Reservoir, especially along the Stanislaus River (Reclamation 2010b). Bats use
39 the caves for roosting and breeding. A type of rare spider, New Melones
40 harvestman, was transplanted from caves that were to be inundated through the
41 filling of New Melones Reservoir into neighboring caves.

42 *Tulloch Reservoir*

43 Many vegetation community types characteristic of the New Melones Reservoir
44 and other portions of the Sierra foothills are found around Tulloch Reservoir,

1 including blue oak woodland, chaparral, grassland, various tree-shrub
2 communities dominated by pines, and grasslands (Tri-Dam Project 2008). The
3 elderberry shrub (*Sambucus* species) occurs at multiple locations around the
4 reservoir and may provide habitat for the Valley Elderberry Longhorn Beetle. A
5 number of nonnative weedy species have been documented around the reservoir
6 including Himalayan blackberry, red brome, tree-of-heaven, slenderflower thistle,
7 yellow star thistle, pampas grass, Bermuda grass, and the aquatic parrot's feather.
8 The vegetation along the water edge is affected by daily and seasonal water
9 elevation variability. Wildlife supported by the vegetative community are similar
10 to wildlife communities near New Melones Reservoir as well as Western Pond
11 Turtle, bat, river otter, and mink (Goodwin Power 2013).

12 *Goodwin Dam*

13 Downstream of Tulloch Dam, the Stanislaus River flows to Goodwin Dam, and
14 then continues approximately 40 miles to the confluence with the San Joaquin
15 River. Goodwin Dam serves as a diversion dam for Oakdale Irrigation District,
16 South San Joaquin Irrigation District, and Stockton East Water District, as
17 described in Chapter 5, Surface Water Resources and Water Supplies (Tri-Dam
18 Project 2003, 2007). The Goodwin Dam impounds 502 acre-feet of water along
19 the Stanislaus River approximately 1.6 miles downstream of Tulloch Dam and
20 8.3 miles downstream of New Melones Dam. Water surface elevations are
21 relatively constant upstream of Goodwin Dam.

22 The vegetation communities in this area of the Stanislaus River are similar to the
23 vegetation near Tulloch Dam, including hardwood and oak woodlands with blue
24 oak, interior live oak, gray pine, California buckeye, toyon, tree of heaven, and
25 California black walnut (Tri-Dam 2003). Near the Stanislaus River, the
26 vegetation is characterized by riparian woodland with cottonwood, willows, white
27 alder, blue elderberry, and Himalayan berry. Some low-gradient areas along the
28 shoreline of Goodwin Lake, especially in coves, support small patches of
29 emergent aquatic vegetation such as bulrush and cattail (Goodwin Power 2013).
30 Wildlife occurrences are similar to conditions near Tulloch Reservoir.

31 *Stanislaus River from Goodwin Dam to the Confluence with the San Joaquin* 32 *River*

33 From Goodwin Dam to Knight's Ferry, the Stanislaus River flows through a
34 bedrock canyon with nearly vertical walls and rock outcrops (DFG 1995). The
35 riparian edge includes valley foothill riparian vegetation in a very narrow band for
36 the entire length of this reach. This habitat is characterized by a canopy layer of
37 cottonwood, California sycamore, and valley oak. Subcanopy cover trees are
38 white alder, boxelder, and Oregon ash. Typical understory shrub layer plants
39 include wild grape, wild rose, California blackberry, elderberry, button brush, and
40 willow. The herbaceous layer consists of sedges, rushes, grasses, miner's lettuce,
41 poison-hemlock, and stinging nettle.

42 From Knights Ferry to the Orange Blossom Bridge, located to the east of the City
43 of Oakdale, the valley foothill riparian habitat continues along the river (DFG
44 1995). Further away from the river, vegetation is dominated by blue oak-digger

1 pine woodland and shrub, including California redbud, California buckeye,
2 ceanothus, manzanita, poison oak, and grasslands. Vernal pools and vernal pool
3 complexes are found within adjacent grasslands.

4 Downstream of the Orange Blossom Bridge, the riparian corridor is virtually
5 nonexistent in some areas with agricultural land uses extending into the riparian
6 corridor (DFG 1995). In a few areas the riparian corridor is wide, such as within
7 Caswell Memorial State Park. The major habitats include valley foothill riparian
8 along the Stanislaus River with annual grasslands and fresh emergent wetlands
9 amount the agricultural and urban developments.

10 **10.3.3.3.3 San Luis Reservoir Complex**

11 The San Luis Reservoir complex, consisting of San Luis Reservoir, O'Neill
12 Forebay, and Los Banos Creek Reservoir, is located in northwestern San Joaquin
13 Valley and is part of the water storage and delivery system for the CVP and SWP.
14 The area is located within several vegetative communities (Reclamation and State
15 Parks 2013). The northern and western portion of the San Luis Reservoir is
16 located within the coastal foothills with blue oak-foothill pine woodlands. The
17 O'Neill Forebay and parts of Los Banos Creek Reservoir are located within the
18 San Joaquin Valley with valley oak habitat.

19 The vegetation around the San Luis Reservoir complex and wildlife management
20 areas consists of riparian woodlands, blue oak woodlands and savanna, coast live
21 oak woodland, ornamental trees, California sagebrush scrub, grasslands, wetlands,
22 alkali sink scrub, and nonnative and weedy plant communities (Reclamation and
23 State Parks 2013). The riparian woodland and wetland communities occur at the
24 edge of the reservoirs and along watercourses. The San Luis Wildlife Area also
25 contains blue oak woodland, blue oak savanna, coast live oak woodland, and
26 California sycamore riparian woodland. California sagebrush scrub occurs on
27 hillsides above and to the west of Los Banos Creek Reservoir. Iodine bush scrub
28 occurs at Salt Spring, a tributary to Los Banos Creek Reservoir. Native purple
29 needlegrass occurs throughout the complex.

30 Along the shorelines, riparian vegetation remains in an early successional stage
31 because either the extreme fluctuation of the water level inundates the vegetation
32 or the vegetation does not receive enough water during the dry season
33 (Reclamation and State Parks 2013). Areas at the edges of O'Neill Forebay and
34 Los Banos Creek Reservoir appear to be slowly changing to riparian vegetation.

35 A herd of more than 200 tule elk occurs towards the western shoreline of San Luis
36 Reservoir within and near Pacheco State Park (Reclamation and State Park 2013).
37 The herd moves down towards the water edge within the reservoir inundation area
38 when the water elevation is low. Another herd of approximately 60 individuals
39 occur around B.F. Sisk Dam which forms San Luis Reservoir; and approximately
40 70 tule elk occur throughout other areas in the complex.

41 **10.3.3.3.4 Agricultural Lands in the San Joaquin Valley**

42 The study area in the San Joaquin Valley includes the counties of Stanislaus,
43 Merced, Madera, San Joaquin, Fresno, Kings, Tulare, and Kern counties. As

1 described in Chapter 12, Agricultural Resources, field and forage crops dominate
 2 the irrigated acreage in the San Joaquin Valley with over 5.5 million agricultural
 3 acres. Hay, cotton, and silage are the largest acreages. Second to field and forage
 4 crops are orchards and vineyards, making up roughly 35 percent of total acreage.
 5 Almonds and grapes are the largest acreages in this category.

6 Typical terrestrial resources of these crops are described in subsection 10.3.4.1.4,
 7 Agricultural Lands. In the grassland and pasture areas, areas not dominated by
 8 crops include nonnative grasses, foxtail barley, and forbs (Reclamation and DWR
 9 2011). The grassland and pasture support Northern Harrier, Ring-Necked
 10 Pheasant, Mourning Dove, Burrowing Owl, Loggerhead Shrike, Deer Mouse,
 11 California Vole, California Ground Squirrel, Botta's Pocket Gopher, American
 12 Badger, coyote, Western Toad, Western Fence Lizard, Western Racer, and
 13 Gopher Snake. The cropland provides foraging areas for raptors and supports
 14 Ground Squirrel, American Crow, Brewer's Blackbird, and European Starling.

15 **10.3.3.3.5 Wildlife Refuges in the San Joaquin Valley**

16 The San Joaquin Valley historically supported three major landscape types:
 17 wetlands, grassland-prairies, and riparian woodlands (Reclamation et al 2001b).
 18 These habitats were hydrologically and biologically linked to the river systems.
 19 Prior to their containment by the construction of dams and levees, the major rivers
 20 meandered, forming oxbows and riparian habitat. Winter floods would inundate
 21 and scour areas along these rivers, creating marshes and early-succession riparian
 22 scrub. Expanses of seasonal wetlands were also created by winter flooding.
 23 These seasonal wetlands formed habitat for overwintering and migrating
 24 waterfowl. Habitat areas such as wetlands are now intensively managed to
 25 support a wide range of birds and other wildlife within small and fragmented
 26 areas. Remnant wetlands and agricultural lands in the Central Valley support
 27 approximately 60 percent of the waterfowl wintering in the Pacific Flyway region.
 28 In addition, another 20 percent of the Pacific Flyway population passes through
 29 the Central Valley, using the wetlands for foraging and resting on their migratory
 30 passage through the region. The Sacramento Valley provides winter habitat for
 31 44 percent of the Pacific Flyway waterfowl. The wetland and associated habitat
 32 are also important to several federally listed and proposed species, and other
 33 special status species such as the American Peregrine Falcon, Bald Eagle,
 34 Aleutian Canada Goose, Giant Garter Snake, and California Tiger Salamander.

35 CVP water supplies are provided to the San Luis NWR Complex which includes
 36 the Merced NWR, San Luis NWR (including the San Luis Unit, West Bear Creek
 37 Unit, East Bear Creek Unit, Freitas Unit, Blue Goose Unit, and Kesterson Unit),
 38 and Grasslands Wildlife Management Area (Reclamation 2012; USFWS 2012b,
 39 2013b). The San Luis NWR Complex also includes the San Joaquin River NWR
 40 which is influenced by CVP operations; however, this refuge does not specifically
 41 receive CVP water under a contract. CVP water supplies are also provided to the
 42 Los Banos Wildlife Area; Volta Wildlife Area; Mendota Wildlife Area; and North
 43 Grasslands Wildlife Area (including China Island Unit and Salt Slough Unit)
 44 (Reclamation 2012b). In the southern San Joaquin Valley, the Kern and Pixley
 45 NWRs provide wildlife viewing opportunities.

1 *San Luis National Wildlife Refuge Complex*

2 The San Luis NWR Complex includes wetlands, riparian forests, native
3 grasslands, and vernal pools (USFWS 2012a, 2012b). The refuge is a major
4 wintering ground and migratory stopover point for a wide range of waterfowl,
5 shorebirds, and other waterbirds. The refuge is host to significant assemblages of
6 birds, mammals, reptiles, amphibians, insects, and plants, some of which, such as
7 the California Tiger Salamander and San Joaquin Kit Fox, are endangered
8 species. Riparian woodlands occur along rivers and sloughs with willow,
9 cottonwood, and oak to support egrets, herons, cormorants, raptors, and songbirds
10 (USFWS 2012b). Wetlands occur on over 25 percent of the San Luis NWR
11 Complex lands and provide nesting habitat for coots, grebes, blackbirds, bitterns,
12 ibis, and marsh wrens; and seasonal wetlands for ducks, geese, shorebirds, and
13 other waterbirds. Grasslands occur on over 70 percent of the lands, including the
14 native creeping wild Rye and alkali sacaton, to support elk, Black-Tailed Deer,
15 Desert Cottontail Rabbit, Black-Tailed Jackrabbit, voles, and songbirds. Vernal
16 pools occur in some areas during the spring, especially in the Kesterson NWR and
17 West Bear Creek Unit. Artificial dens and other habitat structures have been
18 constructed on the refuge, including nest boxes for songbirds, owls, and wood
19 ducks; and dens for kit foxes (USFWS 2012a).

20 *San Luis National Wildlife Refuge*

21 The San Luis NWR contains approximately 26,800 acres of wetlands, riparian
22 forests, native grasslands, and vernal pools (USFWS 2012c). Saline and alkaline
23 conditions on portions of the upland habitat support a rich botanical community of
24 native bunchgrasses, native and nonnative annual grasses, forbs, and native
25 shrubs. Wintering habitat is provided for numerous waterbirds, including green-
26 winged teal, northern shoveler, mallard, gadwall, wigeon, cinnamon teal, northern
27 pintail, ring-necked, canvasback, and ruddy ducks; snow, Ross', and white-
28 fronted geese. Shorebirds include sandpipers and plovers. Tule elk occur in the
29 upland habitats.

30 *Merced National Wildlife Refuge*

31 The Merced NWR contains approximately 10,250 acres of wetlands, native
32 grasslands, vernal pools and riparian areas (USFWS 2012d). In addition to
33 providing breeding habitat for Swainson's Hawk, Tricolored Blackbird, Marsh
34 Wren, and Burrowing Owl; the refuge is host to the largest wintering populations
35 along the Pacific flyway of Lesser Sandhill Crane and Ross' Goose. Mammals
36 such as coyote, Ground Squirrel, rabbit, and beaver are found year-round. Vernal
37 pools are a component of the refuge and are home to many species of vernal pool
38 plants and invertebrates as well as the California Tiger Salamander. Merced
39 NWR also includes approximately 300 acres of cultivated corn and winter wheat
40 crops and more than 500 acres of irrigated pasture for wildlife.

41 *San Joaquin River National Wildlife Refuge*

42 The San Joaquin River NWR encompasses approximately 7,000 acres located
43 where Tuolumne, Stanislaus, and San Joaquin rivers join, creating a mix of
44 habitats for terrestrial wildlife and plant species. Initially established to protect

1 and manage habitat for the Aleutian Cackling Goose, the refuge is currently
2 managed to provide habitat for migratory birds and endangered wildlife species
3 (USFWS 2012e, 2012f). The refuge includes a mosaic of valley oak riparian
4 forest, riverine and slough habitats, seasonal and permanent wetlands, vernal
5 pools, natural uplands, and agricultural fields. Over 500,000 native trees and
6 shrubs such as willow, cottonwood, oak, blackberry, and rose have been planted
7 across 2,200 acres of river floodplain within the refuge, creating the largest block
8 of contiguous riparian woodland in the San Joaquin Valley. Endangered riparian
9 brush rabbits have been re-introduced to this restored habitat from captive-reared
10 populations. These woodlands also support a diversity of breeding songbirds
11 including grosbeak, oriole, flycatcher, warbler, and Least Bell's Vireo; and a
12 heron/egret rookery. The refuge also provides winter and migration habitat for
13 Lesser Sandhill Cranes, Greater Sandhill Cranes, Snow Geese, Ross' Geese, and
14 White-Fronted Goose.

15 Several nonnative invasive plants influence the quality of wildlife habitat on the
16 refuge including yellow star thistle, perennial pepperweed, poison hemlock,
17 Russian thistle, milk thistle, and bull thistle. According to the Comprehensive
18 Conservation Plan for the refuge (USFWS 2006), infestations are greatest in
19 fallow agricultural fields, roadsides, canal banks, and undergrazed pastures, as
20 well as other disturbed sites. Perennial pepperweed is established throughout the
21 riparian areas of the refuge and stands of giant reed are scattered along the banks
22 of the San Joaquin River. Infestations of water hyacinth seasonally disrupt water
23 delivery and create impenetrable surfaces in the streams, sloughs, oxbows,
24 and canals.

25 *Grasslands Wildlife Management Area*

26 The Grasslands Wildlife Management Area is composed entirely of privately
27 owned lands with perpetual conservation easements to preserve wetland and
28 grassland habitats, and wildlife-friendly agricultural lands along the San Joaquin
29 River (GRCD 2014; USFWS 2013c). The Grassland Resource Conservation
30 District, located within the western portion of the Wildlife Management Area,
31 contains approximately 75,000 acres of private wetlands and associated
32 grasslands, and over 30,000 acres of federal National Wildlife Refuges and State
33 Wildlife Management Area. The area constitutes 30 percent of the remaining
34 wetland habitat in the Central Valley and is a major wintering ground for
35 migratory waterfowl and shorebirds of the Pacific Flyway.

36 Grassland Resource Conservation District provides habitat for waterfowl,
37 shorebirds, wading birds, songbirds, raptors, and other wildlife species (GRCD
38 2014; USFWS 2013c). The Grassland Resource Conservation District
39 specifically manages a program to encourage production of natural food plants
40 (such as swamp grass, smartweed, and watergrass). Habitats include seasonally
41 flooded wetlands, moist soil impoundments, permanent wetland, irrigated pasture,
42 and croplands.

1 *Los Banos Wildlife Area*

2 The Los Banos Wildlife Area, located approximately 4 miles northeast of Los
3 Banos, contains more than 6,200 acres in the San Joaquin River floodplain and is
4 dominated by seasonal wetlands (CDFW 2014a; Reclamation 2001b). Permanent
5 and semi-permanent wetlands are also present, along with areas of riparian
6 vegetation. The Los Banos Wildlife Area also supports native and nonnative
7 grasslands. Irrigated pasture and croplands are maintained to provide food,
8 resting, and nesting habitat for waterfowl and other wildlife. Western Pond
9 Turtle, raccoon, Striped Skunk, beaver, muskrat, and mink; as well as over
10 200 species of waterfowl, shore birds, upland game birds, and song birds occur
11 seasonally throughout the area. Seasonal marshes provide habitat for a wide
12 range of waterbirds, upland birds, and seasonal migrants, including American
13 bittern, snowy egret, killdeer, American avocet, wood duck, and mallard.

14 *Volta Wildlife Area*

15 The Volta Wildlife Area consists of approximately 2,900 acres. The Wildlife
16 Area is partially in the Grassland Resource Conservation District (CDFW 2014b;
17 Reclamation et al. 2001b). The Wildlife Area supports permanent and seasonal
18 wetlands and valley alkali shrub. Irrigated pasture and crops are grown to provide
19 food and nesting cover for migratory waterfowl. Beaver, coyote, cottontail, and
20 150 species of birds, including a wide range of waterfowl and shorebirds, are
21 found on the Volta Wildlife Area.

22 *Mendota Wildlife Area*

23 The Mendota Wildlife Area contains more than 12,000 acres of flatlands and
24 floodplain (Huddleston 2001; Reclamation et al. 2001b). The Mendota Wildlife
25 Area has been managed primarily to provide seasonal wetland habitat. Water is
26 used to irrigate natural food crops, such as swamp grass, alkali bulrush,
27 smartweed, and millet, and to flood seasonal and semi-permanent wetlands.
28 Small grains, corn, and pasture are also irrigated in the upland areas. The
29 Wildlife Area has significant white-faced ibis and great-blue heron rookeries.
30 Shorebirds, songbirds, raptors, waterfowl, and wading birds use the wetlands
31 habitat. Mammals that use the refuge include coyote, muskrat, beaver, mink,
32 raccoon, weasel, Black-Tailed jackrabbit, Cottontail Rabbit, Spotted Skunk,
33 Striped Skunks, and Ground Squirrel.

34 *North Grasslands Wildlife Area*

35 The North Grasslands Wildlife Area includes the China Island, Salt Slough, and
36 Galdwall units which encompass 7,069 acres of wetlands, riparian habitat, and
37 uplands (CDFW 2014c). Restoration and enhancement actions have focused on
38 increasing seasonal wetlands, permanent and semi-permanent wetlands, and
39 riparian habitat on the unit, including habitat for the Swainson's hawk and
40 sandhill crane.

41 The China Island Unit of the North Grasslands Wildlife Area borders the San
42 Joaquin River southwest of the confluence with the Merced River (DFG 2011b).
43 The Salt Slough Unit is located on the west side of Salt Slough, adjacent to the
44 San Luis NWR Complex and Los Banos Wildlife Area. Before its acquisition,

1 the unit consisted mainly of irrigated pasture and was managed as a cattle ranch
 2 (DFG 2011c). Habitat on both units includes permanent wetlands that are flooded
 3 continuously; semi-permanent wetlands that are flooded in the spring and
 4 summer; moist soil vegetation to produce seeds and sustain invertebrates,
 5 including swamp timothy, watergrass, and smartweed; seasonal wetlands to
 6 provided flooded areas in the fall for waterfowl; riparian habitat, nesting habitat
 7 for resident breeding birds, including Short-Eared Owl, Northern Harrier, ducks,
 8 and pheasants; upland foraging areas; and pasture which provides late winter and
 9 early spring habitat for geese, and other habitat areas for sandhill crane,
 10 pheasants, and raptors.

11 *Kern National Wildlife Refuge Complex*

12 The Kern NWR Complex consists of the Kern NWR and Pixley NWR (USFWS
 13 2013d). The Kern NWR contains approximately 11,249 acres including seasonal
 14 marsh; moist soil units; and uplands (e.g., grasslands, alkali playa, and valley sink
 15 scrub) (USFWS 2013e). Wetlands on the refuge are seasonal in nature. Fall
 16 flooding begins in mid-August, with a peak in flooded marsh habitat by January.
 17 This habitat is maintained through February, after which the wetland areas are
 18 slowly drained. Selected units are irrigated during late spring and early summer
 19 to encourage plants to grow, to provide food for wintering and migrating birds the
 20 following fall (USFWS 2013e). The refuge is the largest wetland area in the
 21 Southern San Joaquin Valley and plays a vital role in the Pacific Flyway for
 22 migrating waterfowl, shorebirds, and songbirds. Uplands occupy the northeastern
 23 and northwestern portions of the refuge, used by threatened and endangered
 24 species, such as San Joaquin Kit Fox, Tipton Kangaroo Rat, and Blunt-Nosed
 25 Leopard Lizard. Artificial dens have been built for endangered San Joaquin Kit
 26 Foxes and artificial burrows have been provided for Burrowing Owls.

27 The Pixley NWR contains 6,389 acres of grasslands, vernal pools, and playas
 28 along the historic Tulare Lake boundaries (USFWS 2014ak). The refuge includes
 29 approximately 300 acres of managed wetlands for waterfowl and shorebirds. San
 30 Joaquin Kit Fox, Blunt-Nosed Leopard Lizard, and Tipton Kangaroo rat use the
 31 upland areas. Vernal pools also occur on the refuge.

32 **10.3.3.4 Delta, Suisun Marsh, and Yolo Bypass**

33 Historically, the natural Delta system was formed by water inflows from upstream
 34 tributaries in the Delta watershed and outflow to Suisun Bay and San Francisco
 35 Bay (SFEI 2012). Upstream of the Delta, during high Sacramento River flows,
 36 water spilled into the geologic formation known as the Yolo Basin which extends
 37 from Knights Landing Ridge upstream of the confluence between the Sacramento
 38 and Feather rivers to the confluence of Cache Slough and the Sacramento River in
 39 the Delta upstream of Rio Vista and Suisun Marsh. The Delta and Suisun Marsh
 40 have a complex web of channels and islands and is located at the confluence
 41 of the Sacramento and San Joaquin rivers. As described below in
 42 subsection 10.3.4.4.1, Yolo Bypass, is a 59,280-acre floodway through the Yolo
 43 Basin that was constructed as part of the Sacramento River Flood Control Project
 44 to protect the cities of Sacramento and West Sacramento and the north Delta from
 45 extreme flood events.

1 The Delta (as legally defined in the Johnston-Baker-Andal-Boatwright Delta
2 Protection Act of 1992 [California Water Code section 12220]) covers
3 737,358 acres, including 4,278 acres of the Suisun Marsh and 16,762 acres of the
4 Yolo Bypass. Individually, the overall Delta, Suisun Marsh, and Yolo Bypass
5 extend over 737,358 acres, 106,511 acres, and 59,280 acres, respectively. In total,
6 the Delta, Suisun Marsh, and Yolo Bypass constitute a natural floodplain that
7 covers approximately 882,200 acres and drains approximately 40 percent of the
8 state (DWR 2009a).

9 As described in subsection 10.3.2, Overview of Species with Special Status, A
10 listing of wildlife and plant species with special status that occur or may occur in
11 portions of the study area affected by the long-term coordinated operation of the
12 CVP and SWP is provided in Appendix 10A.

13 **10.3.3.4.1 Delta and Suisun Marsh**

14 The Delta overlies the western portions of the Sacramento River and San Joaquin
15 River watersheds. The Delta is a network of islands, channels, and marshland at
16 the confluence of the Sacramento and San Joaquin rivers. Major rivers entering
17 the Delta are the Sacramento River flowing from the north, the San Joaquin River
18 flowing from the south, and eastside tributaries (Cosumnes, Mokelumne, and
19 Calaveras rivers). Suisun Marsh is a tidally influenced brackish marsh located
20 about 35 miles northeast of San Francisco in southern Solano County. It is a
21 critical part of the San Francisco Bay/Sacramento–San Joaquin Delta (Bay-Delta)
22 estuary ecosystem. The Delta, together with Suisun Marsh and greater San
23 Francisco Bay, make up the largest estuary on the west coast of North and South
24 America (DWR 2009a).

25 The Delta was once composed of extensive freshwater and brackish marshes, with
26 tules and cattails, broad riparian thickets of scrub willows, buttonwillow, and
27 native brambles. In addition, there were extensive riparian forests of Fremont
28 cottonwood, valley oak, Oregon ash, boxelder, white alder, and Goodding’s black
29 willow. Upland, non-riparian stands of valley oak and coast live oak occurred in
30 a mosaic with seasonally flooded herbaceous vegetation, including vernal pools
31 and alkali wetlands (SFEI 2012).

32 Substantial areas of the Delta and Suisun Marsh have been modified by
33 agricultural, urban and suburban, and recreational land uses (Reclamation et al.
34 2011; SFEI 2012). Over the past 150 years, levees were constructed in the Delta
35 and Suisun Marsh to provide lands for agricultural, municipal, industrial, and
36 recreational land uses. The remaining natural vegetation is fragmented, and
37 largely restricted to the edges of waterways, flooded islands, and small protected
38 areas such as parks, wildlife areas, and nature reserves (Hickson and Keeler-Wolf
39 2007). A substantial portion of the emergent wetlands exists as thin strips along
40 the margins of constructed levees (SFEI 2012). Current habitat along the Delta
41 waterways includes seasonal wetlands, tidal wetlands, managed wetlands, riparian
42 forests, and riparian scrub.

43 Seasonal wetlands historically had occurred along the riparian corridor at
44 elevations that were inundated during high flow events. Many of the levees were

1 constructed along the riparian corridor edges; and therefore, historic seasonal
2 wetlands were substantially modified (SFEI 2012). Adjacent areas of perennial
3 wetlands on the water-side of the riparian corridor were modified as levees were
4 constructed and channels enlarged. In many of these areas the perennial wetlands
5 were replaced by seasonal wetlands. The vegetation of seasonal wetlands is
6 typically composed of wetland generalist species that occur in frequently
7 disturbed sites such as hyssop loosestrife, cocklebur, dallis grass, Bermuda grass,
8 barnyard grass, and Italian ryegrass.

9 Alkali-related habitats occur near salt-influenced seasonal and perennial wetlands.
10 Alkali seasonal wetlands occur on fine-textured soils that contain relatively high
11 concentrations of dissolved salts. These types of soils are typically found at the
12 historical locations of seasonal ponds in the Yolo Basin in and around the CDFW
13 Tule Ranch Preserve, and upland in seasonal drainages that receive salts in runoff
14 from upslope salt-bearing bedrock such as areas near Suisun Marsh and the
15 Clifton Court Forebay. Alkali wetlands include saltgrass, alkali weed, saltbush,
16 alkali heath, and iodine bush. Small stands of alkali sink scrub (also known as
17 valley sink scrub) are characterized by iodine bush.

18 Tidal wetlands consist of tidal brackish wetlands that occur either as relatively
19 substantial tracts of complex tidal wetlands, or in narrow bands of fringing tidal
20 wetlands (Siegel et al. 2010a). Fringing tidal marsh exists along the outboard side
21 exterior levees and generally has formed since diking for managed wetlands
22 began. Fringing tidal wetlands vary in size and vegetation composition, exhibit
23 less geomorphic complexity, and have a low area-to-edge ratio. Fringing marshes
24 lack connection with the upland transition, are often found in small, discontinuous
25 segments, and can limit movement of terrestrial marsh species.

26 Plant zones in complex tidal wetlands are influenced by inundation regime and
27 salinity. Tidal wetlands can be divided into three zones: low marsh, middle
28 marsh, and high marsh (Reclamation et al. 2011). The low tidal wetland zone is
29 tidally inundated once or twice per day. At the lowest elevations, vegetation is
30 inhibited by frequent, prolonged, often deep inundation and by disturbance by
31 waves or currents. The dominant plant species are bulrushes. Other species
32 occurring in the low tidal wetland zone are pickleweed, lowclub rush, common
33 reed, and cattails. The low tidal wetland zone provides foraging habitat for
34 waterfowl and shorebirds, California Ridgway's Rail, California Black Rail, and
35 other wading birds.

36 The middle tidal wetland zone is tidally inundated at least once per day; there is
37 relatively little cover and no refuge from higher tides, which completely flood the
38 vegetation of the middle marsh. The dominant plant species are pickleweed,
39 saltgrass, and bulrush. Other species occurring in the middle tidal marsh are
40 fleshy jaumea, sea milkwort, rushes, salt marsh dodder, alkali heath, cattail,
41 sneezeweed, and marsh gumplant (Siegel et al. 2010b). The middle tidal wetland
42 zone provides foraging habitat for salt marsh harvest mouse and Suisun shrew, as
43 well as common and special status bird species, including waterfowl and
44 shorebirds, California Ridgway's Rail, California Black Rail, and other wading

1 birds. This zone also provides nesting and foraging habitat for Suisun Song
2 Sparrow and Salt Marsh Common Yellowthroat (Reclamation et al. 2011).

3 The high tidal wetland zone receives intermittent inundation during the monthly
4 tidal cycle, with the higher elevations being inundated during only the highest
5 tides. Historically, the high marsh was an expansive transitional zone between the
6 tidal wetlands and adjacent uplands. The high marsh and associated upland
7 transition zone have been significantly affected by land use changes
8 (e.g., managed wetlands, agriculture). The dominant plants are native species,
9 such as saltgrass, pickleweed, and Baltic rush, and nonnative species, including
10 perennial pepperweed, poison hemlock, and fennel. Other species occurring in
11 the high tidal marsh are saltmarsh dodder, fleshy jaumea, seaside arrowgrass,
12 alkali heath, brass button, and rabbitsfoot grass.

13 The high tidal marsh provides habitat for special status plants, including Suisun
14 Marsh aster, Soft bird's beak, and Suisun thistle (Siegel et al. 2010b). The high
15 marsh zone provides foraging and nesting habitat for waterfowl, shorebirds,
16 California Ridgway's Rail, California Black Rail, and other birds. It also provides
17 foraging and nesting habitat for special status species such as Salt Marsh Harvest
18 Mouse and Suisun Shrew and provides escape cover for Salt Marsh Harvest
19 Mouse, and Suisun Shrew during periods when the middle and lower portions of
20 the high tidal wetland zone are inundated (Reclamation et al. 2011).

21 Managed wetlands are primarily located within the Suisun Marsh, Cache Slough,
22 and near the confluence of the Mokelumne and Sacramento rivers within the
23 historical limits of the high tidal marsh and adjacent uplands that were diked and
24 leveled for agricultural purposes and later managed to enhance habitat values for
25 specific wildlife species (CALFED 2000). Diked managed wetlands and uplands
26 are the most typical land cover type in the Suisun Marsh area. Managed wetlands
27 are considered seasonal wetlands because they may be flooded and drained
28 several times throughout the year. Watergrass and smartweed are typically the
29 dominant species in managed wetlands that use fresher water. Bulrush, cattail,
30 and tule are the dominant species in managed wetlands that employ late
31 drawdown management. Pickleweed, fat hen, and brass buttons are typical in the
32 higher elevations of the managed wetlands. In marshes with higher soil salinity,
33 pickleweed, saltgrass, and other salt-tolerant species are dominant. Managed
34 wetlands are managed specifically as habitat for wintering waterfowl species,
35 including Northern Pintail, Mallard, American Wigeon, Green-Winged Teal,
36 Northern Shoveler, Gadwall, Cinnamon Teal, Ruddy, and Canvasback ducks;
37 White-Fronted Goose, and Canada Goose. Some wetlands are also managed for
38 breeding waterfowl, especially mallard.

39 Riparian forest areas (excluding willow-dominated riparian habitats) are still
40 present in some portions of the Delta along many of the major and minor
41 waterways, oxbows, and levees (CALFED 2000). Riparian forest and woodland
42 communities dominated by tree species are mostly limited to narrow bands along
43 sloughs, channels, rivers, and other freshwater features throughout the Delta.
44 Isolated patches of riparian vegetation are also found on the interior of reclaimed
45 Delta islands, along drainage channels, along pond margins, and in abandoned,

1 low-lying fields. Cottonwoods and willows, Oregon ash, boxelder, and California
 2 sycamore, are the most typical riparian trees in central California. Valley oak and
 3 black walnut are typical in riparian areas in the Delta. Riparian trees are used for
 4 nesting, foraging, and protective cover by many bird species and riparian canopies
 5 provide nesting and foraging habitat for a variety of mammals. Understory shrubs
 6 provide cover for ground-nesting birds that forage among the vegetation and
 7 leaf litter.

8 Riparian scrub in the Delta and Suisun Marsh consists of woody riparian shrubs in
 9 dense thickets (SFEI 2012). Riparian scrub thickets are usually associated with
 10 higher, sloping, better drained edges of marshes or topographic high areas, such
 11 as levee remnants and elevated flood deposits; and along shorelines of ponds or
 12 banks of channels in tidal or non-tidal freshwater habitats. Plant species may
 13 include willow, blackberry, buttonbush, mulefat, and other shrub species.
 14 Willow-dominated habitat types appear to be increasing in extent in recent years;
 15 and willows line many miles of artificial levees where waterways historically had
 16 flowed into freshwater emergent wetland. Nonnative Himalayan blackberry
 17 thickets are a typical element of riparian scrub communities along levees and
 18 throughout pastures in the levees. Willow thickets provide habitat for a wide
 19 range of wildlife species, including the Song Sparrow, Lazuli Bunting, and Valley
 20 Elderberry Longhorn Beetle.

21 **10.3.3.4.2 Yolo Bypass**

22 The Yolo Bypass is a 59,280-acre floodway through the natural-overflow of the
 23 Yolo Basin on the west side of the Sacramento River (DWR 2012). As described
 24 in Chapter 5, Surface Water Resources and Water Supplies, the Yolo Bypass
 25 generally extends north to south from Fremont Weir along the Sacramento River
 26 (near Verona) to upstream of Rio Vista along the Sacramento River in the Delta.
 27 The bypass, part of the Sacramento River Flood Control Project, conveys
 28 floodwaters around the Sacramento River near the cities of Sacramento and West
 29 Sacramento. The bypass is utilized as a flood bypass approximately once every
 30 3 years, generally during the period from November to April. Land use in the
 31 Yolo Bypass is generally restricted to specific agriculture, managed wetlands, and
 32 vegetation communities to ensure that floodway function is maintained (CALFED
 33 et al. 2001; USFWS 2002). Agricultural crops include corn, tomatoes, melons,
 34 safflower, and rice within the northern bypass; and corn, milo, safflower, beans,
 35 tomatoes, and sudan grass in the southern bypass. Waterfowl hunting areas are
 36 generally located in the southern bypass, and include rice fields, permanent open
 37 water, or a mixture of water and upland habitat. The USACE has developed
 38 criteria for managing emergent vegetation (e.g., cattails and bulrushes) in the
 39 Yolo Bypass to maintain flood capacity, including no more than 5 percent of the
 40 vegetation in seasonal wetlands can be emergent wetlands; no more than
 41 50 percent of the vegetation in permanent wetlands can be emergent wetlands;
 42 and riparian vegetation can only occur in specified areas to maintain flood
 43 capacity (DFG and Yolo Basin Foundation 2008).

44 The Yolo Bypass supports several major terrestrial vegetation types, including
 45 riparian woodland, valley oak woodland, open water, and wetland. Historically,

1 riparian woodland and freshwater wetland were the dominant habitat types in the
2 Yolo Basin (CALFED et al. 2001; USFWS 2002). Currently, riparian woodland
3 and associated riparian scrub habitats are primarily found adjacent to Green's
4 Lake, Putah Creek, and along the East Toe Drain within the Yolo Bypass Wildlife
5 Area. Riparian woodland is a tree-dominated community found adjacent to
6 riparian scrub on older river terraces where flooding frequency and duration is
7 less. Riparian woodlands include Fremont cottonwood, valley oak, sycamore,
8 willow, eucalyptus, giant reed, and black oak. The understory is typically sparse
9 in this community with limited areas of California grape, blackberry, poison oak,
10 mugwort, grasses, and forbs. The woodland canopy provides habitat for hawks,
11 owls, American Crow, Great Egret, Great Blue Heron, Red-Tailed Kite, Yellow-
12 Rumped Warbler, Black Phoebe, woodpecker, Wood Duck, bat, and raccoon.

13 Riparian scrub is a shrub-dominated community typically found along stream
14 margins and in the streambed, on gravel bars and similar formations (CALFED et
15 al. 2001; USFWS 2002). This community is typically dominated by
16 phreatophytes (i.e., deep-rooted plants that obtain their water from the water table
17 or the layer of soil just above it), such as willows, and other plants representative
18 of early- to mid-successional stage vegetation communities within riparian areas
19 in the Central Valley. The species include alder, elderberry, cottonwood, wild
20 rose, blackberry, and boxelder. This habitat supports Black-Crowned Night
21 Heron, Snowy Egret, Belted Kingfisher, Black Phoebe, Swallow, and bat.

22 Riparian scrub habitat frequently occurs adjacent to nonwoody riparian habitat,
23 including false bamboo, cocklebur, weedy annual grasses, sedges, rushes,
24 mustard, sweet clover, thistle, and other weedy species. The nonwoody riparian
25 habitat supports Savannah Sparrow, House Finch, American Goldfinch,
26 California Ground Squirrel, Gopher Snake, and pond turtle.

27 Remnants of valley oak woodlands and savanna occur on floodplain terraces in
28 fragmented areas, including downstream of Fremont Weir and along the southern
29 portion of the Toe Drain (CALFED et al. 2001). The habitat also includes
30 sycamore, black walnut, wild grape, poison oak, elderberry, blackberry, grass,
31 and sedge.

32 Depending on the duration of inundation, local soil factors, site history, and other
33 characteristics, seasonal wetlands typically are dominated by species
34 characteristic of one of three natural wetland communities: freshwater marshes,
35 alkali marshes, or freshwater seasonal (often disturbed) wetlands (CALFED et al.
36 2001). Freshwater marsh communities are typically found in areas subjected to
37 prolonged flooding during the winter months, and frequently do not dry down
38 until early summer. Permanent open water is found throughout the Yolo Bypass,
39 including Gray's Bend near Fremont Weir, Green's Lake near Interstate 80, ponds
40 in the Yolo Bypass Wildlife Area, along Cache and Prospect sloughs, and within
41 canals and drainage ditches. The wetlands support duck breeding habitat; and
42 habitat for many lifestages of grebe, ibis, heron, egret, bittern, coot, rails, raptors,
43 muskrat, raccoon, opossum, beaver, Ring-Necked Pheasant, garter snake, Pacific
44 Tree Frog, and bullfrog.

1 Managed wetlands in the Yolo Bypass occur near Fremont Weir, in the
2 16,770-acre Yolo Bypass Wildlife Area, and within and near Cache Slough. The
3 managed wetlands are generally flooded in the fall, with standing water
4 maintained continuously throughout the winter until drawdown occurs in the
5 following spring (CALFED et al. 2001; DFG and Yolo Basin Foundation 2008).
6 A primary objective of seasonal wetland management is to provide an abundance
7 and diversity of seeds, aquatic invertebrates, and other foods for wintering
8 waterfowl and other wildlife. The wetlands also are managed to control the extent
9 of tules and cattails; and more recently, water hyacinth. A portion of the managed
10 wetlands occur within rice fields which are flooded in the winter to provide
11 waterfowl habitat for feeding and resting habitats. A variety of annual plants
12 germinate on the exposed mudflats of seasonal wetlands during the spring draw
13 down, including swamp timothy, watergrass, smartweed, and cocklebur. These
14 plants are then managed through the timing, duration or absence of summer
15 irrigation. The mudflats support sandpiper, plover, avocet, stilt, and other
16 shorebirds.

17 Managed semi-permanent wetlands, commonly referred to as “brood ponds,” are
18 flooded during the spring and summer, but may experience a 2 to 6 month dry
19 period each year. These semi-permanent wetlands provide breeding ducks,
20 ducklings, and other wetland wildlife with protection from predators and
21 abundant invertebrate food supplies (DFG and Yolo Basin Foundation 2008).
22 Permanent wetlands remain flooded throughout the year. Due to year-round
23 flooding, permanent wetlands support a diverse, but usually not abundant,
24 population of invertebrates. Permanent managed wetlands provide deep water
25 habitat for diving ducks, such as Ruddy Duck, Scaup, and Goldeneye; and other
26 water birds, including Pied-Billed Grebe, coot, and moorhen. They often have
27 dense emergent cover on their edges that is the preferred breeding habitat for
28 Marsh Wren and Red-Winged Blackbird; and roosting habitat for Black-Crowned
29 Night Heron, White-Faced Ibis, and egret.

30 The managed wetlands are operated by private hunting clubs; private conservation
31 entities, including conservation banks; and the Federal and state governments
32 (CALFED et al. 2001). Some of the hunting clubs have implemented wetland
33 management agreements with CDFW under the State Presley Program or Wetland
34 Easement Program to coordinate the timing and patterns of flooding, drawdowns,
35 irrigation, soil disturbance, and maintenance of brood habitat. The patterns may
36 be adjusted annually to respond to specific wildlife and hydrologic needs. A
37 similar program focused on providing spring habitat for breeding is provided by
38 the Federal Waterbank Program.

39 Habitat in the Yolo Bypass is affected by periodic flooding (CALFED et al.
40 2001). Following a flood, roads, canals, and ditches may need to be excavated;
41 debris needs to be removed from habitat, and water delivery facilities may need to
42 be repaired. Flooding also disrupts nesting and resting activities of birds. During
43 floods, hunting activities are diminished or ceased.

1 **10.3.3.4.3 Agricultural Lands in the Delta, Suisun Marsh, and Yolo Bypass**

2 Major crops and cover types in agricultural production in the Delta and Suisun
3 Marsh include small grains (wheat and barley), field crops (corn, sorghum, and
4 safflower), truck crops (tomato and sugar beet), forage crops (hay and alfalfa),
5 pastures, orchards, and vineyards. The distribution of seasonal crops varies
6 annually, depending on crop rotation patterns and market forces. In many areas,
7 cropping practices result in monotypic stands of vegetation for the growing
8 season and bare ground in fall and winter. Some farmland is more intensively
9 managed to provide wildlife habitat in addition to crops. Regular maintenance of
10 fallow fields, roads, ditches, and levee slopes can reduce the establishment of
11 ruderal vegetation or native plant communities.

12 Agriculture has been present in the Yolo Bypass since the seasonal wetlands and
13 perennial marsh and riparian areas were first converted to farms in the mid-1800s.
14 For many years, grazing was the primary use of agricultural lands in the Yolo
15 Bypass. In the latter part of the 20th century, irrigation systems were developed
16 and fields were engineered for the production of row crops (DFG and Yolo Basin
17 Foundation 2008). Periodic flooding of the bypass limits the types of crops that
18 can be grown. The Yolo Bypass Wildlife Area utilizes agriculture to manage
19 habitats while providing income for the management and operation of the
20 property. Working with local farmers, the Yolo Bypass Wildlife Area provides
21 fields of milo, corn, and Sudan grass specifically for wildlife forage. Rice is
22 grown, harvested, and flooded to provide food for thousands of waterfowl. Corn
23 fields are harvested to provide forage for geese and cranes. Crops such as
24 safflower are cultivated and mowed to provide seed for upland species such as
25 Ring-Necked Pheasant and Mourning Dove. Row and truck crops are grown
26 across the northern half of the Yolo Bypass Wildlife Area. The primary crops
27 grown include rice, corn, millet, milo, safflower, sunflower, and tomatoes. These
28 crops are cultivated during the summer months. From fall to spring, some farmed
29 areas are fallowed and flooded to provide forage for wildlife as well as seasonal
30 wetland habitat. An extensive area at the southern end of the wildlife area is used
31 for grazing cattle. Cattle are brought onto the Yolo Bypass Wildlife Area in mid-
32 spring or early summer after the threat of flooding has passed and are removed by
33 January. Forage is provided in irrigated pasture, uplands within the bypass and
34 the annual grassland-vernal pool complex. Alfalfa is only grown in the western
35 portion of the bypass south of Interstate 80, along with a variety of row crops that
36 are grown in this region (Yolo County 2013).

37 **10.3.3.4.4 Wildlife Refuges in the Delta, Suisun Marsh, and Yolo Bypass**

38 A number of wildlife areas that could be affected by changes in long-term
39 operations of CVP and SWP are located in the Delta, Suisun Marsh, and Yolo
40 Bypass. Conditions in the Yolo Bypass, including the Yolo Bypass Wildlife
41 Area, are described above and not repeated in this subsection.

42 *Stone Lakes National Wildlife Refuge*

43 The Stone Lakes NWR is located in the Beach-Stone Lakes Basin about 10 miles
44 south of the city of Sacramento. It was established in 1994 and the refuge area is

1 approximately 18,000 acres, of which about 9,000 acres is in a core refuge area
2 owned by the USFWS and an approximately 9,000-acres “Cooperative Wildlife
3 Management Area” where the USFWS seeks to enter into cooperative agreements
4 or purchase conservation easements from willing landowners. The USFWS
5 actively manages around 6,000 acres on the refuge (USFWS 2007).

6 The refuge vegetative communities include agricultural lands, open water,
7 perennial freshwater wetlands, cottonwood-willow riparian, irrigated pasture and
8 wet meadow, managed permanent and seasonal wetland, orchards, riparian scrub,
9 upland forest, valley oak riparian woodland, vernal pool, and grasslands that
10 facilitate wildlife movement and help compensate for habitat fragmentation and
11 buffers the effects of urbanization on agricultural lands in the Delta region
12 (USFWS 2007).

13 The diverse vegetation provides habitat for a wide ranges of mammals, birds,
14 reptiles, and amphibians similar to those described for other sections of the
15 Sacramento Valley (USFWS 2007). The grasslands, pastures, woodlands support
16 White-Faced Ibis, Geese, Black-Bellied Plover, Great Blue Heron, Great Egret,
17 Greater Sand Hill Crane, Northern Harrier, White-Tailed Kite, Red-Shouldered
18 Hawk, Swainson’s Hawk, Great Horned Owl, Barn Owl, Bald Eagle, Golden
19 Eagle, American Kestrel, Prairie Falcon, Tree Swallow, Barn Swallow, Cliff
20 Swallow, songbirds, and birds that use the grasslands, including killdeer, Ring-
21 Necked Pheasant, Burrowing Owl, Mourning Dove, Brewer’s Blackbird, and
22 Turkey Vulture. The waterfowl species include Tundra Swan, White-Fronted
23 Goose, Snow Goose, Canada Goose, Mallard, Northern Pintail, Northern
24 Shoveler, Cinnamon Teal, Green-Winged Teal, Wood, and Ruddy ducks. The
25 wetland areas also support Common Yellowthroat, Red-Winged Blackbird, Marsh
26 Wren, coot, Cormorant, and American White Pelican. Other wildlife species on
27 this refuge include coyote, Deer Mouse, Pocket Gopher, Black Tailed Hare,
28 California Vole, California Ground Squirrel, Pacific Tree Frog, bullfrog, pond
29 turtle, Pond Slider Turtle, Western Fence Lizard, Western Terrestrial Garter
30 Snake, Gopher Snake, Common Garter Snake, California King Snake, and
31 Western Toad.

32 The riparian cottonwood forests include Fremont cottonwood, Gooding’s willow,
33 California grape, California boxelder, California blackberry, white-stemmed
34 raspberry, buttonbush, and blue elderberry. The mixed riparian forest includes
35 valley oak with vegetation similar to the riparian cottonwood forest but at lower
36 densities. The valley oak riparian forest is dominated by valley oak, Oregon ash,
37 California sycamore, and California black walnut with an understory of grasses,
38 vines, and shrubs, including California blackberry and wild rose. The perennial
39 wetlands include cattails, tules, cottonwood, willows, sedges, and rushes with
40 areas of watergrass, smartweed, and swamp timothy that also occur in seasonal
41 wetlands. The riparian vegetation provides vast amounts of insects, perches, and
42 cover to support the wide range of bird species, the valley oak woodlands provide
43 acorns, insects, and perch and nesting sites. The wetland sites provide foraging
44 opportunities for waterbirds and upland species.

1 *Miner Slough Wildlife Area*

2 The Miner Slough Wildlife Area within the Delta is about 10 miles north of Rio
3 Vista at the junction of Miner and Cache sloughs and is accessed by boat (CDFW
4 2014d). The 37-acre Wildlife Area includes approximately 10 acres of tidal
5 wetlands which become a narrow peninsula extending from Prospect Island at low
6 tide. The riparian vegetation of willow, cottonwood, tules, and blackberry
7 support a wide range of wildlife species including beaver, black-crowned night
8 heron, and waterfowl.

9 *Decker Island Wildlife Area*

10 Decker Island is a 648-acre island located about 20 feet above sea level
11 surrounded by the Sacramento River and Horseshoe Bend in the Delta just south
12 of Rio Vista (DWR 2003; Philipp 2005). The island was created between 1917
13 and 1937 as part of the actions to implement the Sacramento Deep Water Ship
14 Channel, as described in Chapter 5, Surface Water Resources and Water Supplies.
15 CDFW owns the northernmost 33 acres of Decker Island and has been working
16 with the California Department of Water Resources (DWR) to reestablish and
17 enhance wetland and upland habitats. The vegetation includes shallow water
18 channels lined with thick stands of tules, sedges, willow, and alder. Many
19 mammal species have been observed, including river otter, mink, beaver, coyote,
20 mice, and voles. Various species of raptors, waterfowl, songbirds, and shorebirds
21 have also been observed. Amphibians and reptiles such as Pacific Tree Frog,
22 Western Fence Lizard, and Gopher Snake have been seen. Invasive plants such as
23 perennial pepperweed, yellow star thistle, water hyacinth, Brazilian water weed
24 and *Egeria* continue to pose a threat to restoration efforts.

25 *Lower Sherman Island Wildlife Area*

26 The Lower Sherman Island Wildlife Area occupies roughly 3,100 acres, primarily
27 marsh and open water, at the confluence of the Sacramento and San Joaquin
28 Rivers in the western Delta (DFG 2007). Riparian vegetation is characterized by
29 narrow linear strips of trees and shrubs, in single-to multiple story canopies.
30 Riparian vegetation primarily occurs along the historic levees above elevations
31 that support tidal marsh. Native woody plant species occurring in the riparian
32 strip include Fremont cottonwood, willow, red alder, and California wild rose.
33 The invasive nonnative, Himalayan blackberry infests many of these areas.
34 Marsh vegetation includes both emergent marsh and areas of floating aquatic
35 vegetation. Most emergent marsh is dominated by bulrush, cattail, and common
36 reed. In the northwestern portion of Lower Sherman Island, there is also upper
37 elevation marsh dominated by pickleweed and saltgrass. Grasslands are
38 dominated by annual grasses, but also include many perennial species that are
39 also typical in seasonal wetlands. Pampas grass and perennial pepperweed,
40 two invasive nonnative species are also found in the grassland areas.

41 At the Lower Sherman Island Wildlife Area, habitat exists for a wide variety of
42 wildlife species, including numerous bird species, mammals, reptiles, and
43 amphibians (DFG 2007). Many of the bird species that occur in the wildlife area
44 are migratory and are there only, or primarily, during the fall and winter months.
45 Wintering birds include waterfowl, shorebirds, wading birds, and raptors. Other

1 groups that utilize the wildlife area seasonally include upland game species,
 2 cavity-nesting birds, and neotropical migratory birds. Typical mammal species
 3 found in the upland grassland and disturbed areas of the wildlife area include
 4 Striped Skunk, raccoon, squirrel, voles, Pocket Gopher, feral cats, fox, and
 5 coyote. Muskrat and beaver may be found in the marsh vegetation. Typical
 6 reptiles and amphibians include Western Fence Lizard, snake, frog, and toad.

7 *Rhode Island Wildlife Area*

8 Rhode Island Wildlife Area is a 67-acre island, located in Contra Costa County
 9 that is managed by CDFW (CDFW 2014e). The vegetation along the perimeter of
 10 the island includes alder, willow, blackberry, and tule. The interior open water
 11 areas include marsh vegetation of tule and cattail. The island provides habitat for
 12 river otters, beaver, muskrat, and many species of birds including Great Blue
 13 Heron; Black-Crowned Night Heron; egrets; and Mallard, Cinnamon Teal, and
 14 Wood ducks.

15 *White Slough Wildlife Area*

16 The White Slough Wildlife Area, west of Lodi and north of Stockton, is an
 17 880-acre area refuge with open water, freshwater marsh, grassland/upland area,
 18 and riparian habitats (CDFW 2014f). The area supports upland game birds such
 19 as Ring-Necked Pheasant, California Quail, Mourning Dove, and a range of
 20 waterfowl species similar to those described for the Delta and Yolo Bypass.

21 *Hill Slough Wildlife Area*

22 Hill Slough Wildlife Area, located in the northern part of Suisun Marsh, is
 23 operated by CDFW and contains 1,723 acres of saltwater tidal marsh, managed
 24 marshes, slough, and upland grassland (CDFW 2014g). The area supports a wide
 25 variety of waterfowl, including Northern Pintail, Mallard, Northern Shoveler, and
 26 Green-Winged Teal ducks; and American wigeon. Ferruginous Hawks and
 27 Rough-Legged Hawks winter in the area while year-round residents such as
 28 Golden Eagle, Northern Harrier, and Red-Tailed Hawk which forage over the
 29 ponds and upland areas. Mammals including raccoon, jackrabbit, and voles are
 30 found here and are preyed upon by the coyotes that hunt and live in the wildlife
 31 area.

32 *Grizzly Island Wildlife Area*

33 Grizzly Island Wildlife Area is administered by CDFW and consists
 34 approximately 15,300 acres of tidal wetlands and managed marshes within Suisun
 35 Marsh (CDFW 2014h, 2014i). The CDFW manages waterways to create more
 36 than 8,500 acres of seasonal ponds containing alkali bulrush and fat-hen. Grizzly
 37 Island Wildlife Area includes habitats that support Northern Pintail Duck, Green-
 38 Winged Teal Duck, American Widgeon, Tule Goose, egret, Great Blue Heron,
 39 Snowy Egret, Black-Crowned Night Heron, Yellowthroat, Marsh Wren, Suisun
 40 Song Sparrow, American White Pelican, Ferruginous Hawk, Sharp-Shinned
 41 Hawk, white Tailed Kite, Red-Tailed Hawk, Prairie Falcon, Peregrine Falcon,
 42 Northern Harrier, and Short-Eared Owl. The Grizzly Island Wildlife Area also
 43 supports mammals, including Plush River Otter and Tule Elk.

1 *Point Edith Wildlife Area*

2 Point Edith Wildlife Area is located in Contra Costa County, approximately
3 2.5 miles east of Martinez. The Point Edith Wildlife Area includes approximately
4 760 acres of marshes which is accessed by boat. The habitat includes open water
5 and tidal wetlands that support waterfowl, including coot and moorhen (CDFW
6 2014j).

7 *Fremont Weir Wildlife Area*

8 The Fremont Weir Wildlife Area is located within the Yolo Bypass from the
9 Sacramento River to downstream of the Fremont Weir. During high flows, water
10 from the Sacramento River flows into the Yolo Bypass over the Fremont Weir as
11 part of the Sacramento River Flood Control Project, as described in Chapter 5,
12 Surface Water Resources and Water Supplies. The 1,461-acre refuge includes
13 valley oak, willow, cottonwood, brush, and weedy vegetation (CDFW 2014k).
14 The area supports pheasant, Valley Quail, Mourning Dove, a range of waterfowl
15 species similar to those described for the Yolo Bypass, Cottontail Rabbit, and
16 jackrabbit.

17 *Sacramento Bypass Wildlife Area*

18 The Sacramento Bypass Wildlife Area is located along a channel that connects the
19 Sacramento River to the Yolo Bypass. During high flows, water from the
20 Sacramento River flows into the Yolo Bypass through the Sacramento Bypass as
21 part of the Sacramento River Flood Control Project, as described in Chapter 5,
22 Surface Water Resources and Water Supplies. The 360-acre refuge includes
23 valley oak, willow, cottonwood, and weedy vegetation (CDFW 2014l). The area
24 supports raptors, songbirds, pheasant, Mourning Dove, and a range of mammal
25 species similar to those described for the Yolo Bypass.

26 *Calhoun Cut Ecological Reserve*

27 The Calhoun Cut Ecological Reserve is located within the Cache Slough area and
28 is only accessed by boat through Lindsay Slough (CDFW 2014m). Vegetation in
29 Calhoun Cut includes grasslands, marshes, and riparian vegetation (Witham and
30 Karacfelas 1994). The grasslands include native purple needlegrass grasslands
31 and vernal pools.

32 **10.3.4 San Francisco Bay Area Region**

33 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,
34 Santa Clara, San Benito, and Napa counties that are within the CVP and SWP
35 service areas. The CVP and SWP water supplies are used in the San Francisco
36 Bay Region by Contra Costa Water District, East Bay Municipal Utility District,
37 Zone 7 Water Agency, Alameda County Water District, Santa Clara Valley Water
38 District, San Benito County Flood Control and Water Conservation District, and
39 Napa County Flood Control and Water Conservation District. The majority of the
40 CVP and SWP water uses in the San Francisco Bay Area Region are for
41 municipal and industrial land uses. Agricultural areas that use CVP and SWP
42 water are located within coastal valleys, especially within the Livermore-Amador

1 valleys of Alameda County, southern Santa Clara County, and northern San
2 Benito County.

3 Many of these agencies store the CVP and/or SWP water supplies in surface
4 water reservoirs, including CVP Contra Loma and San Justo reservoirs; the SWP
5 Bethany Reservoir and Lake Del Valle; the Contra Costa Water District Los
6 Vaqueros Reservoir; and the East Bay Municipal Utility District Upper San
7 Leandro, San Pablo, Briones, and Lafayette reservoirs and Lake Chabot. CVP
8 and SWP are generally not stored in reservoirs within Santa Clara County
9 (SCVWD 2010). Operation of the reservoirs is dependent upon the volume of
10 CVP and/or SWP water blended with other water supplies used by these agencies.
11 Surface water streams are not used to convey the water from the CVP and/or SWP
12 facilities to the reservoirs. As described in subsection 10.3.2, Overview of
13 Species with Special Status, A listing of wildlife and plant species with special
14 status that occur or may occur in portions of the study area affected by the long-
15 term coordinated operation of the CVP and SWP is provided in Appendix 10A.

16 The USFWS has approved two habitat conservation plans in the areas served by
17 CVP and SWP water supplies, including the East Contra Costa County Habitat
18 Conservation Plan/Natural Community Conservation Plan and the Santa Clara
19 Valley Habitat Plan (ECCCHCPA 2006; Reclamation et al. 2009; Santa Clara
20 County et al. 2012).

21 **10.3.4.1 Central Valley Project Reservoirs**

22 The CVP reservoirs in the San Francisco Bay Area Region include Contra Loma
23 and San Justo reservoirs.

24 **10.3.4.1.1 Contra Loma Reservoir**

25 The Contra Loma Reservoir is a CVP facility in Contra Costa County that
26 provides offstream storage along the Contra Costa Canal, as described in
27 Chapter 5, Surface Water Resources and Water Supplies. The 80-acre reservoir is
28 part of 661-acre Contra Loma Regional Park and Antioch Community Park
29 (Reclamation 2014a). The Contra Loma Reservoir area includes open space and
30 recreation facilities. In the open space, vegetative communities include
31 grasslands, blue oak woodland, valley foothill riparian, fresh emergent wetlands,
32 riverine, and open water communities. The annual grasslands include smooth
33 brome, slender wild oats, Italian ryegrass, yellow star thistle, white-stem filaree,
34 and mouse-ear chickweed. Valley foothill riparian occurs along intermittent
35 streams and includes valley oaks, cottonwoods, red willows, Himalayan
36 blackberry, poison oak, and mulefat. The riverine and fresh emergent wetland
37 communities include ryegrass, curly dock, hyssop, loosestrife, Baltic rush,
38 flowering quillwort, cattails, rushes, dallis grass, nutsedge, and cocklebur.
39 Watermilfoil occurs along portions of the shoreline. Recreation areas include
40 urban trees with Oregon ash, black walnut, Fremont cottonwood, blue oak, valley
41 oak, interior live oak, fig, and eucalyptus. East Bay Regional Parks District has
42 initiated restoration actions to improve native grasslands and riparian and provide
43 habitat for quail.

1 Wildlife in the grasslands areas include Burrowing Owl, Horned Lark, Western
2 Meadowlark, Turkey Vulture, Northern Harrier, American Kestrel, White-Tailed
3 Kite, Red-Tailed Hawk, Brewer’s Blackbird, Mourning Dove, Western Fence
4 Lizard, Common Garter Snake, Western Rattlesnake, Black-Tailed Jackrabbit,
5 California Ground Squirrel, Botta’s Pocket Gopher, Western Harvest Mouse,
6 California Vole, American Badger, Mule Deer, and coyote (Reclamation 2014a).
7 The valley foothill riparian and blue oak woodland vegetation support a wide
8 range of birds including Northern Flicker, Yellow Warbler, Acorn Woodpeckers,
9 Western Scrub Jay, White-Tailed kite, Cooper’s Hawk, Red-Shouldered Hawk,
10 American Kestrel, Great Horned Owl, Song Sparrow, Black Phoebe, European
11 Starling, Western Bluebird, and Tree Swallow. The valley foothill riparian and
12 blue oak woodland vegetation also support Pacific Tree Frog, Red-legged Frog,
13 Sharp-Tailed Snake, California Alligator Lizard, Common Garter Snake, Mule
14 Deer, Raccoon, Coyote, Striped Skunk, Deer Mouse, Harvest Mouse, Dusky-
15 Footed Woodrat, and Gray Fox. Riverine and wetlands, and open water support
16 Brewer’s Blackbird, Red-Winged Blackbird, Brown-Headed Cowbird, Great Blue
17 Heron, Great Egret, ducks, American Coot, Common Merganser, Double-Crested
18 Cormorant, American Wigeon, Canada Goose, Western Grebe, and gull; Pacific
19 Tree Frog, Red-legged Frog, Bullfrog, California Tiger Salamander, Western
20 Pond Turtle, Western Toad, and Garter Snake; Deer Mouse, California Vole,
21 Long-Tailed Weasel, and other mammals that use the adjacent woodlands
22 and grasslands.

23 **10.3.4.1.2 San Justo Reservoir**

24 The San Justo Reservoir is a CVP facility in San Benito County that provides
25 offstream storage as part of the San Felipe Division, as described in Chapter 5,
26 Surface Water Resources and Water Supplies. The reservoir is surrounded by
27 steep hills with recreational facilities on the northeast side reservoir and
28 intermittent streams, wetlands, and open water downslope of the reservoir
29 (SBCWD 2012). Adjacent land uses are dominated by irrigated row crops,
30 orchards, and rangeland. Vegetation and wildlife resources of the reservoir area
31 are consistent with grasslands vegetation on uplands.

32 **10.3.4.2 State Water Project Reservoirs**

33 Bethany Reservoir, Patterson Reservoir, and Lake Del Valle are SWP facilities
34 associated with the South Bay Aqueduct in Alameda County, as described in
35 Chapter 5, Surface Water Resources and Water Supplies.

36 Vegetative communities around Bethany Reservoir are characterized by nonnative
37 grasses with several areas of woodland habitat (DWR 2014). The grassland
38 habitat includes slender oat, ripgut brome, soft chess, wild barley, Italian ryegrass,
39 black mustard, bull thistle, redstem filaree, dissected geranium, English plantain,
40 and tumble mustard; and forbs, including sweet fennel, Great Valley gumweed,
41 Mediterranean linseed, and Ithuriel’s spear. The woodland habitat includes white
42 ironbark, Casuarina, and Bishop pine. Coyote bush occurs along the water edge.
43 The grasslands provide habitat for Mourning Dove, Western Scrub-Jay, Finches,
44 Sparrows, Owls, Hawks, California Ground Squirrel, Black-Tailed Jackrabbit,

1 Audubon's Cottontail, Botta's Pocket Gopher, California vole, mice, frogs, toads,
 2 salamanders, snakes, lizards, and turtles. The woodlands support Red-Tailed
 3 Hawk, Osprey, Owls, Black Phoebe, Bullock's Oriole, Yellow Warbler,
 4 amphibians and reptiles, and coyote. Emergent vegetation does not occur along
 5 the shoreline at Bethany Reservoir (DWR 2005).

6 Patterson Reservoir is a small, 100-acre-foot, SWP reservoir located along the
 7 South Bay Aqueduct between Bethany Reservoir and Lake Del Valle. Vegetation
 8 around Patterson Reservoir is characterized by grasslands and upland habitat.
 9 Red-legged Frog has been observed in the vicinity of Patterson Reservoir (DWR
 10 2014).

11 Lake Del Valle is a 77,100 acre-foot SWP facility located along the South Bay
 12 Aqueduct (DWR 2001). Vegetation around Lake Del Valle includes grasslands,
 13 chaparral, shrub, oak woodland, and riparian and freshwater habitats (EBRPD
 14 1996, 2001, 2012, 2013). The grasslands include nonnative grasses and native
 15 perennial bunchgrass. The nonnative grasslands include grasses such as wild
 16 oats, bromes, ryegrass, wild barley, silver hairgrass, and dogtail grass; forbs,
 17 including filaree, clover, and plantain; and lupine, yarrow, and soap plant. Native
 18 grasses include annual and perennial fescues, needlegrass, wild ryes, junegrass,
 19 and California brome. The coastal scrub and chaparral vegetation includes
 20 coyote brush-scrub, California sagebrush, manzanita, black sage, cream bush,
 21 California coffeeberry, yerba santa, blackberry, bush monkeyflower, and poison
 22 oak. The oak woodlands and riparian woodlands include coast live oak, black
 23 oak, valley oak, scrub oak, California bay, and California buckeye. Mixed
 24 deciduous riparian woodlands occur along perennial streams, including white
 25 alder, big-leaf maple, western sycamore, willow, and Fremont cottonwood.
 26 Along springs and seeps, the vegetation includes rabbitsfoot grass, saltgrass,
 27 bentgrasses, rushes, tules, sedges, horsetails, and cattail, buttercup, brass-button,
 28 mint, duckweed, pondweed, and ferns.

29 **10.3.4.3 Contra Costa Water District Los Vaqueros Reservoir**

30 Los Vaqueros Reservoir is a Contra Costa Water District offstream storage
 31 facility in Contra Costa County, as described in Chapter 5, Surface Water
 32 Resources and Water Supplies. The area around the Los Vaqueros reservoir
 33 includes grasslands, upland scrub, valley and foothill woodlands, freshwater
 34 wetlands, and open water habitats (Reclamation et al. 2009). The grasslands
 35 include perennial and alkali habitats with wild oats, ripgut brome, yellow star
 36 thistle, fescue, filaree, mustard, fiddleneck, lupine, popcorn flower, and California
 37 poppy. The grasslands support Northern Harrier, Burrowing Owl, Western
 38 Meadowlark, California Horned Lark, Turkey Vulture, Red-Tailed Hawk,
 39 American Kestrel, White-Tailed Kite, Western Fence Lizard, Common Garter
 40 Snake, Western Rattlesnake, California Tiger Salamander, Western Harvest
 41 Mouse, California Ground Squirrel, Black-Tailed Jackrabbit, Black-Tailed Deer,
 42 and San Joaquin Kit Fox.

43 The upland scrub habitat is dominated by evergreen chaparral species and coastal
 44 scrub, including chamise, California sagebrush, black sage, poison oak, bush

1 monkeyflower, and California buckwheat underlain by annual grasses and purple
2 needlegrass (Reclamation et al. 2009). This habitat supports California Quail,
3 Western Scrub-Jay, Bushtit, California Thrasher, Spotted Towhee, Sage Sparrow,
4 Western Fence Lizard, Common Garter Snake, Common King Snake, Western
5 Rattlesnake, California Mouse, Deer Mouse, and feral pig.

6 The valley and foothill woodlands and riparian woodlands includes willow,
7 Fremont cottonwood, valley oak, sycamore, black walnut, California buckeye,
8 Mexican elderberry, and Himalayan blackberry which occur along much of
9 Kellogg Creek (Reclamation et al. 2009). This habitat supports many birds,
10 reptiles, amphibians, and mammals, including red-legged frog. The freshwater
11 emergent habitat includes meadows with wetland species and stream channels.
12 The vegetation includes tules, bulrushes, and cattail. Wildlife that occurs in this
13 area include Marsh Wren, Common Yellowthroat, Red-Winged Blackbird, Red-
14 legged Frog, and Western Pond Turtle. The open water habitat of the Los
15 Vaqueros Reservoir provides forage, winter, and brood habitat for Canada Goose;
16 American Wigeon; Wood., Gadwall, Mallard, Northern Shoveler, Northern
17 Pintail, Green-Winged Teal, Canvasback, Redhead, Ring-Necked, Greater Scaup,
18 Lesser Scaup, Bufflehead, Common Goldeneye, Hooded Merganser, Common
19 Merganser, and Ruddy ducks; and other habitat values for grebe, sandpiper,
20 pelican, cormorant, egret, heron, and gull.

21 **10.3.4.4 East Bay Municipal Utility District Reservoirs**

22 The East Bay Municipal Utility District reservoirs in Alameda and Contra Costa
23 County used to store water within and near the East Bay Municipal Utility District
24 service area include Briones Reservoir, San Pablo Reservoir, Lafayette Reservoir,
25 Upper San Leandro Reservoir, and Lake Chabot. Water stored in these reservoirs
26 includes water from local watersheds, the Mokelumne River watershed, and
27 CVP water supplies, as described in Chapter 5, Surface Water Resources and
28 Water Supplies.

29 The Briones Reservoir watershed is characterized by grasslands, chaparral,
30 coastal scrub, oak and bay woodlands, riparian, and freshwater wetlands
31 (EBMUD 1999; EBRPD 1996, 2001, 2013). The San Pablo Reservoir watershed
32 is characterized by grasslands, hardwood forest, coastal scrub, Monterey pine
33 planted along the reservoir shoreline, riparian woodland, and eucalyptus. The
34 Lafayette Reservoir watershed is characterized by grasslands, oak and bay
35 woodland, and coastal scrub. The Upper San Leandro Reservoir watershed
36 includes grasslands, chamise-black sage chaparral, coastal scrub, oak and bay
37 woodland, redwood forest, knobcone forest with a dense manzanita understory,
38 and an 18-acre freshwater marsh. The Lake Chabot watershed includes
39 grasslands, coastal scrub, oak and bay woodland, and riparian and freshwater
40 vegetation.

41 The grasslands vegetative communities generally include nonnative grasses and
42 native perennial bunchgrass (EBMUD 1999; EBRPD 1996, 2001). The nonnative
43 grasslands include grasses such as wild oat, bromegrass, ryegrass, wild barley,
44 bluegrass, silver hairgrass, and dogtail grass; forbs, including filaree, bur clover,

1 clovers, owls clover, cat's ear, and English plantain; and brodiaeas, lupine,
 2 mariposa lilies, mule's ear, yarrow, farewell to spring, and soap plant. Native
 3 grasses include annual and perennial fescues, needlegrass, wild rye, California
 4 oatgrass, junegrass, bluegrass, squirreltail, meadow barley, and California
 5 bromegrass. Grasslands are used by wildlife similar to those described for other
 6 San Francisco Bay Area reservoirs, including hawks, owls, shrikes, swallows,
 7 turkey vulture, reptiles, coyote, fox, bobcat, and mice.

8 The coastal scrub and chaparral vegetation includes coyote brush-scrub,
 9 California sagebrush, bitter cherry scrub, manzanita, chamise-black sage, cream
 10 bush, California coffeeberry, wild lilac, yerba santa, blackberry, bush
 11 monkeyflower, and poison oak (EBMUD 1999; EBRPD 1996, 2001). The
 12 woodlands include native and nonnative plants. The native redwood and
 13 knobcone pine forests are located at Upper San Leandro Reservoir and provide
 14 unique habitat. Nonnative eucalyptus and Monterey pine forests occur at San
 15 Pablo Reservoir and Lake Chabot. The eucalyptus trees provide specific habitat
 16 for hummingbird, Bald Eagle, Great Blue Heron, and Great Egret. The oak and
 17 bay woodlands and oak savannas include coast live oak, black oak, valley oak,
 18 blue oak, interior live oak, canyon live oak, California bay, California buckeye,
 19 and madrone.

20 Mixed deciduous riparian woodland occur along perennial streams, including
 21 white alder, big-leaf maple, western sycamore, Fremont cottonwood, and black
 22 cottonwood that supports frogs, newts, and other amphibians; coast live oak,
 23 California bay, and willow woodlands on steep slopes along intermittent streams;
 24 and willow riparian scrub along perennial and intermittent streams (EBMUD
 25 1999; EBRPD 1996, 2001). Along springs and seeps, the vegetation includes
 26 grasses, includes rabbitsfoot grass, saltgrass, bentgrasses, rushes, tules, sedges,
 27 horsetails, and cattail; and forbs includes buttercup, watercress, stinging nettle,
 28 brass-buttons, mints, duckweed, and pondweed.

29 **10.3.5 Central Coast Region**

30 The Central Coast Region includes portions of San Luis Obispo and Santa
 31 Barbara counties served by the SWP. The SWP water is provided to the Central
 32 Coast Region by the Central Coast Water Authority (CCWA 2013). The facilities
 33 divert water from the SWP California Aqueduct at Devil's Den and convey the
 34 water to a water treatment plant at Polonto Pass. The treated water is conveyed to
 35 municipal water users in San Luis Obispo and Santa Barbara counties to reduce
 36 groundwater overdraft in these areas. Water is delivered to southern Santa
 37 Barbara County communities through Cachuma Lake.

38 As described in subsection 10.3.2, Overview of Species with Special Status, A
 39 listing of wildlife and plant species with special status that occur or may occur in
 40 portions of the study area affected by the long-term coordinated operation of the
 41 CVP and SWP is provided in Appendix 10A.

1 **10.3.5.1 Cachuma Lake**

2 Cachuma Lake is a facility owned and operated by Reclamation in Santa Barbara
3 County, as described in Chapter 5, Surface Water Resources and Water Supplies.
4 The Cachuma Lake watershed is located in the Coast Range and extends into the
5 Los Padres National Forest. The primary habitats include hardwood woodland,
6 chaparral, coastal sage scrub, nonnative grassland, and riparian woodland and
7 scrub (Reclamation 2010c). The hardwood woodlands includes oak woodland,
8 oak savannah, and pine woodland with blue oak, coast live oak, gray pine, skunk
9 brush, and poison oak. The chaparral and coastal sage scrub includes mountain
10 mahogany, greenbark ceonothus, blue oak, interior live oak, scrub oak, holly leaf
11 redberry, buck brush, toyon, chaparral mallow, chamise, California sage brush,
12 purple sage, deer weed, and coyote brush-scrub with understory of grasses and
13 forbs. Birds that use the hardwood woodlands and savannah include Turkey
14 Vulture; raptors including Red-Tailed Hawk and Bald Eagle; woodpecker,
15 California Quail, Rufous-Crowned Sparrow, wren, California Thrasher, and
16 Spotted Towhee. Nonnative grasslands are dominated by rip-gut brome and dove
17 weed. Native grasses include purple needlegrass, blue-eyed grass, Johnny-jump-
18 up, Chinese houses, rusty popcorn flower, slender cottonseed, forget-me-not,
19 lupine, mountain dandelion, checkerbloom, narrow-leaved milkweed, fleabane,
20 vinegar weed, California milkweed, and verbena.

21 Riparian habitat along streams and stream terraces include arroyo willow, red
22 willow, yellow willow, black willow, sycamore, oak, cottonwood, Pacific
23 blackberry, California rose, poison oak, elderberry, mulefat, California goldenrod,
24 California brome, black mustard, mugwort, clover, stinging nettle, red brome, and
25 California buckwheat (Reclamation 2010c). Habitat near the shoreline of
26 Cachuma Lake includes willows, tamarisk, cattail, mulefat, and mugwort.
27 Disturbed lands around the lake are characterized by weedy species, including
28 yellow star thistle, Spanish broom, tamarisk, giant reed, pampas grass, scotch
29 broom, veldt grass, perennial pepperweed, red brome, fennel, and cheatgrass.
30 Marginal vegetation, reedy marshes, and riparian woodland support killdeer,
31 spotted Sandpiper, Red-Winged Blackbird, Common Yellowthroat, Song
32 Sparrow, Marsh Wren, Warbling Vireo, Yellow Warbler, Yellow-Breasted Chat,
33 and Brown-Headed Cowbird. The open water of Cachuma Lake supports diving
34 birds, including diving duck, American Coot, Pied-Billed Grebe, Western Grebe,
35 Clark's Grebe, Double-Crested Cormorant, Heron, Egret, pelican, Osprey, and
36 Bald Eagle. Amphibians and reptiles that occur near Cachuma Lake include
37 Monterey Salamander, California Slender Salamander, Western Spadefoot,
38 California Toad, Pacific Tree Frog, Bullfrog, Red-legged Frog, Yellow-Legged
39 Frog, Southwestern Pond Turtle, Western Skink, and Southern Alligator Lizard.
40 Mammals which depend upon habitat near Cachuma Lake include bat, hare,
41 rabbit, pika, bear, coyote, fox, weasel, raccoon, cats, chipmunk, squirrel, marmot,
42 shrew, mice, rat, mule deer, and feral pig.

43 **10.3.6 Southern California Region**

44 The Southern California Region includes portions of Ventura, Los Angeles,
45 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

1 The SWP water supplies generally are conveyed to Southern California
 2 municipal, industrial, and agricultural water users in canals and pipelines. There
 3 are six SWP reservoirs along the main canal, West Branch, and East Branch of the
 4 California Aqueduct and many other reservoirs owned and operated by regional
 5 and local agencies. The Metropolitan Water District of Southern California's
 6 Diamond Valley Lake and Lake Skinner primarily store water from the SWP.
 7 Other reservoirs store SWP water, including United Water Conservation District's
 8 Lake Piru; City of Escondido's Dixon Lake; City of San Diego's San Vicente
 9 Reservoir and Lower Otay Reservoir; Helix Water District's Lake Jennings; and
 10 Sweetwater Authority's Sweetwater Reservoir.

11 As described in subsection 10.3.2, Overview of Species with Special Status, A
 12 listing of wildlife and plant species with special status that occur or may occur in
 13 portions of the study area affected by the long-term coordinated operation of the
 14 CVP and SWP is provided in Appendix 10A.

15 The USFWS has approved several habitat conservation plans in the Southern
 16 California Region within areas served by CVP and SWP water, including the
 17 following plans (County of Orange 1996; Riverside County 2003; Riverside
 18 County Habitat Conservation Agency 2014; SDCWA and USFWS 2010;
 19 San Diego County 2014a, 2014b, 2015; SANDAG 2003; CVAG 2007).

- 20 • County of Orange Central and Coastal Subregion Natural Community
 21 Conservation Plan and Habitat Conservation Plan.
- 22 • Western Riverside County Multiple Species Conservation Plan.
- 23 • Habitat Conservation Plan for the Stephen's Kangaroo Rat in Western
 24 Riverside County which is administered by the Riverside County Habitat
 25 Conservation Agency for Riverside County and the cities of Corona, Hemet,
 26 Lake Elsinore, Menifee, Moreno Valley, Murrieta, Perris, Riverside,
 27 Temecula, and Vail Lake, and which includes areas around Diamond Valley
 28 Lake and Lake Skinner.
- 29 • San Diego County Water Authority Subregional Natural Community
 30 Conservation Plan/Habitat Conservation Plan (NCCP/HCP).
- 31 • San Diego County Multiple Species Conservation Plan including the initial
 32 area which includes the lands served by the City of San Diego Wastewater
 33 Sewer System; future North County Plan expansion (extends from the areas
 34 near the cities of Oceanside, Encinitas, San Marcos, Vista, and Escondido to
 35 the Cleveland National Forest and Riverside County boundary), and
 36 remaining land within the county (including lands from Alpine east to the
 37 Imperial and Riverside counties boundaries).
- 38 • Multiple Habitat Conservation Program for the cities of Carlsbad, Encinitas,
 39 Escondido, Oceanside, San Marcos, Solana Beach, and Vista.
- 40 • Coachella Valley Multiple Species Habitat Conservation Plan.

1 **10.3.6.1 State Water Project Reservoirs**

2 The SWP reservoirs include Quail Lake, Pyramid Lake, and Castaic Lake in Los
3 Angeles County; Silverwood Lake and Crafton Hills Reservoir in San Bernardino
4 County; and Lake Perris in Riverside County, as described in Chapter 5, Surface
5 Water Resources and Water Supplies.

6 Quail Lake was formed by seismic activity on the San Andres Fault and enlarged
7 by the Department of Water Resources (DWR) as part of the West Branch of the
8 SWP (DWR 1997). Quail Lake is bordered by the Tehachapi and Liebre
9 Mountains. The area is characterized by cottonwood and oak woodlands that
10 support Crested Sparrow, Red-Winged Blackbird, Golden Eagle, Red-Tailed
11 Hawk, fox, coyote, deer, squirrel, and Pronghorn Antelope. The open water
12 habitat support Canada Geese, egrets and Blue Herons

13 Pyramid Lake is located in the Angeles and Los Padres National Forests, as
14 described in Chapter 15, Recreation Resources. Upland areas around Pyramid
15 Lake are assumed to be similar to upland areas around Middle Piru Creek
16 downstream of Pyramid Dam (DWR 2004c). The vegetative communities
17 include coastal sage scrub and chaparral with oak woodlands and nonnative
18 grasslands. Water is released from Pyramid Lake to provide habitat flows in Piru
19 Creek, including flows to support habitat for the Arroyo Toad.

20 Terrestrial resources for Castaic Lake include coastal scrub, red shank-chamise
21 chaparral, and chaparral scrub (DWR 2007b). Castaic Lagoon is located
22 immediately downstream of Castaic Dam and is surrounded by coastal scrub.
23 Vegetation includes pines, eucalyptus, and nonnative and native grasses. The
24 habitat is used by Western Grebe, Canada Goose, Mallard Duck, gull, American
25 Coot, Bald Eagle, and Western Mastiff Bat.

26 Silverwood Lake is located in the San Bernardino National Forest and surrounded
27 by the Silverwood Lake State Recreation Area at the edge of the Mojave Desert
28 and at the base of the San Bernardino Mountains. The area contains a wide
29 variety of vegetative communities including live oak and scrub oak woodlands,
30 ponderosa pine and Douglas-fir forests, mixed scrub, chaparral, and riparian
31 hardwood (State Parks 2006, 2009). Chamise, interior live oak, manzanita,
32 mountain mahogany, and ceanothus are found along the shoreline and willow,
33 alders, and sycamores grow along area streams. The forest, chaparral, and
34 riparian woodland habitats support a wide variety of small mammals, reptiles, and
35 amphibians including rabbit, squirrel, woodrat, Western Fence Lizard,
36 Rattlesnake, Pacific Tree Frog, California Toad, coyote, Mule Deer, bobcat,
37 beaver, and skunk. The open water supports Great Blue Heron, Western Grebe,
38 Avocet, Egret, Canada Goose, and ducks. A number of raptors are found around
39 the lake including Bald Eagle, Osprey, owls, Cooper's Hawk, and Red-Tailed
40 hawk.

41 The Crafton Hills Reservoir area includes 4.5 acres of open water and 1.9 acres of
42 open space (DWR 2009b). The open space is characterized by chaparral scrub
43 and grass species, including chamise, golden yarrow, hoaryleaf ceanothus,
44 brittlebush, California sagebush, California buckwheat, deerweed, black sage,

1 purple needlegrass, heartleaf penstemon, ripgut grass, soft chess, foxtail chess,
 2 wild oat, Italian thistle, tocalote, short-pod mustard, and wild oat. The area is
 3 used by Mallard Duck, Killdeer, Red-Tailed Hawk, Cassin's Kingbird, and
 4 Wrentit; California Toad, Pacific Tree Frog, Western Fence Lizard, Common
 5 Side-Blotched Lizard, and California Kingsnake; and Desert Cottontail, Desert
 6 Woodrat, coyote, raccoon, and bobcat.

7 Lake Perris is located adjacent to the cities of Moreno Valley and Perris and the
 8 Perris Fairgrounds which includes a motor sports complex (DWR 2010a). Lake
 9 Perris is located within the Lake Perris State Recreation Area which provides
 10 extensive recreational opportunities, as described in Chapter 15, Recreation
 11 Resources. The open space areas are characterized by willow and sage scrub,
 12 willow and eucalyptus woodland, and nonnative grassland. The scrub areas
 13 include California sagebrush, lemonadeberry, sugarbush, yellow bush penstemon,
 14 coyote brush, Mexican elderberry, sweetbush, boxthorn, tall prickly-pear,
 15 California buckwheat, red brome, bur ragweed, California aster, ripgut brome,
 16 sticky monkeyflower, prickly sow thistle, and Russian thistle. The willow
 17 woodland includes Goodding's black willow, red willow, narrow leaved willow,
 18 Fremont's cottonwood, California sycamore, gooseberry, mulefat, tarragon,
 19 curley dock, ragweed, southwestern spinyrush, and bromes. Eucalyptus
 20 woodland includes eucalyptus underlain by nonnative grassland. Nonnative
 21 grasslands includes soft chess, wild oat, foxtail barley, mustard, sweet fennel,
 22 California sagebrush, and California buckwheat. Habitat has been restored within
 23 the grasslands to provide habitat for the Stephen's Kangaroo Rat. Mourning
 24 Dove, Anna's Hummingbird, raven, California Kingsnake, Raccoon, Black-Tailed
 25 Deer, Striped Skunk, coyote, and bobcat use the shoreline. The woodland is used
 26 by Ash-Throated Flycatcher, Western Kingbird, Least Bell's Vireo, House Wren,
 27 California Towhee, Spotted Towhee, Black-Headed Grosbeak, Blue Grosbeak,
 28 Song Sparrow, Bullock's Oriole, House Finch, Lesser Goldfinch, Nuttall's
 29 Woodpecker, Red-Tailed Hawk, Red-Shouldered Hawk, Cooper's Hawk,
 30 Cottontail Rabbit, Black-Tailed Jackrabbit, raccoon, and Long-Tailed Weasel.
 31 The scrub supports California Quail, Greater Roadrunner, White-Throated Swift,
 32 Rock Wren, California Towhee, Western Fence Lizard, Gopher Snake, Red
 33 Diamond Rattlesnake, Southern Pacific Rattlesnake, Side Blotched Lizard,
 34 Granite Spiny Lizard, Coastal Western Whiptail, Black-Tailed Jackrabbit, bobcat,
 35 coyote, and rodents.

36 **10.3.6.2 Non-SWP Reservoirs in Riverside County**

37 Non-SWP reservoirs in Riverside County that store SWP water include Diamond
 38 Valley Lake and Lake Skinner that are owned and operated by Metropolitan
 39 Water District of Southern California, and Vail Lake that is owned and operated
 40 by Rancho California Water District, as described in Chapter 5, Surface Water
 41 Resources and Water Supplies.

42 Diamond Valley Lake is located adjacent to the City of Hemet along the northern
 43 boundary, and adjacent to pasture and dairies along the eastern and western
 44 boundaries (City of Hemet 2012). Sage scrub and nonnative grasslands occur
 45 between the lake and the City of Hemet. Chaparral with sage scrub occur along

1 the southern boundary of the lake. Riversidean sage scrub includes California
2 sagebrush, flat top buckwheat, black sage, and California encelia. Wildlife
3 movement corridors occur around Diamond Valley Lake. Open space around
4 Lake Skinner is also characterized by grassland and sage scrub vegetation
5 (USFWS 2004).

6 Diamond Valley Lake and Lake Skinner are located within the Southwestern
7 Riverside County Multi-Species Reserve, an area of 11,000 acres surrounding and
8 connecting Diamond Valley Lake and Lake Skinner through the Dr. Roy Shipley
9 Reserve (MWD 2014). At least eight types of habitat are found in the reserve, but
10 coastal sage scrub, nonnative grassland, and chaparral are dominant. There are
11 smaller areas of coast live oak woodland, willow scrub with live oak, and
12 cottonwood-willow riparian forests. The reserve is home to the California
13 Gnatcatcher, Bell's Sage Sparrow, San Diego Horned Lizard, Payson's
14 Jewelflower, and Parry's Spineflower.

15 Areas around Vail Lake support habitat for Bald Eagle, Golden Eagle, and Great
16 Blue Heron (RCWD 2015).

17 **10.3.6.3 Non-SWP Reservoir in Ventura County**

18 Lake Piru, located in Ventura County, is used to store SWP water by United
19 Water Conservation District, as described in Chapter 5, Surface Water Resources
20 and Water Supplies (UWCD 1999, 2014). The area surrounding the lake is
21 characterized by chaparral on the hills and coast live oak woodlands along the
22 stream channels.

23 **10.3.6.4 Non-SWP Reservoirs in San Diego County**

24 Reservoirs in San Diego County that are used to store SWP water include the City
25 of Escondido Dixon Lake; City of San Diego San Vicente, El Capitan, Lower
26 Otay, and Lake Hodges reservoirs; Lake Jennings owned by Helix Water District;
27 and Sweetwater Reservoir owned by Sweetwater Authority.

28 Dixon Lake is located in the hills above the City of Escondido within the
29 Escondido Multiple Habitat Conservation Plan area (City of Escondido 2012).
30 Habitat around Lake Dixon is characterized by coastal sage scrub and chaparral.
31 The coastal sage scrub includes California sagebrush, flat-top buckwheat, white
32 sage, laurel sumac, black sage, California encelia, San Diego County viguiera,
33 goldenbush, coast prickly-pear, and lemonadeberry and sugarbush. Chaparral
34 includes chamise, scrub oak, toyon, thick-leaf ceanothus, black sage, wild
35 cucumber, morning glory, saw-toothed goldenbush, and nonnative grasses.

36 The San Vicente Reservoir is characterized by rocky or coarse sand, with
37 occasional willow trees and mulefat (SDCWA and USACE 2008). The
38 constantly fluctuating water levels make it difficult for wetland or riparian
39 vegetation to become established. Much of the shoreline around San Vicente
40 Reservoir, therefore, is a non-vegetated fringe. Outside of the fringe, the area
41 around the reservoir is primarily sage scrub with nonnative grassland and coast
42 live oak woodland. Along the stream channel, vegetation includes southern
43 willow scrub and live oak riparian forest with chaparral. Submerged aquatic

1 vegetation occurs in an intermittent band surrounding almost the entire reservoir.
 2 Freshwater marsh vegetation of cattail, bulrush, and sedges occurs between the
 3 open water and lakeshore fringe. Birds associated with the open water include
 4 grebe, cormorant, heron, egret, ducks and geese, coot, plover, sandpiper, gull, and
 5 tern. Other birds associated with open water and riparian habitats include the bald
 6 eagle, osprey, and kingfisher. The uplands support rabbit, snakes, lizards, ground
 7 squirrel, pocket gopher, raccoon, mule deer, bats, mice, fox, skunk, bobcat, and
 8 mountain lion.

9 El Capitan Reservoir is located within Diegan coastal sage scrub with areas of oak
 10 woodlands and chaparral (San Diego County 2011; SDRWWG 2005; SDRP
 11 2015). The Lower Otay Reservoir, Lake Hodges, and Lake Jennings are located
 12 within coastal sage scrub. Sweetwater Reservoir is surrounded by coastal sage
 13 scrub and chaparral with riparian forest along stream channels.

14 **10.3.6.5 Non-SWP Reservoir in San Bernardino County**

15 Lake Arrowhead, in San Bernardino County, is used to store SWP water by the
 16 Lake Arrowhead Community Services District (County of San Bernardino 2011;
 17 LACSD 2014a, 2014b). Lake Arrowhead is located within chaparral, sage scrub,
 18 oak woodlands, oak and sycamore woodlands, dogwood tree along the lake,
 19 cottonwood and willow forests along stream channels, Ponderosa pine forests, and
 20 wetlands. The habitat supports Stellar Jay, blue jay, quail, ducks, western
 21 Tanager, Northern Tanager, woodpecker, chickadee, Barn Owl, Bald Eagle,
 22 hawks, rattlesnake, coyote, bobcat, Black Bear, Gray Squirrel, Ground Squirrel,
 23 chipmunk, raccoon, mountain lion, skunk, and cougar.

24 **10.4 Impact Analysis**

25 This section describes the potential mechanisms and analytical methods for
 26 change in terrestrial resources; results of the impact analysis; potential mitigation
 27 measures; and cumulative effects.

28 **10.4.1 Potential Mechanisms for Change and Analytical Methods**

29 As described in Chapter 4, Approach to Environmental Analysis, the impact
 30 analysis considers changes in terrestrial resources conditions related to changes in
 31 CVP and SWP operations under the alternatives as compared to the No Action
 32 Alternative and Second Basis of Comparison.

33 Changes in CVP and SWP operations under the alternatives as compared to the
 34 No Action Alternative and Second Basis of Comparison could change surface
 35 water resources affected by CVP and SWP operations.

36 **10.4.1.1 Changes in CVP and SWP Reservoir Elevations**

37 Changes in surface water elevations at the CVP and SWP reservoirs would
 38 influence the extent of the drawdown zone (the area of shoreline between the full
 39 inundation elevation and the water level), which can influence the availability and
 40 quality of nesting habitat for some ground-nesting birds (e.g., waterfowl) and

1 possibly the prey base for nesting fish-eating raptors (e.g., Bald Eagle and
2 Osprey) in March through June. The creation of barren zones through reservoir
3 drawdown can also affect the ability of wildlife species to access water, which
4 could cause them to be more vulnerable to predation.

5 As described in Chapter 5, Surface Water Resources and Water Supplies, surface
6 water elevations would be similar in all months and all water year types at Trinity
7 Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir
8 under Alternatives 1 through 5 as compared to the No Action Alternative and the
9 Second Basis of Comparison. Surface water elevations would change at San Luis
10 Reservoir under Alternatives 1 through 5 as compared to the No Action
11 Alternative and the Second Basis of Comparison. However, it does not appear
12 that nesting fish-eating raptors or ground-nesting waterfowl use the San Luis
13 Reservoir shoreline during these nesting lifestages (Reclamation 2013).
14 Therefore, changes in CVP and SWP operations under the alternatives would
15 result in similar conditions (within 5 percent change) for terrestrial resources at
16 CVP and SWP reservoirs; and these factors are not analyzed in this EIS.

17 **10.4.1.2 Changes in Rivers Downstream of the CVP and SWP Reservoirs**

18 Operation of the CVP and SWP would influence flow regimes that renew and
19 support adjacent riparian and wetland plant and wildlife communities. For
20 example, certain riparian plants (e.g., willows) require a specific sequence and
21 timing of flow events to prepare the seedbed and to support germination and
22 seedling growth in March through May. Changes in flow that support or interfere
23 with these processes could influence riparian vegetation and its value as wildlife
24 habitat. The analysis is focused on Trinity, Sacramento, Feather, American, and
25 Stanislaus rivers because these rivers are used to convey water from the reservoirs
26 to CVP and SWP water users. Therefore, changes in CVP and SWP operations
27 could result in substantial changes in flow patterns in these rivers. At other
28 reservoirs that are used to store CVP and SWP water supplies (e.g., San Luis
29 Reservoir), the CVP and SWP water are conveyed from the reservoirs in canals or
30 pipelines. The reservoirs may be operated to provide minimum flows to support
31 habitat in streams adjacent to these reservoirs; however, changes in CVP and
32 SWP operations would not affect the minimum instream flow releases.
33 Therefore, changes in terrestrial resources in these streams is not analyzed in
34 this EIS.

35 Channel maintenance flows to improve adjacent floodplain habitat conditions
36 would occur along Clear Creek under the No Action Alternative and Alternatives
37 2 and 5, to the extent possible. The high-flow, short-duration pulse flows would
38 be released, if physically possible, from Whiskeytown Lake to mobilize
39 streambed material in Clear Creek in accordance with the 2009 NMFS Biological
40 Opinion (BO).

41 **10.4.1.3 Changes in Sacramento, American, and Stanislaus Rivers** 42 **Habitats due to Fish Passage at Dams**

43 Fish passage would be provided under the No Action Alternative and
44 Alternative 5 around Shasta, Folsom, and New Melones dams. Salmon runs play

1 an important role in the transfer of large quantities of marine-derived nutrients to
2 adjacent forest ecosystems with substantial effects on plant and wildlife
3 production. Spawning salmon contribute to the release of nutrients into streams
4 through normal metabolic processes, release of gametes during spawning, decay
5 of their carcasses following death, and through consumption of their flesh by
6 predators and scavengers (Merz and Moyle 2006). Returning fish to the upper
7 stream segments, fish passage could influence the forest ecosystem and associated
8 wildlife in the upper watersheds and result in less nutrients along the rivers
9 downstream of the dams. This analysis would assume that the objectives of the
10 2009 NMFS BO were achieved by 2030, including implementation of fish
11 passage at these CVP reservoirs. However, any changes in nutrients in the stream
12 corridors are expected to be minimal based on information in Merz and Moyle
13 (2006). Therefore, habitat conditions related to changes in nutrient loading
14 associated with fish passage actions would be the same under Alternatives 1
15 through 5 as under the No Action Alternative and the Second Basis of
16 Comparison. Therefore, this potential change is not analyzed in this EIS.

17 **10.4.1.4 Changes in River and Delta Floodplains**

18 Alternative 4 assumes additional institutional requirements for development
19 within the floodplain and floodways that would require compliance with
20 Endangered Species Act in defining floodplain map revisions, allow for
21 improvements in floodplain management criteria to support natural and beneficial
22 functions, and prohibit new development and substantial improvements to
23 existing development within any designated floodway or within 170 feet of the
24 ordinary high water line of any floodway. However, as described in Chapter 13,
25 Land Use, in 2030, development along major river corridors in the Central Valley
26 would continue to be limited by state regulations implemented by the Central
27 Valley Flood Protection Board and the USACE.

28 Within the Delta, the floodways are further regulated by the Delta Protection
29 Commission and Delta Stewardship Council to preserve and protect the natural
30 resources of the Delta; and prevent encroachment into Delta floodways. These
31 regulations, as implemented in all alternatives and the Second Basis of
32 Comparison, would prevent development within the Delta floodplains and
33 floodways and in the Sacramento, Feather, American, and San Joaquin rivers
34 corridors upstream of the Delta, as described in Chapter 13. Provisions in
35 Alternative 4 would require additional setbacks along the floodways as compared
36 to other alternatives and the Second Basis of Comparison. The qualitative
37 analysis considers the potential changes in habitat due to these changes in
38 floodplain and floodway development regulations.

39 Another potential change in Delta habitat would occur under Alternative 4,
40 additional vegetation would remain along the levees in the Delta as compared to
41 conditions under the other alternatives, the No Action Alternative, and the Second
42 Basis of Comparison, as described in Chapter 3, Description of Alternatives.
43 Under Alternatives 1, 2, 3, and 5; the No Action Alternative; and the Second
44 Basis of Comparison existing vegetation would remain along the Delta levees
45 until the levees are repaired. Following repairs, vegetation would be removed

1 along the riparian corridor to improve the structural reliability of the levees in
2 accordance with USACE requirements. It is assumed that by 2030, much of the
3 vegetation would be removed from the levees due to levee repairs.

4 **10.4.1.5 Changes in Flows over Fremont Weir into the Yolo Bypass**

5 All of the alternatives, including the No Action Alternative and the Second Basis
6 of Comparison, include operations of an operable gate at Fremont Weir, as
7 described in Chapter 3, Description of Alternatives. However, the flow patterns
8 into the Yolo Bypass would change based upon the magnitude of flows in the
9 Sacramento River at Fremont Weir.

10 **10.4.1.6 Changes in Wetlands Habitat**

11 The No Action Alternative, Alternatives 1 through 5, and Second Basis of
12 Comparison all include implementation of restoration of more than 10,000 acres
13 of intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;
14 17,000 to 20,000 acres of seasonal floodplain restoration in the Yolo Bypass; and
15 continued delivery of refuge water supplies under the Central Valley Project
16 Improvement Act. There would be no changes in wetlands habitat between
17 Alternatives 1 through 5 as compared to the No Action Alternative, and the
18 Second Basis of Comparison. Therefore, changes to wetland habitats are not
19 analyzed in this EIS.

20 **10.4.1.7 Changes in Delta Habitat**

21 Changes in CVP and SWP operations under the alternatives as compared to the
22 No Action Alternative and Second Basis of Comparison would change the Delta
23 salinity which could affect survival of riparian vegetation. The analysis evaluates
24 changes in salinity by comparing the end of month X2 position.

25 Another potential change in Delta habitat would occur under Alternative 4, due to
26 additional vegetation along the levees in the Delta as compared to conditions
27 under the other alternatives, the No Action Alternative, and the Second Basis of
28 Comparison, as described in Chapter 3, Description of Alternatives.

29 **10.4.1.8 Changes in Irrigated Agricultural Acreage Habitats in Areas that
30 use CVP and SWP Water**

31 As described in Section 10.3, Affected Environment, agricultural lands provide
32 considerable value to terrestrial wildlife, which varies with crop type and wildlife
33 species. Generally, rice production provides high habitat value for some species
34 because it supports many of the attributes of wetlands. Most notably, flooded rice
35 fields during the growing season provide foraging and nesting habitat for
36 waterfowl and shorebirds, as well as habitat for the federally listed Giant Garter
37 Snake. In the fall and early winter, flooding for rice straw decomposition plays an
38 important role in providing habitat for migrating waterbirds. Other crops, such as
39 alfalfa and irrigated pasture, also provide habitat value, primarily because of their
40 perennial nature and the application of flood irrigation. These crops provide
41 valuable foraging habitat for species such as the state-listed Swainson's Hawk.
42 Grain crops provide seasonal value to species such as Greater Sandhill Crane and

1 others, but orchards, vineyards, vegetable, and truck crops generally provide
2 relatively low habitat value for terrestrial species.

3 Changes in CVP and SWP operations under the alternatives could change the
4 extent of irrigated acreage and associated habitats over the long-term average
5 condition and in dry and critical dry years as compared to the No Action
6 Alternative and Second Basis of Comparison, as described in Chapter 12,
7 Agricultural Resources. However, irrigated acreage under Alternatives 1
8 through 5 would be similar (within 5 percent change) to irrigated acreage under
9 the No Action Alternative and the Second Basis of Comparison. Therefore, there
10 would be no change in terrestrial habitat at the irrigated acreage; and this factor is
11 not analyzed in this EIS.

12 **10.4.1.9 Effects due to Cross Delta Water Transfers**

13 Historically water transfer programs have been developed on an annual basis.
14 The demand for water transfers is dependent upon the availability of water
15 supplies to meet water demands. Water transfer transactions have increased over
16 time as CVP and SWP water supply availability has decreased, especially during
17 drier water years.

18 Parties seeking water transfers generally acquire water from sellers who have
19 available surface water and who can make the water available through releasing
20 previously stored water, pumping groundwater instead of using surface water
21 (groundwater substitution); idling crops; or substituting crops that uses less water
22 in order to reduce normal consumptive use of surface water.

23 Water transfers using CVP and SWP Delta pumping plants and south of Delta
24 canals generally occur when there is unused capacity in these facilities. These
25 conditions generally occur during drier water year types when the flows from
26 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento
27 Valley water demands and the CVP and SWP export allocations. In non-wet
28 years, the CVP and SWP water allocations would be less than full contract
29 amounts; therefore, capacity may be available in the CVP and SWP conveyance
30 facilities to move water from other sources.

31 Projecting future terrestrial resources conditions related to water transfer activities
32 is difficult because specific water transfer actions required to make the water
33 available, convey the water, and/or use the water would change each year due to
34 changing hydrological conditions, CVP and SWP water availability, specific local
35 agency operations, and local cropping patterns. Reclamation recently prepared a
36 long-term regional water transfer environmental document which evaluated
37 potential changes in conditions related to water transfer actions (Reclamation
38 2014d). Results from this analysis were used to inform the impact assessment of
39 potential effects of water transfers under the alternatives as compared to the No
40 Action Alternative and the Second Basis of Comparison.

1 **10.4.2 Conditions in Year 2030 without Implementation of**
2 **Alternatives 1 through 5**

3 This EIS includes two bases of comparison, as described in Chapter 3,
4 Description of Alternatives: the No Action Alternative and the Second Basis of
5 Comparison. Both of these bases are evaluated at 2030 conditions.

6 Changes that would occur over the next 15 years without implementation of the
7 alternatives are not analyzed in this EIS. However, the changes to terrestrial
8 resources that are assumed to occur by 2030 under the No Action Alternative and
9 the Second Basis of Comparison are summarized in this section. Many of the
10 changed conditions would occur in the same manner under both the No Action
11 Alternative and the Second Basis of Comparison.

12 **10.4.2.1 Common Changes in Conditions under the No Action**
13 **Alternative and Second Basis of Comparison**

14 Conditions in 2030 would be different than existing conditions due to:

- 15 • Climate change and sea level rise
- 16 • General plan development throughout California, including increased water
17 demands in portions of Sacramento Valley.
- 18 • Implementation of reasonable and foreseeable water resources management
19 projects to provide water supplies, including general plan development, future
20 water management and supply projects, and river and Delta floodplain
21 development.

22 **10.4.2.1.1 Climate Change and Sea Level Rise**

23 It is anticipated that climate change would result in more short-duration high-
24 rainfall events and less snowpack in the winter and early spring months. The
25 reservoirs would be full more frequently by the end of April or May by 2030 than
26 in recent historical conditions. However, as the water is released in the spring,
27 there would be less snowpack to refill the reservoirs. This condition would
28 reduce reservoir storage and available water supplies to downstream uses in the
29 summer. The reduced end of September storage also would reduce the ability to
30 release stored water to downstream regional reservoirs. These conditions would
31 occur for all reservoirs in the California foothills and mountains, including non-
32 CVP and SWP reservoirs.

33 These changes would result in a decline of the long-term average CVP and SWP
34 water supply deliveries by 2030 as compared to recent historical long-term
35 average deliveries under the No Action Alternative and the Second Basis of
36 Comparison. However, the CVP and SWP water deliveries would be less under
37 the No Action Alternative as compared to the Second Basis of Comparison, as
38 described in Chapter 5, Surface Water Resources and Water Supplies, which
39 could result in more crop idling.

40 The Delta estuarine habitat is complex due to the freshwater-saltwater interface
41 that supports numerous terrestrial species that require freshwater conditions
42 primarily in the winter and spring and may withstand periods of higher salinity in

1 the late summer and fall months. Climate change and sea level rise and CVP and
 2 SWP operations would change the location of the freshwater-saltwater interface in
 3 the Delta which would affect the survivability of vegetation within that area,
 4 especially in the western Delta and Suisun Marsh. Operations of the CVP and
 5 SWP would continue to maintain freshwater conditions in the spring in
 6 accordance with the State Water Resources Control Board Decision 1641.
 7 However, higher salinity conditions would occur in the summer months and in the
 8 fall of drier years which would affect the types of riparian vegetation in the
 9 western Delta and in Suisun Marsh under the No Action Alternative and Second
 10 Basis of Comparison in 2030 as compared to recent historical conditions.

11 **10.4.2.1.2 Reasonable and Foreseeable Projects and Programs**

12 Under the No Action Alternative and the Second Basis of Comparison, land uses
 13 in 2030 would occur in accordance with adopted general plans. Development
 14 under the general plans would change terrestrial resources, especially near
 15 municipal areas.

16 The No Action Alternative and the Second Basis of Comparison assumes
 17 completion of water resources management and environmental restoration
 18 projects that would have occurred without implementation of Alternatives 1
 19 through 5, including regional and local recycling projects, surface water and
 20 groundwater storage projects, conveyance improvement projects, and desalination
 21 projects, as described in Chapter 3, Description of Alternatives. The No Action
 22 Alternative and the Second Basis of Comparison also assumes implementation of
 23 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological
 24 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that
 25 would have been implemented without the BOs by 2030, as described in
 26 Chapter 3, Description of Alternatives. These projects would include several
 27 projects that would affect terrestrial resources, including:

- 28 • Habitat Restoration includes restoration of more than 10,000 acres of
 29 intertidal and associated subtidal wetlands in Suisun Marsh and Cache Slough;
 30 and at least 17,000 to 20,000 acres of seasonal floodplain restoration in Yolo
 31 Bypass.
- 32 • Sacramento River, American River, and Clear Creek Spawning Gravel
 33 Augmentation.
- 34 • Battle Creek Restoration.
- 35 • Lower American River Flow Management Standard.

36 **10.4.2.1.3 Changes in River and Delta Floodplains**

37 It is assumed that under the No Action Alternative and the Second Basis of
 38 Comparison, the State of California would continue to implement flood
 39 management projects to reduce flood risks along the Sacramento and San Joaquin
 40 rivers and in the Delta (DWR 2013b). These programs would be implemented in
 41 a manner that would be coordinated with opportunities to restore or maintain the
 42 function of natural systems with consideration of future conditions with climate

1 change and sea level rise. However, terrestrial resources would be changed by
2 2030 as compared to recent historical conditions.

3 Terrestrial resources along Delta levees also would be affected through
4 implementation of USACE policies for vegetation on levees. Historically, the
5 USACE has allowed brush and small trees to be located on the waterside of
6 federal flood management project levees if the vegetation would preserve, protect,
7 and/or enhance natural resources, and/or protect rights of Native Americans,
8 while maintaining the safety, structural integrity, and functionality of the levee
9 (DWR 2011). After Hurricane Katrina in 2005, the USACE issued a policy and
10 draft policy guidance to remove substantial vegetation from these levees
11 throughout the nation (USACE 2009). This policy requires federally authorized
12 levee systems that have maintenance agreements with the USACE (including
13 Delta levees along the Sacramento and San Joaquin rivers) and other levees that
14 are eligible for the federal Rehabilitation and Inspection Program (Public
15 Law 84-99) to remove vegetation in the following manner.

- 16 • Removal of all vegetation from the upper third of the waterside slope of the
17 levee, the top of the levee, landside slope of the levee, or within 15 feet of the
18 toe of the levee on the landside (“toe” is where the levee slope meets the
19 ground surfaces).
- 20 • Removal of all vegetation over 2 inches in diameter on the lower two-thirds of
21 the waterside slope of the levee and within 15 feet of the toe of the levee on
22 the waterside along benches above the water surface.

23 In 2010, the USACE issued a draft policy guidance letter, *Draft Process for*
24 *Requesting a Variance from Vegetation Standards for Levees and Floodwalls—*
25 *75 Federal Register 6364-68* (USACE 2010) that included procedures for State
26 and local agencies to request variances on a site-specific basis. DWR has been in
27 negotiations with USACE to remove vegetation on the upper third of the
28 waterside slope, top, and landside of the levees, and continue to allow vegetation
29 on the lower two-thirds of the waterside slope of the levee and along benches
30 above the water surface (DSC 2011). By 2030, it is anticipated that much of the
31 existing vegetation on the upper third of the waterside slopes, tops, landside
32 slopes, and within 15 feet of the landside toe of the levees would be removed.

33 By 2030 under the No Action Alternative and the Second Basis of Comparison,
34 development along major river corridors in the Central Valley would continue to
35 be limited by state regulations implemented by the Central Valley Flood
36 Protection Board and the USACE. Within the Delta, the floodways would
37 continue to be regulated by the Delta Protection Commission and Delta
38 Stewardship Council to preserve and protect the natural resources of the Delta;
39 and prevent encroachment into Delta floodways. These requirements would
40 prevent development within the Delta floodplains and floodways and in the
41 Sacramento, Feather, American, and San Joaquin rivers corridors upstream of
42 the Delta.

1 **10.4.3 Evaluation of Alternatives**

2 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1
3 through 5 have been compared to the No Action Alternative; and the No Action
4 Alternative and Alternatives 1 through 5 have been compared to the Second Basis
5 of Comparison.

6 **10.4.3.1 No Action Alternative**

7 As described in Chapter 4, Approach to Environmental Analysis, the No Action
8 Alternative is compared to the Second Basis of Comparison.

9 **10.4.3.1.1 Trinity River Region**

10 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

11 River flows in Trinity River downstream of Lewiston Dam in the critical period
12 for terrestrial resources of March through May would be similar under the No
13 Action Alternative and the Second Basis of Comparison, as described in
14 Chapter 5, Surface Water Resources and Water Supplies. Therefore, terrestrial
15 resources habitat conditions along the Trinity River and lower Klamath River
16 riparian corridors would be similar under the No Action Alternative and Second
17 Basis of Comparison.

18 **10.4.3.1.2 Central Valley Region**

19 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

20 Flows in the spring months would be similar in the Sacramento River at Keswick
21 and Freeport and American River downstream of Nimbus Dam; increased flows
22 in the Stanislaus River downstream of Goodwin Dam (over 100 percent); and
23 reduced in the Feather River downstream of Thermalito Complex (25 to
24 30 percent) under the No Action Alternative as compared to the Second Basis of
25 Comparison. This analysis does not include site specific evaluation of all
26 terrestrial resources along these riparian corridors. However, the changes in flows
27 are indicative of the potential for change in the terrestrial resources. Therefore,
28 under the No Action Alternative as compared to the Second Basis of Comparison,
29 the potential for similar or improved terrestrial resources would occur along the
30 Sacramento, American, and Stanislaus rivers; and the potential for reduced
31 terrestrial resources would occur along the Feather River.

32 Monthly Clear Creek flows under the No Action Alternative as compared to the
33 Second Basis of Comparison are identical except in May. In May, under the No
34 Action Alternative, flows are up to 40.7 percent higher than under the Second
35 Basis of Comparison in accordance with the 2009 NMFS BO. Terrestrial
36 resources habitat in the floodplains of lower Clear Creek would be slightly
37 improved under the No Action Alternative as compared to the Second Basis of
38 Comparison.

39 *Potential Effects on Special Status Species*

40 Habitat changes along the riparian corridors related to changes in spring flows
41 that support riparian vegetation recruitment would affect numerous bird species
42 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least

1 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,
2 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
3 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
4 could occur to these species due to reduced flows in the spring months on the
5 Feather River.

6 *Changes in River and Delta Floodplains*

7 It is assumed that under the No Action Alternative and the Second Basis of
8 Comparison, the State of California would continue to implement flood
9 management projects to reduce flood risks along the Sacramento and San Joaquin
10 rivers and in the Delta with consideration for opportunities to restore or maintain
11 the function of natural ecosystems. The related terrestrial habitat conditions
12 would be similar under the No Action Alternative and the Second Basis of
13 Comparison.

14 *Changes in Flows over Fremont Weir into the Yolo Bypass*

15 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir are
16 similar under the No Action Alternative and the Second Basis of Comparison;
17 therefore, terrestrial habitat could be similar.

18 *Changes in Delta Habitat due to Changes in Water Quality*

19 Under the No Action Alternative, the freshwater interface would be similar to
20 conditions under the Second Basis of Comparison in all months in below normal,
21 dry, and critical dry years; and from January through August in wet and above
22 normal years. In the fall months in wet years, the X2 location would be 9 to
23 14 kilometers towards the west in September through December under the No
24 Action Alternative as compared to the Second Basis of Comparison.

25 *Potential Effects on Special Status Species*

26 Lower Delta salinity under the No Action Alternative as compared to the Second
27 Basis of Comparison would improve habitat for Bolander's Water Hemlock,
28 Delta Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun
29 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

30 *Effects Related to Cross Delta Water Transfers*

31 Potential effects to terrestrial resources could be similar to those identified in a
32 recent environmental analysis conducted by Reclamation for long-term water
33 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
34 Potential effects to terrestrial resources were identified as changes in stream flows
35 due declining groundwater levels along streams due to the use of groundwater
36 substitution to provide transfer water. The analysis indicated that these potential
37 impacts would not be substantial due to the inclusion of a monitoring and
38 mitigation program.

39 Under the No Action Alternative, the timing of cross Delta water transfers would
40 be limited to July through September and include annual volumetric limits, in
41 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second
42 Basis of Comparison, water could be transferred throughout the year without an
43 annual volumetric limit. Overall, the potential for cross Delta water transfers

1 would be less under the No Action Alternative than under the Second Basis of
2 Comparison.

3 **10.4.3.2 Alternative 1**

4 Alternative 1 is identical to the Second Basis of Comparison. As described in
5 Chapter 4, Approach to Environmental Analysis, Alternative 1 is compared to the
6 No Action Alternative and the Second Basis of Comparison. However, because
7 water resource conditions under Alternative 1 are identical to water resource
8 conditions under the Second Basis of Comparison; Alternative 1 is only compared
9 to the No Action Alternative.

10 **10.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

11 *Trinity River Region*

12 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

13 River flows in Trinity River downstream of Lewiston Dam in the critical period
14 for terrestrial resources of March through May would be similar under
15 Alternative 1 and the No Action Alternative. Therefore, terrestrial resources
16 habitat conditions along the Trinity River and lower Klamath River riparian
17 corridors would be similar under Alternative 1 as compared to the No Action
18 Alternative.

19 *Central Valley Region*

20 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

21 Flows in the spring months would be similar in the Sacramento River at Keswick
22 and Freeport and American River downstream of Nimbus Dam; increased in the
23 Feather River downstream of Thermalito Complex (35 percent); and reduced
24 flows in the Stanislaus River downstream of Goodwin Dam (60 percent) under
25 Alternative 1 as compared to the No Action Alternative. This analysis does not
26 include site specific evaluation of all terrestrial resources along these riparian
27 corridors. However, the changes in flows are indicative of the potential for
28 change in the terrestrial resources. Therefore, under Alternative 1 as compared to
29 the No Action Alternative, the potential for similar or improved terrestrial
30 resources would occur along the Sacramento, American, and Feather rivers; and
31 the potential for reduced terrestrial resources would occur along the
32 Stanislaus River.

33 Monthly Clear Creek flows under Alternative 1 as compared to the No Action
34 Alternative are identical except in May. In May, under Alternative 1, flows are
35 up to 29 percent lower as compared to the No Action Alternative. Terrestrial
36 resources habitat in the floodplains of lower Clear Creek could be decreased
37 under Alternative 1 as compared to the No Action Alternative.

38 *Potential Effects on Special Status Species*

39 Habitat changes along the riparian corridors related to changes in spring flows
40 that support riparian vegetation recruitment would affect numerous bird species
41 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least
42 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,

1 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
2 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
3 could occur to these species due to reduced flows in the spring months on the
4 Stanislaus River.

5 *Changes in River and Delta Floodplains*

6 It is assumed that under Alternative 1 and the No Action Alternative, the State of
7 California would continue to implement flood management projects to reduce
8 flood risks along the Sacramento and San Joaquin rivers and in the Delta with
9 consideration for opportunities to restore or maintain the function of natural
10 ecosystems. The related terrestrial habitat conditions that would occur due to
11 implementation of the flood management projects would be the same under
12 Alternative 1 and the No Action Alternative.

13 *Changes in Flows over Fremont Weir into the Yolo Bypass*

14 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would
15 be similar or higher under Alternative 1 as compared to the No Action
16 Alternative; therefore, terrestrial habitat could be similar or increased depending
17 upon the flow pattern.

18 *Changes in Delta Habitat due to Changes in Water Quality*

19 Under Alternative 1, the freshwater interface would be similar to conditions under
20 the No Action Alternative in all months in below normal, dry, and critical dry
21 years; and from January through August in wet and above normal years. In the
22 fall months in wet years, the X2 location would be 9 to 14 kilometers towards the
23 east in September through December under Alternative 1 as compared to the No
24 Action Alternative. This could adversely affect terrestrial species that have
25 acclimated to freshwater conditions.

26 *Potential Effects on Special Status Species*

27 Higher Delta salinity under Alternative 1 as compared to the No Action
28 Alternative would reduce habitat conditions for Bolander's Water Hemlock, Delta
29 Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun
30 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

31 *Effects Related to Cross Delta Water Transfers*

32 Potential effects to terrestrial resources could be similar to those identified in a
33 recent environmental analysis conducted by Reclamation for long-term water
34 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
35 Potential effects to terrestrial resources were identified as changes in stream flows
36 due declining groundwater levels along streams due to the use of groundwater
37 substitution to provide transfer water. The analysis indicated that these potential
38 impacts would not be substantial due to the inclusion of a monitoring and
39 mitigation program.

40 Under Alternative 1, water could be transferred throughout the year without an
41 annual volumetric limit. Under the No Action Alternative, the timing of cross
42 Delta water transfers would be limited to July through September and include
43 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009

1 NMFS BO. Overall, the potential for cross Delta water transfers would be greater
2 under Alternative 1 as compared to the No Action Alternative.

3 **10.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

4 Alternative 1 is identical to the Second Basis of Comparison.

5 **10.4.3.3 Alternative 2**

6 The CVP and SWP operations under Alternative 2 are identical to the CVP and
7 SWP operations under the No Action Alternative; therefore, Alternative 2 is only
8 compared to the Second Basis of Comparison.

9 **10.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

10 The CVP and SWP operations under Alternative 2 are identical to the CVP and
11 SWP operations under the No Action Alternative. Therefore, changes in
12 terrestrial resources under Alternative 2 as compared to the Second Basis of
13 Comparison would be the same as the impacts described in Section 10.4.3.1, No
14 Action Alternative.

15 **10.4.3.4 Alternative 3**

16 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
17 under Alternative 3 are similar to the Second Basis of Comparison with modified
18 Old and Middle River flow criteria and New Melones Reservoir operations. As
19 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is
20 compared to the No Action Alternative and the Second Basis of Comparison.

21 **10.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

22 *Trinity River Region*

23 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

24 River flows in Trinity River downstream of Lewiston Dam in the critical period
25 for terrestrial resources of March through May would be similar under
26 Alternative conditions along the Trinity River and lower Klamath River
27 riparian corridors would be similar under Alternative 3 as compared to the
28 No Action Alternative.

29 *Central Valley Region*

30 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

31 Flows in the spring months would be similar in the Sacramento River at Keswick
32 and Freeport and American River downstream of Nimbus Dam; increased in the
33 Feather River downstream of Thermalito Complex (25 to 35 percent); and
34 reduced flows in the Stanislaus River downstream of Goodwin Dam (60 percent)
35 under Alternative 3 as compared to the No Action Alternative. This analysis does
36 not include site specific evaluation of all terrestrial resources along these riparian
37 corridors. However, the changes in flows are indicative of the potential for
38 change in the terrestrial resources. Therefore, under Alternative 3 as compared to
39 the No Action Alternative, the potential for similar or improved terrestrial
40 resources would occur along the Sacramento, American, and Feather rivers; and

1 the potential for reduced terrestrial resources would occur along the
2 Stanislaus River.

3 Monthly Clear Creek flows under Alternative 3 as compared to the No Action
4 Alternative are identical except in May. In May, under Alternative 3, flows are
5 up to 29 percent lower as compared to the No Action Alternative. Terrestrial
6 resources habitat in the floodplains of lower Clear Creek would be decreased
7 under Alternative 3 as compared to the No Action Alternative.

8 *Potential Effects on Special Status Species*

9 Habitat changes along the riparian corridors related to changes in spring flows
10 that support riparian vegetation recruitment would affect numerous bird species
11 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least
12 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,
13 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
14 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
15 could occur to these species due to reduced flows in the spring months on the
16 Stanislaus River.

17 *Changes in River and Delta Floodplains*

18 It is assumed that under Alternative 3 and the No Action Alternative, the State of
19 California would continue to implement flood management projects to reduce
20 flood risks along the Sacramento and San Joaquin rivers and in the Delta with
21 consideration for opportunities to restore or maintain the function of natural
22 ecosystems. The related terrestrial habitat that would occur due to
23 implementation of the flood management projects would be the same under
24 Alternative 3 and the No Action Alternative.

25 *Changes in Flows over Fremont Weir into the Yolo Bypass*

26 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would
27 be similar or higher (10 to 30 percent) under Alternative 3 as compared to the No
28 Action Alternative. Terrestrial habitat could be similar or increased due to the
29 flow patterns.

30 *Changes in Delta Habitat due to Changes in Water Quality*

31 Under Alternative 3, the freshwater interface would be similar to conditions under
32 the No Action Alternative in all months in below normal, dry, and critical dry
33 years; and from January through August in wet and above normal years. In the
34 fall months in wet years, the X2 location would be 9 to 14 kilometers towards the
35 east in September through December under Alternative 3 as compared to the No
36 Action Alternative.

37 *Potential Effects on Special Status Species*

38 Higher Delta salinity under Alternative 3 as compared to the No Action
39 Alternative would reduce habitat conditions for Bolander's Water Hemlock, Delta
40 Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun
41 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

1 *Effects Related to Cross Delta Water Transfers*

2 Potential effects to terrestrial resources could be similar to those identified in a
 3 recent environmental analysis conducted by Reclamation for long-term water
 4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
 5 Potential effects to terrestrial resources were identified as changes in stream flows
 6 due declining groundwater levels along streams due to the use of groundwater
 7 substitution to provide transfer water. The analysis indicated that these potential
 8 impacts would not be substantial due to the inclusion of a monitoring and
 9 mitigation program.

10 Under Alternative 3, water could be transferred throughout the year without an
 11 annual volumetric limit. Under the No Action Alternative, the timing of cross
 12 Delta water transfers would be limited to July through September and include
 13 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
 14 NMFS BO. Overall, the potential for cross Delta water transfers would be greater
 15 under Alternative 3 as compared to the No Action Alternative.

16 **10.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

17 *Trinity River Region*

18 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

19 River flows in Trinity River downstream of Lewiston Dam in the critical period
 20 for terrestrial resources of March through May would be similar under
 21 Alternative 3 and the Second Basis of Comparison. Therefore, terrestrial
 22 resources habitat conditions along the Trinity River and lower Klamath River
 23 riparian corridors would be similar under Alternative 3 as compared to the Second
 24 Basis of Comparison.

25 *Central Valley Region*

26 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

27 Flows in the spring months would be similar in the Sacramento River at Keswick
 28 and Freeport, Feather River downstream of Thermalito Complex, and American
 29 River downstream of Nimbus Dam; and reduced flows in the Stanislaus River
 30 downstream of Goodwin Dam (6 to 52 percent, depending upon water year type)
 31 under Alternative 3 as compared to the Second Basis of Comparison. This
 32 analysis does not include site specific evaluation of all terrestrial resources along
 33 these riparian corridors. However, the changes in flows are indicative of the
 34 potential for change in the terrestrial resources. Therefore, under Alternative 3 as
 35 compared to the Second Basis of Comparison, the potential for similar terrestrial
 36 resources habitat would occur along the Sacramento, American, and Feather
 37 rivers; and the potential for reduced terrestrial resources would occur along the
 38 Stanislaus River.

39 Monthly Clear Creek flows under Alternative 3 as compared to the Second Basis
 40 of Comparison are identical under Alternative 3; therefore, terrestrial resources
 41 habitat in the floodplains of lower Clear Creek would be similar under
 42 Alternative 3 as compared to the Second Basis of Comparison.

1 *Potential Effects on Special Status Species*

2 Habitat changes along the riparian corridors related to changes in spring flows
3 that support riparian vegetation recruitment would affect numerous bird species
4 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least
5 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,
6 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
7 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
8 could occur to these species due to reduced flows in the spring months on the
9 Stanislaus River.

10 *Changes in River and Delta Floodplains*

11 It is assumed that under Alternative 3 and the Second Basis of Comparison, the
12 State of California would continue to implement flood management projects to
13 reduce flood risks along the Sacramento and San Joaquin rivers and in the Delta
14 with consideration for opportunities to restore or maintain the function of natural
15 ecosystems. The related terrestrial habitat conditions that would occur due to
16 implementation of the flood management projects would be the same under
17 Alternative 3 and the Second Basis of Comparison.

18 *Changes in Flows over Fremont Weir into the Yolo Bypass*

19 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir and
20 associated terrestrial habitat would be similar under Alternative 3 as compared to
21 the Second Basis of Comparison.

22 *Changes in Delta Habitat due to Changes in Water Quality*

23 Under Alternative 3, the freshwater-saltwater interface would be similar to
24 conditions under the Second Basis of Comparison in all months and in all water
25 year types.

26 *Potential Effects on Special Status Species*

27 Delta salinity under Alternative 3 as compared to the Second Basis of Comparison
28 would result in similar habitat conditions for Bolander's Water Hemlock, Delta
29 Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-beak, Suisun
30 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

31 *Effects Related to Cross Delta Water Transfers*

32 Potential effects to terrestrial resources could be similar to those identified in a
33 recent environmental analysis conducted by Reclamation for long-term water
34 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
35 Potential effects to terrestrial resources were identified as changes in stream flows
36 due declining groundwater levels along streams due to the use of groundwater
37 substitution to provide transfer water. The analysis indicated that these potential
38 impacts would not be substantial due to the inclusion of a monitoring and
39 mitigation program.

40 Under Alternative 3 and the Second Basis of Comparison, water could be
41 transferred throughout the year without an annual volumetric limit. Overall, the
42 potential for cross Delta water transfers would be similar under Alternative 3 as
43 compared to the Second Basis of Comparison.

1 **10.4.3.5 Alternative 4**

2 The CVP and SWP operations under Alternative 4 are identical to the CVP and
3 SWP operations under the Second Basis of Comparison and Alternative 1.
4 Alternative 4 also includes additional institutional requirements for development
5 within the floodplain and floodways, including the following items.

- 6 • Compliance with Endangered Species Act in defining floodplain map
7 revisions.
- 8 • Improvements in floodplain management criteria to support natural and
9 beneficial functions.
- 10 • Prohibition of new development and substantial improvements to existing
11 development within any designated floodway or within 170 feet of the
12 ordinary high water line of any floodway.
- 13 • Modification of USACE requirements to remove vegetation along portions of
14 the waterside of levees, as described in Section 10.4.3.1, No Action
15 Alternative.

16 Alternative 4 is compared to the No Action Alternative and the Second Basis of
17 Comparison.

18 **10.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

19 These actions would not change CVP and SWP operations; and would only affect
20 the Changes in River and Delta Floodplains. Therefore, changes in terrestrial
21 resources due to changes in CVP and SWP under Alternative 4 as compared to the
22 No Action Alternative would be the same as the impacts described in
23 Section 10.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

24 *Changes in River and Delta Floodplains*

25 It is assumed that under the No Action Alternative, the State of California would
26 continue to implement flood management projects to reduce flood risks along the
27 Sacramento and San Joaquin rivers and in the Delta with consideration for
28 opportunities to restore or maintain the function of natural ecosystems. The
29 USACE policies for vegetation on levees would be implemented; and by 2030,
30 much of the vegetation along Delta channels would have been removed.

31 Under Alternative 4, implementation of institutional provisions would result in
32 development of the floodplains and floodways, especially in the Delta, that would
33 be similar to development under the No Action Alternative. Under the No Action
34 Alternative, as described in Chapter 13, Land Use, development along major river
35 corridors in the Central Valley would be limited by state regulations implemented
36 by the Central Valley Flood Protection Board and the USACE. Within the Delta,
37 the floodways are further regulated by the Delta Protection Commission and Delta
38 Stewardship Council to preserve and protect the natural resources of the Delta;
39 and prevent encroachment into Delta floodways. These regulations would
40 prevent development within the Delta floodplains and floodways and in the
41 Sacramento, Feather, American, and San Joaquin rivers corridors upstream of the
42 Delta. Under Alternative 4, development would be prevented within 170 feet

1 from the ordinary high water line of any floodway. This setback area could
2 provide opportunities to establish vegetative corridors.

3 Under Alternative 4 and the No Action Alternative, vegetation management along
4 the Delta levees would include removal of all vegetation from the upper third of
5 the waterside slope of the levee, the top of the levee, landside slope of the levee,
6 and within 15 feet on the landside of the toe of the levee (“toe” is where the levee
7 slope meets the ground surfaces). Under Alternative 4, vegetation could be
8 maintained on the lower two-thirds of the waterside slope of the levee and within
9 15 feet of the toe of the levee on the waterside along benches above the water
10 surface. This would provide shaded riverine aquatic habitat and riparian
11 vegetation along many of the Delta channels as compared to the No Action
12 Alternative.

13 Overall, Alternative 4 would result in increased vegetation along the riparian
14 corridors related to recruitment of riparian vegetation in the Delta watershed as
15 compared to the No Action Alternative.

16 **10.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

17 The changes in river and Delta floodplain actions would not change CVP and
18 SWP operations which would be identical under Alternative 4 and under the
19 Second Basis of Comparison.

20 *Changes in River and Delta Floodplains*

21 It is assumed that under the Second Basis of Comparison, the State of California
22 would continue to implement flood management projects to reduce flood risks
23 along the Sacramento and San Joaquin rivers and in the Delta with consideration
24 for opportunities to restore or maintain the function of natural ecosystems. The
25 USACE policies for vegetation on levees would be implemented; and by 2030,
26 much of the vegetation along Delta channels would have been removed.

27 Under Alternative 4, implementation of institutional provisions would result in
28 development of the floodplains and floodways, especially in the Delta, that would
29 be similar to development under the Second Basis of Comparison. Under the
30 Second Basis of Comparison, as described in Chapter 13, Land Use, development
31 along major river corridors in the Central Valley would be limited by state
32 regulations implemented by the Central Valley Flood Protection Board and the
33 USACE. Within the Delta, the floodways are further regulated by the Delta
34 Protection Commission and Delta Stewardship Council to preserve and protect the
35 natural resources of the Delta; and prevent encroachment into Delta floodways.
36 These regulations would prevent development within the Delta floodplains and
37 floodways and in the Sacramento, Feather, American, and San Joaquin rivers
38 corridors upstream of the Delta. Under Alternative 4, development would be
39 prevented within 170 feet from the ordinary high water line of any floodway.
40 This setback area could provide opportunities to establish vegetative corridors.

41 Under Alternative 4 and the Second Basis of Comparison, vegetation
42 management along the Delta levees would include removal of all vegetation from
43 the upper third of the waterside slope of the levee, the top of the levee, landside

1 slope of the levee, and within 15 feet on the landside of the toe of the levee (“toe”
 2 is where the levee slope meets the ground surfaces). Under Alternative 4,
 3 vegetation could be maintained on the lower two-thirds of the waterside slope of
 4 the levee and within 15 feet of the toe of the levee on the waterside along benches
 5 above the water surface. This would provide shaded riverine aquatic habitat and
 6 riparian vegetation along many of the Delta channels as compared to the Second
 7 Basis of Comparison.

8 Overall, Alternative 4 would result in increased terrestrial resources along the
 9 riparian corridors related to recruitment of riparian vegetation in the Delta
 10 watershed as compared to the Second Basis of Comparison.

11 **10.4.3.6 Alternative 5**

12 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
 13 under Alternative 5 are similar to the No Action Alternative with modified Old
 14 and Middle River flow criteria and New Melones Reservoir operations. As
 15 described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is
 16 compared to the No Action Alternative and the Second Basis of Comparison.

17 **10.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

18 *Trinity River Region*

19 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

20 River flows in Trinity River downstream of Lewiston Dam in the critical period
 21 for terrestrial resources of March through May would be similar under
 22 Alternative 5 and the No Action Alternative. Therefore, terrestrial resources
 23 habitat conditions along the Trinity River and lower Klamath River riparian
 24 corridors would be similar under Alternative 5 as compared to the No
 25 Action Alternative.

26 *Central Valley Region*

27 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

28 Flows in the spring months would be similar in the Sacramento River at Keswick
 29 and Freeport, Feather River downstream of Thermalito Complex, American River
 30 downstream of Nimbus Dam; and flows in the Stanislaus River downstream of
 31 Goodwin Dam would increase 22 to 40 percent in some spring months and 8 to
 32 18 percent in other spring months, depending upon water year type under
 33 Alternative 5 as compared to the No Action Alternative. This analysis does not
 34 include site specific evaluation of all terrestrial resources along these riparian
 35 corridors. However, the changes in flows are indicative of the potential for
 36 change in the terrestrial resources. Therefore, under Alternative 5 as compared to
 37 the No Action Alternative, the potential for similar or improved terrestrial
 38 resources habitat would occur along the Sacramento, Feather, and American
 39 rivers; and the potential for both increased and reduced terrestrial resources
 40 habitat would occur along the Stanislaus River.

41 Monthly Clear Creek flows would be identical under Alternative 5 as compared to
 42 the No Action Alternative; therefore, terrestrial resources habitat in the

1 floodplains of lower Clear Creek would be similar under Alternative 5 as
2 compared to the Second Basis of Comparison.

3 *Potential Effects on Special Status Species*

4 Habitat changes along the riparian corridors related to changes in spring flows
5 that support riparian vegetation recruitment would affect numerous bird species
6 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least
7 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,
8 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
9 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
10 could occur to these species due to reduced flows in the spring months on the
11 Stanislaus River.

12 *Changes in River and Delta Floodplains*

13 It is assumed that under Alternative 5 and the No Action Alternative, the State of
14 California would continue to implement flood management projects to reduce
15 flood risks along the Sacramento and San Joaquin rivers and in the Delta with
16 consideration for opportunities to restore or maintain the function of natural
17 ecosystems. The related terrestrial habitat conditions that would occur due to
18 implementation of the flood management projects would be the same under
19 Alternative 5 and the No Action Alternative.

20 *Changes in Flows over Fremont Weir into the Yolo Bypass*

21 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir and
22 associated terrestrial habitat would be similar under Alternative 5 as compared to
23 the No Action Alternative.

24 *Changes in Delta Habitat due to Changes in Water Quality*

25 Under Alternative 5, the freshwater interface would be similar to conditions under
26 the No Action Alternative in all months and in all water year types.

27 *Potential Effects on Special Status Species*

28 Similar Delta salinity under Alternative 5 as compared to the No Action
29 Alternative would result in similar habitat conditions for Bolander's Water
30 Hemlock, Delta Button-celery, Delta Tule Pea, Mason's Lilaeopsis, Soft Birds-
31 beak, Suisun Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

32 *Effects Related to Cross Delta Water Transfers*

33 Potential effects to terrestrial resources could be similar to those identified in a
34 recent environmental analysis conducted by Reclamation for long-term water
35 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
36 Potential effects to terrestrial resources were identified as changes in stream flows
37 due declining groundwater levels along streams due to the use of groundwater
38 substitution to provide transfer water. The analysis indicated that these potential
39 impacts would not be substantial due to the inclusion of a monitoring and
40 mitigation program.

41 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
42 water transfers would be limited to July through September and include annual

1 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
 2 Overall, the potential for cross Delta water transfers would be similar under
 3 Alternative 5 as compared to the No Action Alternative.

4 **10.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

5 *Trinity River Region*

6 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

7 River flows in Trinity River downstream of Lewiston Dam in the critical period
 8 for terrestrial resources of March through May would be similar under
 9 Alternative 5 and the Second Basis of Comparison. Therefore, terrestrial
 10 resources habitat conditions along the Trinity River and lower Klamath River
 11 riparian corridors would be similar under Alternative 5 as compared to the Second
 12 Basis of Comparison.

13 *Central Valley Region*

14 *Changes in Rivers Downstream of CVP and SWP Reservoirs*

15 Flows in the spring months would be similar in the American River downstream
 16 of Nimbus Dam; increased flows in the Stanislaus River downstream of Goodwin
 17 Dam (over 100 percent); and reduced in the Sacramento River at Keswick and
 18 Freeport and Feather River downstream of Thermalito Complex (8 to 13 percent
 19 and 25 to 45 percent, respectively) under Alternative 5 as compared to the Second
 20 Basis of Comparison. This analysis does not include site specific evaluation of all
 21 terrestrial resources along these riparian corridors. However, the changes in flows
 22 are indicative of the potential for change in the terrestrial resources. Therefore,
 23 under Alternative 5 as compared to the Second Basis of Comparison, the potential
 24 for similar or improved terrestrial resources habitat would occur along the
 25 American and Stanislaus rivers; and the potential for reduced terrestrial resources
 26 habitat would occur along the Sacramento and Feather rivers.

27 Monthly Clear Creek flows under Alternative 5 as compared to the Second Basis
 28 of Comparison are identical except in May. In May, under Alternative 5, flows
 29 are up to 40.7 percent higher than under the Second Basis of Comparison in
 30 accordance with the 2009 NMFS BO. Terrestrial resources habitat in the
 31 floodplains of lower Clear Creek would be improved under Alternative 5 as
 32 compared to the Second Basis of Comparison.

33 *Potential Effects on Special Status Species*

34 Habitat changes along the riparian corridors related to changes in spring flows
 35 that support riparian vegetation recruitment would affect numerous bird species
 36 that use the riparian corridor, including Black Tern, Least Bell's Vireo, Least
 37 Bittern, Swainson's Hawk, Tricolored Blackbird, Western Yellow-billed Cuckoo,
 38 White-tailed Kite, Yellow Warbler, Ringtail, Western Pond Turtle, Valley
 39 Elderberry Longhorn Beetle, and Delta Button-celery. Potential adverse effects
 40 could occur to these species due to reduced flows in the spring months on the
 41 Sacramento and Feather rivers.

1 *Changes in River and Delta Floodplains*

2 It is assumed that under Alternative 5 and the Second Basis of Comparison, the
3 State of California would continue to implement flood management projects to
4 reduce flood risks along the Sacramento and San Joaquin rivers and in the Delta
5 with consideration for opportunities to restore or maintain the function of natural
6 ecosystems. The related terrestrial habitat conditions that would occur due to
7 implementation of the flood management projects would be the same under
8 Alternative 5 and the Second Basis of Comparison.

9 *Changes in Flows over Fremont Weir into the Yolo Bypass*

10 Flows from the Sacramento River into the Yolo Bypass at Fremont Weir would
11 similar or lower (24 percent) under Alternative 5 as compared to the Second Basis
12 of Comparison. The decrease in the extent of flow inundation in the Yolo Bypass
13 could cause degradation of terrestrial habitat as compared to the Second Basis of
14 Comparison.

15 *Changes in Delta Habitat due to Changes in Water Quality*

16 Under Alternative 5, the freshwater interface would be similar to conditions under
17 the Second Basis of Comparison in all months in below normal, dry, and critical
18 dry years; and from January through August in wet and above normal years. In
19 the fall months in wet years, the X2 location would be 9 to 14 kilometers towards
20 the west in September through December under Alternative 5 as compared to the
21 Second Basis of Comparison.

22 *Potential Effects on Special Status Species*

23 Lower Delta salinity under Alternative 5 as compared to the Second Basis of
24 Comparison would improve habitat conditions for Bolander's Water Hemlock,
25 Delta Button-celery, Delta Tule Pea, Mason's Lilaepsis, Soft Birds-beak, Suisun
26 Marsh Aster, Salt Marsh Harvest Mouse, and Suisun Shrew.

27 *Effects Related to Cross Delta Water Transfers*

28 Potential effects to terrestrial resources could be similar to those identified in a
29 recent environmental analysis conducted by Reclamation for long-term water
30 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014d).
31 Potential effects to terrestrial resources were identified as changes in stream flows
32 due declining groundwater levels along streams due to the use of groundwater
33 substitution to provide transfer water. The analysis indicated that these potential
34 impacts would not be substantial due to the inclusion of a monitoring and
35 mitigation program.

36 Under Alternative 5, the timing of cross Delta water transfers would be limited to
37 July through September and include annual volumetric limits, in accordance with
38 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,
39 water could be transferred throughout the year without an annual volumetric limit.
40 Overall, the potential for cross Delta water transfers would be less under
41 Alternative 5 as compared to the Second Basis of Comparison.

1 **10.4.3.7 Summary of Environmental Consequences**

2 The results of the environmental consequences of implementation of
 3 Alternatives 1 through 5 as compared to the No Action Alternative and the
 4 Second Basis of Comparison are presented in Tables 10.2 and 10.3.

5 **Table 10.2 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased salt water habitat in the western Delta in the fall months of wet and above normal water years could adversely affect species that have acclimated to freshwater conditions.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>
Alternative 2	No effects on terrestrial resources.	None needed
Alternative 3	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar or improved terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased salt water habitat in the western Delta in the fall months of wet and above normal water years could adversely affect species that have acclimated to freshwater conditions.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>
Alternative 4	<p>Same effects as described for Alternative 1 compared to the No Action Alternative; except for increased terrestrial vegetation along the riparian corridors related to recruitment of riparian vegetation.</p>	<p>No mitigation measures identified at this time to reduce flow reduction impacts on the Stanislaus River, and adverse impacts due to increased salinity in the western Delta in the fall months of wet and above normal water year types.</p>

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Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p>Similar flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Increased flows along the Stanislaus River in the spring; therefore, could be improved terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Similar freshwater and salt water habitats.</p>	None needed.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **Table 10.3 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	<p>Similar or increased flows along Trinity, Sacramento, American, and Stanislaus rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Feather River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased freshwater habitat in the western Delta.</p>	Not considered for this comparison.
Alternative 1	No effects on terrestrial resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	<p>Similar or increased flows along Trinity, Sacramento, American, and Feather rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Stanislaus River in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar terrestrial conditions in Yolo Bypass related to water that flows from the Sacramento River at the Fremont Weir.</p> <p>Similar freshwater and salt water habitats.</p>	Not considered for this comparison.
Alternative 4	Similar effects except for increased terrestrial vegetation along the riparian corridors related to recruitment of riparian vegetation.	Not considered for this comparison.

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 5	<p>Similar or increased flows along Trinity, American, and Stanislaus rivers in the spring to support riparian terrestrial habitat. Reduced flows along the Sacramento and Feather rivers in the spring; therefore, could be reduced terrestrial habitat conditions.</p> <p>Similar or decreased terrestrial conditions in Yolo Bypass related to similar or lower water that flows from the Sacramento River at the Fremont Weir.</p> <p>Increased freshwater habitat in the western Delta.</p>	Not considered for this comparison.

Note: Due to the limitations and uncertainty in the CalSim II monthly model and other analytical tools, incremental differences of 5 percent or less between alternatives and the No Action Alternative are considered to be “similar.”

1 **10.4.3.8 Potential Mitigation Measures**

2 Mitigation measures are included in EISs to avoid, minimize, rectify, reduce,
3 eliminate, or compensate for adverse environmental effects of alternatives as
4 compared to the No Action Alternative. Mitigation measures are not included in
5 this EIS to address adverse impacts under the alternatives as compared to the
6 Second Basis of Comparison because this analysis was included in this EIS for
7 information purposes only.

8 Changes in CVP and SWP operations under Alternatives 1, 3, and 4 as compared
9 to the No Action Alternative would result in adverse changes in terrestrial
10 resources along Stanislaus River when spring flows are less than under the No
11 Action Alternative; and when the salinity increases in the western Delta.

12 However, mitigation measures have not been identified at this time to reduce the
13 adverse effects of flow reductions in the spring on the Stanislaus River and of
14 increased salinity in the western Delta in the fall months of wet and above normal
15 water year types under Alternatives 1, 3, and 4.

16 **10.4.3.9 Cumulative Effects Analysis**

17 As described in Chapter 3, the cumulative effects analysis considers projects,
18 programs, and policies that are not speculative; and are based upon known or
19 reasonably foreseeable long-range plans, regulations, operating agreements, or
20 other information that establishes them as reasonably foreseeable.

21 The cumulative effects analysis Alternatives 1 through 5 for Terrestrial Resources
22 are summarized in Table 10.4.

1
2

Table 10.4 Summary of Cumulative Effects on Terrestrial Resources of Alternatives 1 through 5 as Compared to the No Action Alternative

Scenarios	Actions	Cumulative Effects of Actions
<p>Past & Present, and Future Actions Included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Consistent with Affected Environment conditions plus:</p> <p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - San Joaquin River Restoration Program - Contra Loma Recreation Resource Management Plan - San Luis Reservoir State Recreation Area Resource Management Plan/General Plan 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Climate change and sea level rise and development under the general plans are anticipated to reduce carryover storage in reservoirs and changes in stream flow patterns in a manner that would change shoreline, riparian, and floodplain habitat.</p> <p>Other actions, including restoration projects, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to improve shoreline, riparian, and floodplain habitat.</p>
<p>Future Actions Considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Some of the future reasonably foreseeable actions to improve water quality and FERC Relicensing projects would improve shoreline, riparian, and floodplain habitat.</p> <p>Other future reasonably foreseeable actions, such as expanded or new reservoirs, would reduce some types of terrestrial habitat and increase other types of terrestrial habitat within the reservoir area.</p>

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of No Action Alternative with future reasonably foreseeable actions would result in changes in stream flows and levee vegetation policies that would result in changes to related terrestrial resources as compared to conditions prior to the BOs.</p> <p>Reduced riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to recent conditions.</p>
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 1 with future reasonably foreseeable actions would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Similar riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 2 with future reasonably foreseeable actions for terrestrial resources would be the same as for the No Action Alternative with the added actions.</p>

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Scenarios	Actions	Cumulative Effects of Actions
<p>Alternative 3 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 3 with future reasonably foreseeable action would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Similar riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
<p>Alternative 4 with Associated Cumulative Effects Actions in Year 2030</p>	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>No implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 4 with future reasonably foreseeable actions would result in changes in stream flows along the Stanislaus River in all water year types, and in salinity in the western Delta fall months of wet and above normal water year types that could result in adverse terrestrial conditions as compared to the No Action Alternative with the added actions.</p> <p>Implementation of Alternative 4 also would result in increased riparian habitat along effected levees</p> <p>Increased riparian habitat along levees within the federally authorized levee systems that have maintenance agreements with the USACE as compared to the No Action Alternative with the added actions.</p>
<p>Alternative 5 with Associated Cumulative Effects Actions in Year 20530</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p> <p>Full implementation of the USACE vegetation standards for levees</p>	<p>Implementation of Alternative 5 with future reasonably foreseeable actions for terrestrial resources would be similar as under the No Action Alternative with the added actions.</p>

1 10.5 References

- 2 BLM (Bureau of Land Management). 2006. *Welcome to the Sacramento River*
3 *Rail Trail*.
- 4 BLM and NPS (Bureau of Land Management and National Park Service). 2008.
5 *Environmental Assessment for the Lower Clear Creek Anadromous Fish*
6 *Restoration & Management Project*. BLM EA RE-2008-16. April.
- 7 CALFED (CALFED Bay-Delta Program). 2000. *Final Programmatic*
8 *Environmental Impact Statement/Environmental Impact Report*. July.
- 9 CALFED et al. (CALFED Bay-Delta Program, Yolo Bypass Working Group, and
10 Yolo Basin Foundation). 2001. *A Framework for the Future: Yolo*
11 *Bypass Management Strategy*. August.
- 12 Cal-IPC (California Invasive Plant Council). 2006. *California Invasive Plant*
13 *Inventory*. Cal-IPC Publication 2006-02. February.
- 14 CalTrans and DFG (California Department of Transportation and California
15 Department of Fish and Game [now known as Department of Fish and
16 Wildlife]). 2010. *California Essential Habitat Connectivity Project: A*
17 *Strategy for Conserving a Connected California*. February.
- 18 CBDA (California Bay-Delta Authority). 2004. *Environmental Water Program*
19 *Pilot Flow Augmentation Project: Concept Proposal for Flow Acquisition*
20 *on Lower Clear Creek*. August.
- 21 CCWA (Central Coastal Water Authority). 2013. *Central Coast Water Authority*
22 *fiscal year 2013/14 Budget*. April 25.
- 23 CDFW (California Department of Fish and Wildlife). 2014a. *Los Banos Wildlife*
24 *Area – Merced County*. Site accessed July 28, 2014.
25 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Los-Banos-WA>.
- 26 CDFW (California Department of Fish and Wildlife). 2014b. *Volta Wildlife Area*
27 *– Merced County*. Site accessed July 28, 2014.
28 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Volta-WA>.
- 29 CDFW (California Department of Fish and Wildlife). 2014c. *North Grasslands*
30 *Wildlife Area – Merced & Stanislaus County*. Site accessed July 28, 2014.
31 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/North-Grasslands-WA>.
- 32 CDFW (California Department of Fish and Wildlife). 2014d. *Miner Slough*
33 *Wildlife Area – Solano County*. Site accessed August 15, 2014.
34 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Miner-Slough-WA>.
- 35 CDFW (California Department of Fish and Wildlife). 2014e. *Rhode Island*
36 *Wildlife Area – Contra Costa County*. Site accessed August 15, 2014.
37 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Rhode-Island-WA>.
- 38 CDFW (California Department of Fish and Wildlife). 2014f. *White Slough*
39 *Wildlife Area – San Joaquin County*. Site accessed August 15, 2014.
40 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/White-Slough-WA>.

- 1 CDFW (California Department of Fish and Wildlife). 2014g. *Hill Slough*
2 *Wildlife Area – Solano County*. Site accessed August 15, 2014.
3 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Hill-Slough-WA>.
- 4 CDFW (California Department of Fish and Wildlife). 2014h. *Grizzly Island*
5 *Wildlife Area – General Information*. Site accessed August 15, 2014.
6 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Grizzly-Island-WA>.
- 7 CDFW (California Department of Fish and Wildlife). 2014i. *What's Going on at*
8 *Grizzly Island Wildlife Area During the Year*. Site accessed August 15,
9 2014. [https://www.wildlife.ca.gov/Lands/Places-to-Visit/Grizzly-Island-](https://www.wildlife.ca.gov/Lands/Places-to-Visit/Grizzly-Island-WA)
10 [WA](https://www.wildlife.ca.gov/Lands/Places-to-Visit/Grizzly-Island-WA).
- 11 CDFW (California Department of Fish and Wildlife). 2014j. *Point Edith Wildlife*
12 *Area – Contra Costa County*. Site accessed August 15, 2014.
13 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Point-Edith-WA>.
- 14 CDFW (California Department of Fish and Wildlife). 2014k. *Fremont Weir*
15 *Wildlife Area – Sutter and Yolo Counties*. Site accessed October 7, 2014.
16 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Fremont-Weir-WA>.
- 17 CDFW (California Department of Fish and Wildlife). 2014l. *Sacramento Bypass*
18 *Wildlife Area – Yolo County*. Site accessed October 7, 2014.
19 [https://www.wildlife.ca.gov/Lands/Places-to-Visit/Sacramento-Bypass-](https://www.wildlife.ca.gov/Lands/Places-to-Visit/Sacramento-Bypass-WA)
20 [WA](https://www.wildlife.ca.gov/Lands/Places-to-Visit/Sacramento-Bypass-WA).
- 21 CDFW (California Department of Fish and Wildlife). 2014m. *Calhoun Cut*
22 *Ecological Reserve – Solano County*. Site accessed October 7, 2014.
23 <https://www.wildlife.ca.gov/Lands/Places-to-Visit/Calhoun-Cut-ER>.
- 24 City of Escondido. 2012. *Escondido General Plan Update, Downtown Specific*
25 *Plan Update, and Climate Action Plan, Environmental Impact Report*.
26 April 23.
- 27 City of Hemet. 2012. *City of Hemet General Plan 2030, Environmental Impact*
28 *Report, Final*. January 12.
- 29 County of Orange. 1996. *Final (Administrative Record Copy) Natural*
30 *Community Conservation Plan & Habitat Conservation Plan*. July 17.
- 31 County of San Bernardino. 2011. *County of San Bernardino General Plan*
32 *Amendment and Greenhouse Gas Reduction Plan, Draft Supplemental*
33 *Program Environmental Impact Report*. March.
- 34 County of Sacramento. 2008. *American River Parkway Plan 2008*.
- 35 CVAG (Coachella Valley Association of Governments). 2007. *Final*
36 *Recirculated Coachella Valley Multiple Species Habitat Conservation*
37 *Plan and Natural Community Conservation Plan*. September.
- 38 DFG (California Department of Fish and Game [now known as Department of
39 Fish and Wildlife]). 1988. *California Wildlife Habitat Relationships*
40 *System, Fresh Emergent Wetland* by Gary Kramer. Site accessed October
41 6, 2014. https://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp.

- 1 DFG (California Department of Fish and Game [now known as Department of
2 Fish and Wildlife]). 1995. *Stanislaus River Basin and Calaveras River*
3 *Water Use Program Threatened and Endangered Species Report*. March.
4 Site accessed September 30, 2014.
5 <http://www.dfg.ca.gov/delta/reports/stanriver/> with 56 attachments from
6 this website.
- 7 DFG (California Department of Fish and Game [now known as Department of
8 Fish and Wildlife]). 1999a. *California Wildlife Habitat Relationships*
9 *System, Deciduous Orchard* by Robert F. Schultze. Site accessed October
10 6, 2014. https://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp.
- 11 DFG (California Department of Fish and Game [now known as Department of
12 Fish and Wildlife]). 1999b. *California Wildlife Habitat Relationships*
13 *System, Evergreen Orchard* by Robert F. Schultze. Site accessed October
14 6, 2014. https://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp.
- 15 DFG (California Department of Fish and Game [now known as Department of
16 Fish and Wildlife]). 1999c. *California Wildlife Habitat Relationships*
17 *System, Vineyard* by Robert F. Schultze. Site accessed October 6, 2014.
18 https://www.dfg.ca.gov/biogeodata/cwhr/wildlife_habitats.asp.
- 19 DFG (California Department of Fish and Game [now known as Department of
20 Fish and Wildlife]). 2007. *Lower Sherman Island Wildlife Area Land*
21 *Management Plan, Final*. April.
- 22 DFG (California Department of Fish and Game [now known as Department of
23 Fish and Wildlife]). 2008. *California Aquatic Invasive Species*
24 *Management Plan*. January.
- 25 DFG (California Department of Fish and Game [now known as Department of
26 Fish and Wildlife]). 2011a. *Gray Lodge Wildlife Area Water*
27 *Management Plan*. July 11.
- 28 DFG (California Department of Fish and Game [now known as Department of
29 Fish and Wildlife]). 2011b. *North Grasslands Wildlife Area, China*
30 *Island Unit, Water Management Plan*. June 23.
- 31 DFG (California Department of Fish and Game [now known as Department of
32 Fish and Wildlife]). 2011c. *North Grasslands Wildlife Area, Salt Slough*
33 *Unit, Water Management Plan*. February 16.
- 34 DFG (California Department of Fish and Game [now known as Department of
35 Fish and Wildlife]). 2012. California Natural Diversity Database
- 36 DFG and Yolo Basin Foundation (California Department of Fish and Game [now
37 known as Department of Fish and Wildlife] and Yolo Basin Foundation).
38 2008. *Yolo Bypass Wildlife Area Land Management Plan*. June.
- 39 DOI and DFG (Department of the Interior and California Department of Fish and
40 Game [now known as Department of Fish and Wildlife]). 2012. *Klamath*
41 *Facilities Removal Final Environmental Impact Statement/Environmental*
42 *Impact Report*. December.

- 1 DSC (Delta Stewardship Council). 2011. *Draft Delta Plan Program*
2 *Environmental Impact Report*. November.
- 3 DWR (California Department of Water Resources). 1997. *Quail Lake*. July.
- 4 DWR (California Department of Water Resources). 2001. *South Bay Aqueduct*
5 *(Bethany Reservoir and Lake Del Valle)*. April.
- 6 DWR (California Department of Water Resources). 2003. *Initial Study/Mitigated*
7 *Negative Declaration, Public Review Draft, Decker Island Phase II*
8 *Habitat Development and Levee Rehabilitation Project*. July.
- 9 DWR (California Department of Water Resources). 2004a. *Draft Final Report*
10 *SP-T1: Effects of Project Operations and Features on Wildlife and*
11 *Wildlife Habitat, Oroville Facilities Relicensing FERC Project No. 2100*.
12 April.
- 13 DWR (California Department of Water Resources). 2004b. *SP-T3/5 Project*
14 *Effects on Riparian Resources, Wetlands, and Associated Floodplains,*
15 *Draft Final Report, Oroville Facilities Relicensing FERC Project No.*
16 *2100*. July.
- 17 DWR (California Department of Water Resources). 2004c. *Draft Environmental*
18 *Impact Report for the Simulation of Natural Flows in Middle Piru Creek*.
19 November.
- 20 DWR (California Department of Water Resources). 2005. *Department of Water*
21 *Resources South Bay Aqueduct Improvement and Enlargement Project,*
22 *Conformed EIR*. June.
- 23 DWR (California Department of Water Resources). 2007a. *Draft Environmental*
24 *Impact Report Oroville Facilities Relicensing—FERC Project No. 2100*.
25 May.
- 26 DWR (California Department of Water Resources). 2007b. *Monterey Plus Draft*
27 *Environmental Impact Report*. October.
- 28 DWR (California Department of Water Resources). 2007c. *Value Engineering*
29 *Study, Franks Tract Pilot Project, Final Report*. June.
- 30 DWR (California Department of Water Resources). 2009a. *The California Water*
31 *Plan Update 2009, Bulletin 160-09*. December.
- 32 DWR (California Department of Water Resources). 2009b. *East Branch*
33 *Extension Phase I Improvements Project, Draft Supplemental*
34 *Environmental Impact Report No. 2*. March.
- 35 DWR (California Department of Water Resources). 2010a. *Perris Dam*
36 *Remediation Program, Draft Environmental Impact Report*. January.
- 37 DWR (California Department of Water Resources). 2010b. *Final Environmental*
38 *Impact Report, North Delta Flood Control and Ecosystem Restoration*
39 *Project*. October.

- 1 DWR (Department of Water Resources). 2011. Effects of U.S. Army Corps of
2 Engineers' Policy on Levee Vegetation in California. Accessed
3 September 26, 2011. water.ca.gov/floodsafe/leveeveg/.
- 4 DWR (California Department of Water Resources). 2012. *2012 Central Valley
5 Flood Protection Plan Consolidated Final Program Environmental
6 Impact Report*. July.
- 7 DWR (California Department of Water Resources). 2013a. *Upper Feather River
8 Lakes*. April.
- 9 DWR (California Department of Water Resources). 2013b. *California's Flood
10 Future Highlights, Recommendations for Managing the State's Flood
11 Risk, Final*. November.
- 12 DWR (California Department of Water Resources). 2014. *Initial Study/Proposed
13 Mitigated Negative Declaration, Bethany Reservoir Sediment Removal
14 Project*. May.
- 15 DWR and Reclamation (Department of Water Resources and Bureau of
16 Reclamation). 2002. *Riparian Vegetation of the San Joaquin River.
17 Technical Information Record SJD-02-1*. May.
- 18 DWR, Reclamation, USFWS and NMFS (California Department of Water
19 Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and
20 National Marine Fisheries Service). 2013. *Draft Environmental Impact
21 Report/Environmental Impact Statement for the Bay Delta Conservation
22 Plan*. November.
- 23 DWR et al. (California Department of Water Resources, Yuba County Water
24 Agency, Bureau of Reclamation). 2007. *Draft Environmental Impact
25 Report/Environmental Impact Statement for the Proposed Lower Yuba
26 River Accord*. June.
- 27 EBMUD (East Bay Municipal Utility District). 1999. *East Bay Watershed
28 Master Plan*. March.
- 29 EBRPD (East Bay Regional Park District). 1996. *Master Plan 1997*. December
30 17.
- 31 EBRPD (East Bay Regional Park District). 2001. *Wildland Management
32 Policies and Guidelines*. June 5.
- 33 EBRPD (East Bay Regional Park District). 2012. *Del Valle Regional Park,
34 Checklist of Wild Plants, Sorted Alphabetically by Growth, Form
35 Scientific Name*. February 27.
- 36 EBRPD (East Bay Regional Park District). 2013. *Master Plan 2013*. July 16.
- 37 ECCCHCPA (East Contra Costa County Habitat Conservation Plan Association).
38 2006. *Final East Contra Costa County Habitat Conservation
39 Plan/Natural Community Conservation Plan*. October.

- 1 FERC (Federal Energy Regulatory Commission). 2007. *Final Environmental*
2 *Impact Statement for Hydropower License, Oroville Facilities – FERC*
3 *Project No. 2100-052*. May.
- 4 FERC (Federal Energy Regulatory Commission). 2013. *Draft Environmental*
5 *Impact Statement for the Drum-Spaulding Project (P-2310-173) and*
6 *Yuba-Bear Hydroelectric Project (P-2266-096)*. May 17.
- 7 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
8 *General Information – Licensing*. Site accessed April 29, 2015.
9 <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>.
- 10 Goodwin Power, LLC. 2013. Submittal to Federal Energy Regulatory
11 Commission by American Renewables, LLC. Re: Goodwin Dam
12 Hydroelectric Project. FERC Project No. 13728. Transmittal of
13 Notification of Intent and Pre-Application Document, Request for
14 Comments. October 30.
- 15 GRCD (Grasslands Resource Conservation District). 2014. *Grasslands Resource*
16 *Conservation District*. Site accessed October 1, 2014.
17 <http://gwdwater.org/grcd/who-we-are.php>.
- 18 Green Diamond Resource Company. 2006. *Aquatic Habitat Conservation Plan*
19 *and Candidate Conservation Agreement with Assurances*. October.
- 20 Hartman, C.A., and K. Kyle. 2010. *Farming for Birds: Alfalfa and Forages as*
21 *Valuable Wildlife Habitat*. IN: Proceedings, 2010 California Alfalfa &
22 Forage Symposium and Corn/Cereal Silage Mini-Symposium, Visalia,
23 CA, 1-2. December, 2010. UC Cooperative Extension, Plant Sciences
24 Department, University of California, Davis.
- 25 Hickson, D., and T. Keeler-Wolf. 2007. *Vegetation and Land Use Classification*
26 *and Map of the Sacramento-San Joaquin River Delta*. February.
- 27 Huddleston, Robert J. 2001. “Mendota Wildlife Area: A key habitat in the San
28 Joaquin Valley” *Outdoor California*, July-August 2001.
- 29 Kozlowski, T.T., and S.G. Pallardy. 2002. “Acclimation and Adaptive
30 Responses of Woody Plants to Environmental Stresses”. *The Botanical*
31 *Review*, Vol. 68, No. 2, pp. 270–334.
- 32 Lake Arrowhead. 2014a. *Lake Arrowhead*. Site accessed May 19, 2014.
33 <http://www.lakearrowhead.com/activities.html>.
- 34 Lake Arrowhead. 2014b. *Lake Arrowhead, Hiking Tips*. Site accessed
35 October 5, 2014. <http://www.lakearrowhead.com/hikingtips.html>.
- 36 Merz, J.E., Moyle, P.B. 2006. *Salmon, Wildlife, and Wine: Marine-derived*
37 *Nutrients in Human-Dominated Ecosystems of Central California*.
38 *Ecological Applications* 16: 999–1009.
- 39 MWD (Metropolitan Water District of Southern California). 2014. *Diamond*
40 *Valley Lake, Southwestern Riverside County Multi-Species Reserve*. Site
41 accessed October 5, 2014. <http://www.dvlake.com/shiple01.html>.

- 1 NCRWQCB et al. (California North Coast Regional Water Quality Control Board
2 and Bureau of Reclamation). 2009. *Channel Rehabilitation and Sediment*
3 *Management for Remaining Phase 1 and Phase 2 Sites, Draft Master*
4 *Environmental Impact Report and Environmental Assessment*. June.
- 5 NCRWQCB et al. (California North Coast Regional Water Quality Control
6 Board, Bureau of Reclamation, Bureau of Land Management). 2013.
7 *Trinity River Channel Rehabilitation Sites: Bucktail, (River*
8 *Mile 105.3-106.35) and Lower Junction City (River Mile 78.8-79.8), Draft*
9 *Environmental Assessment/Initial Study*. December.
- 10 NID (Nevada Irrigation District). 2005. *Raw Water Master Plan Update,*
11 *Phase I: Technical Analysis, Volume I, Final Report*. September.
- 12 Nogeire T.M., F.W. Davis, J.M. Duggan, K.R. Crooks, and E.E. Boydston.
13 2013. *Carnivore Use of Avocado Orchards across an Agricultural-*
14 *Wildland Gradient*. PLoS ONE 8(7): e68025.
15 <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0068025>.
- 16 NPS (National Park Service). 1999. *Whiskeytown Unit, Whiskeytown-Shasta-*
17 *Trinity National Recreation Area General Management Plan and*
18 *Environmental Impact Statement*. June.
- 19 NPS (National Park Service). 2014. *Whiskeytown National Recreation Area,*
20 *Environmental Assessment and Assessment of Effect, Princess Ditch Trail*
21 *Construction*. March.
- 22 PFC (Pacific Flyway Council). 2014. *Pacific Flyway Council, Coordinated*
23 *Management*. Site accessed October 7, 2014.
24 <http://www.pacificflyway.gov/>.
- 25 Philipp, M. 2005. *Decker Island Wildlife Area: Enhancing Delta wetlands one*
26 *phase at a time*. Outdoor California. March-April edition. Pages 4-8.
- 27 Plumas County. 2012. *2035 Plumas County General Plan Update Draft*
28 *Environmental Impact Report*. November.
- 29 Putnam, D., M. Russelle, S. Orloff, J. Kuhn, L. Fitzhugh, L. Godfrey, A.
30 Kleiss, and R. Long. 2001. *Alfalfa, Wildlife, and the Environment: the*
31 *Importance and Benefits of Alfalfa in the 21st Century*. Published by
32 California Alfalfa and Forage Association.
- 33 RCWD (Rancho California Water District). 2015. *Welcome to Vail Lake*. Site
34 accessed June 15, 2015.
35 <http://www.ranchowater.com/index.aspx?NID=265>.
- 36 Reclamation (Bureau of Reclamation). 2005a. *Central Valley Project Long-Term*
37 *Water Service Contract Renewal American River Division Environmental*
38 *Impact Statement*. June.
- 39 Reclamation (Bureau of Reclamation). 2005b. *Central Valley Project Long-*
40 *Term Water Service Contract Renewal San Luis Unit, Public Draft*
41 *Environmental Impact Statement and Appendices*. September.

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- 1 Reclamation (Bureau of Reclamation). 2010a. *2010-2011 Water Transfer*
2 *Program Draft Environmental Assessment*. January.
- 3 Reclamation (Bureau of Reclamation). 2010b. *New Melones Lake Area, Final*
4 *Resource Management Plan and Environmental Impact Statement*.
5 February.
- 6 Reclamation (Bureau of Reclamation). 2010c. *Cachuma Lake Final Resource*
7 *Management Plan/Environmental Impact Statement*. May.
- 8 Reclamation (Bureau of Reclamation). 2012. *Refuge Water Supply Program*
9 *2012 Annual Work Plan, CVPIA 3406(b)(3) & (d)(1)(2)(5)*.
- 10 Reclamation (Bureau of Reclamation). 2013a. *Shasta Lake Water Resources*
11 *Investigation Draft Environmental Impact Statement*. June.
- 12 Reclamation (Bureau of Reclamation). 2013b. *Record of Decision, Water*
13 *Transfer Program for the San Joaquin River Exchange Contractors Water*
14 *Authority, 2014-2038*. July 30.
- 15 Reclamation (Bureau of Reclamation). 2014a. *Draft Resource Management Plan*
16 *and Draft Environmental Impact Statement, Contra Loma Reservoir and*
17 *Recreation Area*. May.
- 18 Reclamation (Bureau of Reclamation). 2014b. *Findings of No Significant*
19 *Impact, 2014 Tehama-Colusa Canal Authority Water Transfers*. April 22.
- 20 Reclamation (Bureau of Reclamation). 2014c. *Findings of No Significant*
21 *Impact, 2014 San Luis & Delta-Mendota Water Authority Water*
22 *Transfers*. April 22.
- 23 Reclamation (Bureau of Reclamation). 2014d. *Long-Term Water Transfers*
24 *Environmental Impact Statement/Environmental Impact Report, Public*
25 *Draft*. September.
- 26 Reclamation (Bureau of Reclamation). 2014e. *Upper San Joaquin River Basin*
27 *Storage Investigation, Draft Environmental Impact Statement*. August.
- 28 Reclamation and DWR (Bureau of Reclamation, and California Department of
29 Water Resources). 2011. *San Joaquin River Restoration Program*
30 *Environmental Impact Statement/Report*.
- 31 Reclamation and State Parks (Bureau of Reclamation and California Department
32 of Parks and Recreation). 2010. *Millerton Lake Final Resource*
33 *Management Plan/General Plan Environmental Impact*
34 *Statement/Environmental Impact Report*. April.
- 35 Reclamation and State Parks (Bureau of Reclamation and California Department
36 of Parks and Recreation). 2013. *San Luis Reservoir State Recreation*
37 *Area, Final Resource Management Plan/General Plan and Final*
38 *Environmental Impact Statement/ Environmental Impact Report*. June.
- 39 Reclamation, CCWD, and Western (Bureau of Reclamation, Contra Costa Water
40 District, and Western Area Power Administration). 2010. *Los Vaqueros*

- 1 *Expansion Project, Environmental Impact Statement/Environmental*
 2 *Impact Report.* March.
- 3 Reclamation et al. (Bureau of Reclamation, U.S. Fish and Wildlife Service,
 4 California Department of Fish and Game (now known as Department of
 5 Fish and Wildlife Service)). 2001a. *Final NEPA Environmental*
 6 *Assessment and CEQA Initial Study, Refuge Water Supply Long-Term*
 7 *Water Supply Agreements, Sacramento River Basin.* January.
- 8 Reclamation et al. (Bureau of Reclamation, U.S. Fish and Wildlife Service,
 9 California Department of Fish and Game (now known as Department of
 10 Fish and Wildlife Service)). 2001b. *Final NEPA Environmental*
 11 *Assessment and CEQA Initial Study, Refuge Water Supply Long-Term*
 12 *Water Supply Agreements, San Joaquin River Basin.* January.
- 13 Reclamation et al. (Bureau of Reclamation, U.S. Army Corps of Engineers,
 14 California Department of Water Resources, State of California
 15 Reclamation Board, and Sacramento Area Flood Control Agency). 2006.
 16 *Folsom Dam Safety and Flood Damage Reduction Draft Environmental*
 17 *Impact Statement/Environmental Impact Report.* December.
- 18 Reclamation et al. (Bureau of Reclamation, Contra Costa Water District, and
 19 Western Area Power Administration). 2009. *Draft Los Vaqueros*
 20 *Reservoir Expansion Project, Environmental Impact Statement*
 21 *Environmental Impact Report.* February.
- 22 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
 23 Game [now known as Department of Fish and Wildlife], and U.S. Fish
 24 and Wildlife Service). 2011. *Suisun Marsh Habitat Management,*
 25 *Preservation, and Restoration Plan Final Environmental Impact*
 26 *Statement/Environmental Impact Report.* November.
- 27 Riverside County. 2003. *Western Riverside County Multiple Species Habitat*
 28 *Conservation Plan.* June 17, 2003.
- 29 Riverside County Habitat Conservation Agency. 2014. *Habitat Conservation*
 30 *Plan for the Stephen's Kangaroo Rat in Western Riverside County,*
 31 *California.* Site accessed October 7, 2014.
 32 <http://www.skrplan.org/skr.html>.
- 33 Roberts et al. (Roberts, M.D., D.R. Peterson, D.E. Jukkola, and V.L. Snowden).
 34 2002. *A Pilot Investigation of Cottonwood Recruitment on the*
 35 *Sacramento River, The Nature Conservancy.* May.
- 36 SANDAG (San Diego Association of Governments). 2003. *Final MHCP Plan,*
 37 *Multiple Habitat Conservation Program.* March.
- 38 San Diego County. 2011. *San Diego County General Plan Update, Final*
 39 *Environmental Impact Report.* August.
- 40 San Diego County. 2014a. *Multiple Species Conservation Program.* Site
 41 accessed October 7, 2014. <http://www.sandiegocounty.gov/pds/mscp/>.

- 1 San Diego County. 2014b. *About the MSCP*. Site accessed October 7, 2014.
2 <http://www.sandiegocounty.gov/content/sdc/pds/mscp/overview.html>.
- 3 San Diego County. 2015. *About the MSCP*. Site accessed June 15, 2015.
4 <http://www.sandiegocounty.gov/content/sdc/pds/mscp/overview.html>.
- 5 Santa Clara County et al. (County of Santa Clara, City of San Jose, City of
6 Morgan Hill, City of Gilroy, Santa Clara Valley Water District, and Santa
7 Clara Valley Transportation Authority). 2012. *Final Santa Clara Valley*
8 *Habitat Plan*. August.
- 9 SBCWD (San Benito County Water District). 2012. *Initial Study, Zebra Mussel*
10 *Eradication Project: San Justo Reservoir, Hollister Conduit, & San Benito*
11 *County Water District Subsystems*. January.
- 12 SCVWD (Santa Clara Valley Water District). 2010. *Urban Water Management*
13 *Plan*.
- 14 SDCWA and USACE (San Diego County Water Authority and U.S. Army Corps
15 of Engineers). 2008. *Final Environmental Impact Report/Environmental*
16 *Impact Statement for the Carryover Storage and San Vicente Dam Raise*
17 *Project*. April 2008.
- 18 SDCWA and USFWS (San Diego County Water Authority and U.S. Fish and
19 Wildlife Service). 2010. *Final Environmental Impact*
20 *Report/Environmental Impact Statement (EIR/EIS) for the San Diego*
21 *County Water Authority Subregional Natural Community Conservation*
22 *Plan/Habitat Conservation Plan (NCCP/HCP)*. October.
- 23 SDRP (San Dieguito River Park). *Keep Your Eye on Lake Hodges Wildlife*. Site
24 accessed June 15, 2015.
25 [http://www.sdrp.org/resources/What's%20Growing%20On/Lake%20Hodg](http://www.sdrp.org/resources/What's%20Growing%20On/Lake%20Hodges%20Wildlife.htm)
26 [es%20Wildlife.htm](http://www.sdrp.org/resources/What's%20Growing%20On/Lake%20Hodges%20Wildlife.htm).
- 27 SDRWWG (San Diego River Watershed Work Group). 2005. *San Diego River*
28 *Watershed Management Plan, Final Watershed Management Plan*.
29 March.
- 30 SFEI (San Francisco Estuary Institute-Aquatic Science Center). 2012.
31 *Sacramento-San Joaquin Delta Historical Ecology Investigation:*
32 *Exploring Pattern and Process*. Whipple, A.A., R.M. Grossinger, D.
33 Rankin, B. Stanford, and R.A. Askevold. Prepared for the California
34 Department of Fish and Game and Ecosystem Restoration Program.
35 Historical Ecology Program Publication #672. August.
- 36 Siegel et al. (Siegel, S., C. Enright, C. Toms, C. Enos, and J. Sutherland).
37 2010a. "Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual
38 Model. Chapter 1: Physical Processes, Final Review Draft". *Suisun*
39 *Marsh Habitat Management, Restoration and Preservation Plan*.
40 September 15.
- 41 Siegel et al. (Siegel, S., C. Toms, D. Gillenwater, and C. Enright). 2010b.
42 "Suisun Marsh Tidal Marsh and Aquatic Habitats Conceptual Model.

- 1 Chapter 3: Tidal Marsh, In-progress Review Draft.” *Suisun Marsh Habitat*
2 *Management, Restoration and Preservation Plan*. October 26.
- 3 State Parks (California Department of Parks and Recreation). 2006. *Silverwood*
4 *Lake State Recreation Area*. Site accessed February 21, 2013.
5 www.rockymountainrec.com/lakes/lake-silverwood.htm.
- 6 State Parks (California Department of Parks and Recreation). 2009. *Silverwood*
7 *Lake State Recreation Area, Nature Center Interpretive Project Plan*.
8 April.
- 9 STNF (Shasta-Trinity National Forest). 2014. *Management Guide, Shasta and*
10 *Trinity Units*. Version 2.12.2014.
- 11 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control*
12 *Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.
13 December 13.
- 14 SWRCB (State Water Resources Control Board). 2013. *Comprehensive*
15 *(Phase 2) Review and Update to the Bay-Delta Plan, DRAFT Bay-Delta*
16 *Plan Workshops Summary Report*. January.
- 17 SWSD (Semitropic Water Storage District). 2011. *Delta Wetlands Project Place*
18 *of Use, Final Environmental Impact Report*. August.
- 19 Tri-Dam Project. 2003. Letter from Steve Felte, Tri-Dam Project, and Mick
20 Klasson, Stanislaus County, to Interested Agencies Re: Request for
21 Preliminary Input on the Proposed Goodwin Hydroelectric Project.
22 August 8.
- 23 Tri-Dam Project. 2007. Submittal to Federal Energy Regulatory Commission by
24 Tri-Dam Project, Re: Tulloch Project No. 2067, License Compliance
25 Filings, *Tulloch Project, FERC No. 2067, Tulloch Reservoir Shoreline*
26 *Management Plan*. November 21.
- 27 Tri-Dam Project. 2008. Submittal to Federal Energy Regulatory Commission by
28 Tri-Dam Project, Re: Tulloch Project No. 2067, License Compliance
29 Filings, *Tulloch Project, FERC No. 2067, Tulloch Reservoir Shoreline*
30 *Management Plan*. June 23.
- 31 USACE (U.S. Army Corps of Engineers). 2009. *ETL 1110-2-571 Guidelines For*
32 *Landscape Planting and Vegetation Management at Levees, Floodwalls,*
33 *Embankment Dams, and Appurtenant Structures*. April 10.
- 34 USACE (U.S. Army Corps of Engineers). 2010. *Draft Process for Requesting a*
35 *Variance from Vegetation Standards for Levees and Floodwalls--75 Fed.*
36 *Reg. 6364-68*. February 9.
- 37 USACE (U.S. Army Corps of Engineers). 2013. *Biological Assessment for the*
38 *U.S. Army Corps of Engineers Ongoing Operation and Maintenance of*
39 *Englebright Dam and Reservoir on the Yuba River*. October.

- 1 USACE (U.S. Army Corps of Engineers). 2014. *Voluntary Conservation*
2 *Measures – Habitat Enhancement on the Lower Yuba River, Yuba County,*
3 *California, Draft Environmental Assessment.* July.
- 4 USFS (U.S. Forest Service). 2005. *Upper Trinity River Watershed Analysis,*
5 *Shasta-Trinity National Forest.*
- 6 USFS (U.S. Forest Service). 2012. *Bald Eagles of Shasta, Trinity, and Lewiston*
7 *Lakes.* April.
- 8 USFWS (U.S. Fish and Wildlife Service). 1975. *Deer Loss Compensation*
9 *Program Resulting from Trinity River Division.* April.
- 10 USFWS (U.S. Fish and Wildlife Service). 2002. *Environmental Assessment*
11 *Proposed North Delta National Wildlife Refuge.*
- 12 USFWS (U.S. Fish and Wildlife Service). 2004. Intra-Service Formal Section 7
13 Consultation/Conference for Issuance of an Endangered Species Act
14 Section 10(a)(1)(B) Permit (TE-088609-0) for the Western Riverside
15 County Multiple Species Habitat Conservation Plan, Riverside County,
16 California. June 22.
- 17 USFWS (U.S. Fish and Wildlife Service). 2006. *San Joaquin River National*
18 *Wildlife Refuge Draft Comprehensive Conservation Plan and*
19 *Environmental Assessment.* Prepared by California/Nevada Operations
20 Office, San Luis National Wildlife Refuge Complex, and
21 California/Nevada Refuge Planning Office.
- 22 USFWS (U.S. Fish and Wildlife Service). 2007. *Stone Lakes National Wildlife*
23 *Refuge Comprehensive Conservation Plan.* January.
- 24 USFWS (U.S. Fish and Wildlife Service). 2010. *Notice of Availability of*
25 *Federal Assistance 2010 Request for Proposals, Mill Creek.*
- 26 USFWS (U.S. Fish and Wildlife Service). 2012a. *San Luis National Wildlife*
27 *Refuge, Resource Management.* December 18. Site accessed September
28 30, 2014.
29 [http://www.fws.gov/Refuge/San_Luis/what_we_do/resource_management](http://www.fws.gov/Refuge/San_Luis/what_we_do/resource_management.html)
30 [.html.](http://www.fws.gov/Refuge/San_Luis/what_we_do/resource_management.html)
- 31 USFWS (U.S. Fish and Wildlife Service). 2012b. *San Luis National Wildlife*
32 *Refuge, Wildlife & Habitat.* December 18. Site accessed
33 September 30, 2014.
34 [http://www.fws.gov/Refuge/San_Luis/wildlife_and_habitat/index.html.](http://www.fws.gov/Refuge/San_Luis/wildlife_and_habitat/index.html)
- 35 USFWS (U.S. Fish and Wildlife Service). 2012c. *San Luis National Wildlife*
36 *Refuge.* December 18. Site accessed September 30, 2014.
37 [http://www.fws.gov/Refuge/San_Luis/about.html.](http://www.fws.gov/Refuge/San_Luis/about.html)
- 38 USFWS (U.S. Fish and Wildlife Service). 2012d. *Merced National Wildlife*
39 *Refuge, About the Merced National Wildlife Refuge.* December 19. Site
40 accessed on July 28, 2014.
41 [http://www.fws.gov/Refuge/Merced/about.html.](http://www.fws.gov/Refuge/Merced/about.html)

- 1 USFWS (U.S. Fish and Wildlife Service). 2012e. *San Joaquin River National*
2 *Wildlife Refuge Wildlife & Habitat*. December 21. Site accessed
3 July 28, 2014.
4 [http://www.fws.gov/Refuge/San_Joaquin_River/wildlife_and_habitat/inde](http://www.fws.gov/Refuge/San_Joaquin_River/wildlife_and_habitat/index.html)
5 [x.html](http://www.fws.gov/Refuge/San_Joaquin_River/wildlife_and_habitat/index.html).
- 6 USFWS (U.S. Fish and Wildlife Service). 2012f. *San Joaquin River National*
7 *Wildlife Refuge, About the Refuge*. December 21. Site accessed
8 October 1, 2014.
9 http://www.fws.gov/Refuge/San_Joaquin_River/about.html.
- 10 USFWS (U.S. Fish and Wildlife Service). 2013a. *Sacramento National Wildlife*
11 *Refuge, About the Sacramento NWR Complex*. Site accessed
12 July 28, 2014.
13 <http://www.fws.gov/refuge/Sacramento/Aboutthecomplex.html>.
- 14 USFWS (U.S. Fish and Wildlife Service). 2013b. *San Luis National Wildlife*
15 *Refuge, About the Complex*. April 2. Site accessed September 30, 2014.
16 http://www.fws.gov/refuge/san_luis/About_the_Complex.html.
- 17 USFWS (U.S. Fish and Wildlife Service). 2013c. *San Luis National Wildlife*
18 *Refuge, Grasslands Wildlife Management Area*. April 9. . Site accessed
19 July 28, 2014. http://www.fws.gov/refuge/san_luis/grasslands.html.
- 20 USFWS (U.S. Fish and Wildlife Service). 2013d. *Kern National Wildlife Refuge,*
21 *About the Complex*. November 21. Site accessed July 29, 2014.
22 http://www.fws.gov/refuge/Kern/About_the_Complex.html.
- 23 USFWS (U.S. Fish and Wildlife Service). 2013e. *Kern National Wildlife Refuge,*
24 *Wildlife & Habitat*. November 21. Site accessed July 29, 2014.
25 http://www.fws.gov/refuge/Kern/wildlife_and_habitat/index.html.
- 26 USFWS (U.S. Fish and Wildlife Service). 2014a. Critical habitat list for
27 Alameda County. Site accessed September 28, 2014.
28 <http://ecos.fws.gov/crithab/>.
- 29 USFWS (U.S. Fish and Wildlife Service). 2014b. Critical habitat list for Butte
30 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 31 USFWS (U.S. Fish and Wildlife Service). 2014c. Critical habitat list for Colusa
32 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 33 USFWS (U.S. Fish and Wildlife Service). 2014d. Critical habitat list for Contra
34 Costa County. Site accessed September 28, 2014.
35 <http://ecos.fws.gov/crithab/>.
- 36 USFWS (U.S. Fish and Wildlife Service). 2014e. Critical habitat list for Del
37 Norte County. Site accessed September 28, 2014.
38 <http://ecos.fws.gov/crithab/>.
- 39 USFWS (U.S. Fish and Wildlife Service). 2014f. Critical habitat list for El
40 Dorado County. Site accessed September 28, 2014.
41 <http://ecos.fws.gov/crithab/>.

Chapter 10: Terrestrial Biological Resources

- 1 USFWS (U.S. Fish and Wildlife Service). 2014g. Critical habitat list for Fresno
2 County. Site accessed September 28, 2014.
3 <http://ecos.fws.gov/crithab/politicalList.do>
- 4 USFWS (U.S. Fish and Wildlife Service). 2014h. Critical habitat list for Glenn
5 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 6 USFWS (U.S. Fish and Wildlife Service). 2014i. Critical habitat list for
7 Humboldt County. Site accessed September 28, 2014.
8 <http://ecos.fws.gov/crithab/>.
- 9 USFWS (U.S. Fish and Wildlife Service). 2014j Critical habitat list for Kern
10 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 11 USFWS (U.S. Fish and Wildlife Service). 2014k. Critical habitat list for Kings
12 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 13 USFWS (U.S. Fish and Wildlife Service). 2014l. Critical habitat list for Los
14 Angeles County. Site accessed September 28, 2014.
15 <http://ecos.fws.gov/crithab/>.
- 16 USFWS (U.S. Fish and Wildlife Service). 2014m. Critical habitat list for Madera
17 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 18 USFWS (U.S. Fish and Wildlife Service). 2014n. Critical habitat list for Merced
19 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 20 USFWS (U.S. Fish and Wildlife Service). 2014o. Critical habitat list for Nevada
21 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 22 USFWS (U.S. Fish and Wildlife Service). 2014p. Critical habitat list for Orange
23 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 24 USFWS (U.S. Fish and Wildlife Service). 2014q. Critical habitat list for Placer
25 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 26 USFWS (U.S. Fish and Wildlife Service). 2014r. Critical habitat list for Plumas
27 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 28 USFWS (U.S. Fish and Wildlife Service). 2014s. Critical habitat list for
29 Riverside County. Site accessed September 28, 2014.
30 <http://ecos.fws.gov/crithab/>.
- 31 USFWS (U.S. Fish and Wildlife Service). 2014t. Critical habitat list for
32 Sacramento County. Site accessed September 28, 2014.
33 <http://ecos.fws.gov/crithab/>.
- 34 USFWS (U.S. Fish and Wildlife Service). 2014u. Critical habitat list for San
35 Benito County. Site accessed September 28, 2014.
36 <http://ecos.fws.gov/crithab/>.
- 37 USFWS (U.S. Fish and Wildlife Service). 2014v. Critical habitat list for San
38 Bernardino County. Site accessed September 28, 2014.
39 <http://ecos.fws.gov/crithab/>.

- 1 USFWS (U.S. Fish and Wildlife Service). 2014w. Critical habitat list for San
2 Diego County. Site accessed September 28, 2014.
3 <http://ecos.fws.gov/crithab/>.
- 4 USFWS (U.S. Fish and Wildlife Service). 2014x. Critical habitat list for San
5 Joaquin County. Site accessed September 28, 2014.
6 <http://ecos.fws.gov/crithab/>.
- 7 USFWS (U.S. Fish and Wildlife Service). 2014y. Critical habitat list for Santa
8 Barbara County. Site accessed September 28, 2014.
9 <http://ecos.fws.gov/crithab/>.
- 10 USFWS (U.S. Fish and Wildlife Service). 2014z. Critical habitat list for Santa
11 Clara County. Site accessed September 28, 2014.
12 <http://ecos.fws.gov/crithab/>.
- 13 USFWS (U.S. Fish and Wildlife Service). 2014aa. Critical habitat list for Shasta
14 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 15 USFWS (U.S. Fish and Wildlife Service). 2014ab. Critical habitat list for Solano
16 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 17 USFWS (U.S. Fish and Wildlife Service). 2014ac. Critical habitat list for
18 Stanislaus County. Site accessed September 28, 2014.
19 <http://ecos.fws.gov/crithab/>.
- 20 USFWS (U.S. Fish and Wildlife Service). 2014ad. Critical habitat list for Sutter
21 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 22 USFWS (U.S. Fish and Wildlife Service). 2014ae. Critical habitat list for
23 Tehama County. Site accessed September 28, 2014.
24 <http://ecos.fws.gov/crithab/>.
- 25 USFWS (U.S. Fish and Wildlife Service). 2014af. Critical habitat list for Trinity
26 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 27 USFWS (U.S. Fish and Wildlife Service). 2014ag. Critical habitat list for Tulare
28 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 29 USFWS (U.S. Fish and Wildlife Service). 2014ah. Critical habitat list for
30 Ventura County. Site accessed September 28, 2014.
31 <http://ecos.fws.gov/crithab/>.
- 32 USFWS (U.S. Fish and Wildlife Service). 2014ai. Critical habitat list for Yolo
33 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 34 USFWS (U.S. Fish and Wildlife Service). 2014aj. Critical habitat list for Yuba
35 County. Site accessed September 28, 2014. <http://ecos.fws.gov/crithab/>.
- 36 USFWS (U.S. Fish and Wildlife Service). 2014ak. *Pixley National Wildlife*
37 *Refuge*. Site accessed October 1, 2014.
38 <http://www.fws.gov/refuges/profiles/index.cfm?id=81612>.

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- 1 USFWS et al. (U.S. Fish and Wildlife Service, Bureau of Reclamation, Hoopa
2 Valley Tribe, and Trinity County). 1999. *Trinity River Mainstem Fishery*
3 *Restoration Environmental Impact Statement/Report*. October.
- 4 UWCD (United Water Conservation District). 1999. *Lake Piru Recreation Area*
5 *Master Plan, Final Initial Study/Mitigated Negative Declaration*. August.
- 6 UWCD (United Water Conservation District). 2014. *Facilities and Strategies*.
7 Site accessed March 26, 2014. [http://www.unitedwater.org/about-us-](http://www.unitedwater.org/about-us-6/facilities-a-strategies)
8 [6/facilities-a-strategies](http://www.unitedwater.org/about-us-6/facilities-a-strategies).
- 9 Witham, C.W and Karacelas, G.A. 1994. *Final Report, Botanical Resources*
10 *Inventory At Calhoun Cut Ecological Reserve Following California's*
11 *Recent Drought*. Prepared for California Department of Fish and Game
12 (now known as California Department of Fish and Wildlife). August 15.
- 13 YNHP (Yolo County Natural Heritage Program). 2015. *Yolo Natural Heritage*
14 *Plan*. Site accessed June 3, 2015. <http://www.yoloconservationplan.org/>.
- 15 Yolo County. 2013. *Final Report: Agricultural and Economic Impacts of Yolo*
16 *Bypass Fish Habitat Proposals*. Prepared by Richard Howitt, Duncan
17 MacEwan, Chloe Garnache, Josue Medellin Azura, Petrea Marchand,
18 Doug Brown, Johan Six, and Juhwan Lee. April.
- 19 Yurok Tribe. 2000. *Lower Klamath River Sub-Basin Watershed Restoration*
20 *Plan*. April.
- 21 Yuba County. 2011. *Final Yuba County 2030 General Plan Environmental*
22 *Impact Report*. May.

Chapter 11

1 **Geology and Soils Resources**

2 **11.1 Introduction**

3 This chapter describes the geology and soils resources in the project area; and
4 potential changes that could occur as a result of implementing the alternatives
5 evaluated in this Environmental Impact Statement (EIS). Implementation of
6 alternatives could affect geology and soils resources through potential changes in
7 operation of the Central Valley Project (CVP) and State Water Project (SWP).

8 **11.2 Regulatory Environment and Compliance** 9 **Requirements**

10 Potential actions that could be implemented under the alternatives evaluated in
11 this EIS could affect reservoirs, streams, and lands served by CVP and SWP
12 water supplies located on lands affected by seismic, landslide, and liquefaction
13 hazards; subsidence; and unstable soils. Actions located on public agency lands;
14 or implemented, funded, or approved by Federal and state agencies would need to
15 be compliant with appropriate Federal and state agency policies and regulations,
16 as summarized in Chapter 4, Approach to Environmental Analysis.

17 **11.3 Affected Environment**

18 This section describes the geological, regional seismic, and soils characteristics
19 and subsidence potential that could be potentially affected by the implementation
20 of the alternatives considered in this EIS. Changes in soils characteristics due to
21 changes in CVP and SWP operations may occur in the Trinity River, Central
22 Valley, San Francisco Bay Area, and Central Coast and Southern California
23 regions. Geomorphic provinces in California are shown on Figure 11.1.

24 **11.3.1 Trinity River Region**

25 The Trinity River Region includes the area in Trinity County along the Trinity
26 River from Trinity Lake to the confluence with the Klamath River; and in
27 Humboldt and Del Norte counties along the Klamath River from the confluence
28 with the Trinity River to the Pacific Ocean.

29 **11.3.1.1 Geologic Setting**

30 The Trinity River Region is located within the southwest area of the Klamath
31 Mountains Geomorphic Province and the northwest area of the Coast Ranges
32 Geomorphic Province, as defined by the U.S. Geological Survey (USGS)
33 geomorphic provinces (CGS 2002a). The Klamath Mountains Geomorphic
34 Province covers approximately 12,000 square miles of northwestern California

1 between the Coast Range on the west and the Cascade Range on the east and is
2 considered to be a northern extension of the Sierra Nevada (CGS 2002a,
3 Reclamation 1997).

4 The Klamath Mountains trend mostly northward. The province is primarily
5 formed by the eastern Klamath Mountain belt, central metamorphic belt, the
6 western Paleozoic and Triassic, and the western Jurassic belt. Rocks in this
7 province include Paleozoic meta-sedimentary and meta-volcanic rocks, Mesozoic
8 igneous rocks, Ordovician to Jurassic aged marine deposits in the Klamath belt,
9 Paleozoic hornblend, mica schists and ultramafic rocks in the central
10 metamorphic belt and slightly metamorphosed sedimentary and volcanic rocks in
11 the western Jurassic, Paleozoic, and Triassic belt (Reclamation 1997).

12 The Trinity River watershed is located within the Klamath Mountain Geomorphic
13 Province. Although the Trinity River watershed includes portions of both the
14 Coast Ranges Province and the Klamath Mountains Province, the Trinity River
15 riverbed is underlain by rocks of the Klamath Mountains Province
16 (NCRWQCB et al. 2009). The Klamath Mountains Province formations
17 generally dip towards the east and are exposed along the riverbed. Downstream
18 of Lewiston Dam to Deadwood Creek, the area is underlain by the Eastern
19 Klamath Terrane of the Klamath Mountains Province. The rocks in this area are
20 primarily Copley Greenstone, metamorphosed volcanic sequence with
21 intermediate and mafic volcanic rocks; and Bragdon formation, metamorphosed
22 sedimentary formation with gneiss and amphibolite. Along the Trinity River
23 between Lewiston Dam and Douglas City, outcrops of the Weaverville Formation
24 occur. The Weaverville Formation, a series of nonmarine deposits, includes
25 weakly consolidated mudstone, sandstone, and conglomerate of clays matrix and
26 sparse beds of tuff. Downstream of Douglas City, the Trinity River is underlain
27 by the Northfork and Hayfork terranes. The Northfork Terrane near Douglas City
28 includes silicious tuff, chert, mafic volcanic rock, phyllite, and limestone
29 sandstone and pebble conglomerate with serpentine intrusions. As the riverbed
30 extends towards the Klamath River, the geologic formation extends into the
31 Hayfork Terrane that consists of metamorphic and meta-volcanic rock. Terraces
32 of sand and gravel from glacial erosion along the Trinity River flanks near
33 Lewiston Dam contribute sediment into Trinity River.

34 The Trinity River flows into the Klamath River near Weitchpec. Downstream of
35 the Weitchpec, the Klamath River flows to the Pacific Ocean through the Coast
36 Ranges Geomorphic Province. The geology along the Klamath River in the Coast
37 Ranges Geomorphic Province is characterized by the Eastern Belt of the
38 Franciscan Complex and portions of the Central Belt of this complex. The
39 Franciscan Complex consists of sandstone with some shale, chert, limestone,
40 conglomerate, serpentine, and blueschist. The Eastern Belt is composed of schist
41 and meta-sedimentary rocks with minor amounts of shale, chert, and
42 conglomerate. The Central Belt is primarily composed of an argillite-matrix
43 mélangé with slabs of greenstone, serpentine, graywacke, chert, high-grade
44 metamorphics, and limestone.

1 **11.3.1.2 Regional Seismicity**

2 The areas along the Trinity River have been categorized as regions that are distant
3 from known, active faults and generally would experience infrequent, low levels
4 of shaking. However, infrequent earthquakes with stronger shaking could occur
5 (CGS 2008). The closest areas to the Trinity River with known seismic active
6 areas capable of producing an earthquake with a magnitude of 8.5 or greater are
7 the northern San Andreas Fault Zone and the Cascadia Subduction Zone which
8 are approximately 62 and 124 miles away, respectively (NCRWQCB et al. 2009).

9 The areas along the lower Klamath River downstream of the confluence with the
10 Trinity River have a slightly higher potential for greater ground shaking than
11 areas along the Trinity River (CGS 2008). The lower Klamath River is closer
12 than the Trinity River to the offshore Cascadia Subduction Zone, which runs
13 offshore of Humboldt and Del Norte counties and Oregon and Washington states.
14 The Klamath River is approximately 30 to 40 miles from the Trinidad Fault,
15 which extends from the area near Trinidad northwest to the coast near Trinidad
16 State Beach. The Trinidad Fault is potentially capable of generating an
17 earthquake with a moment magnitude of 7.3 (Humboldt County 2012).

18 The San Andreas Fault, under the Pacific Ocean in a northwestern direction from
19 the Humboldt and Del Norte counties, is where the Pacific Plate moves towards
20 the northwest relative to North America (Humboldt County 2012). The Cascadia
21 Subduction Zone, located under the Pacific Ocean offshore from Cape Mendocino
22 in southwest Humboldt County to Vancouver Island in British Columbia, has
23 produced numerous earthquakes with magnitudes greater than 8. The Cascadia
24 Subduction Zone is where the Gorda Plate and the associated Juan de Fuca Plate
25 descend under the North American Plate.

26 **11.3.1.3 Regional Volcanic Potential**

27 Active centers of volcanic activity occur in the vicinity of Mount Shasta, located
28 near the northeastern edge of the Trinity River Region. Mount Shasta is located
29 about 45 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta
30 erupted about once every 800 years. During the past 4,500 years, Mount Shasta
31 erupted about once every 600 years with the most recent eruption in 1786. Lava
32 flows, dome, and mudflows occurred during the eruptions (Reclamation 2013a).

33 **11.3.1.4 Soil Characteristics**

34 Soils in the southern region of the Klamath Mountain Geomorphic Province,
35 where the Trinity River is located, are generally composed of gravelly loam with
36 some alluvial areas with dredge tailings, river wash, and xerofluvents
37 (NCRWQCB et al. 2009).

38 Soils along the lower Klamath River are generally composed of gravelly clay
39 loam and gravelly sandy loam with sand and gravels within the alluvial deposits
40 (DOI and DFG 2012). Alluvial deposits (river gravels) and dredge tailings
41 provide important spawning habitat for salmon and steelhead.

42 **11.3.1.5 Subsidence**

43 Land subsidence is not a major occurrence in the Trinity River Region.

1 **11.3.2 Central Valley Region**

2 The Central Valley Region extends from above Shasta Lake to the Tehachapi
3 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and
4 Suisun Marsh.

5 **11.3.2.1 Geologic Setting**

6 The Central Valley Region is bounded by the Klamath Mountains, Cascade
7 Range, Great Valley, Coast Ranges, and Sierra Nevada geomorphic provinces
8 (CGS 2002a).

9 The Klamath Mountains Geomorphic Province was described in subsection
10 11.3.2, Trinity River Region. The Cascade Range Geomorphic Province consists
11 of volcanic rocks of the Miocene to Pleistocene age. Several volcanoes within the
12 Cascade Range Geomorphic Province and the Central Valley Region include
13 Mount Shasta and Lassen Peak (Reclamation 2013a).

14 The Great Valley Geomorphic Province is an approximately 400 mile long,
15 50 mile wide valley that extends from the northwest to the southeast between the
16 Sierra Nevada and Coast Ranges geomorphic provinces. The faulted and folded
17 sediments of the Coast Range extend eastward beneath most of the Central
18 Valley; and the igneous and metamorphic rocks of the Sierra Nevada extend
19 westward beneath the eastern Central Valley (Reclamation 1997). The valley
20 floor is an alluvial plain of sediments that have been deposited since the Jurassic
21 age (CGS 2002a). Below these deposits are Cretaceous Great Valley Sequence
22 shales and sandstones and upper Jurassic bedrock of metamorphic and igneous
23 rocks associated in the east with the Sierra Nevada and in the west with the Coast
24 Ranges (DWR 2007). Sediments deposited along the submarine fans within the
25 Great Valley Geomorphic Province include mudstones, sandstones, and
26 conglomerates from the Klamath Mountains and Sierra Nevada geomorphic
27 provinces.

28 The valley floor in the Great Valley Geomorphic Province includes dissected
29 uplands, low alluvial fans and plains, river floodplains and channels, and overflow
30 lands and lake bottoms. The dissected uplands include consolidated and
31 unconsolidated Tertiary and Quaternary continental deposits. The alluvial fans
32 along the western boundary include poorly sorted fine sand, silt, and clay. The
33 alluvial fans along the eastern boundary consist of well sorted gravel and sand
34 along major tributaries, and poorly sorted materials along intermittent streams.
35 River and floodplains primarily consist of coarse sands and fine silts. The lake
36 bottoms primarily occur in the in the southern San Joaquin Valley and composed
37 of clay layers (Reclamation 1997).

38 The Sierra Nevada Geomorphic Province along the eastern boundary of the Great
39 Valley Geomorphic Province is composed of pre-Tertiary igneous and
40 metamorphic rocks. The Sierra Nevada Geomorphic Province is an uplifted fault
41 block nearly 400 miles long with a series of metamorphic rock on the east and
42 deep river cuts on a gentle slope, which disappears under sediments of the Central
43 Valley on the west. Gold-bearing veins are present in the northwest trending

1 Mother Lode metamorphic bedrock. The province is bordered by the Cascade
 2 Range on the north (Placer County 2007).

3 The Coast Ranges Geomorphic Province is composed of pre-Tertiary and Tertiary
 4 semiconsolidated to consolidated marine sedimentary rocks. The Coast Ranges
 5 Province is characterized by active uplift related to the San Andreas Fault and
 6 plate boundary system tectonics. The province extends westward toward the
 7 coastline and eastward toward the Great Valley Geomorphic Province. Rocks in
 8 this region include mafic and ultramafic rock associated with the Coast Range
 9 ophiolite, and Miocene volcanic rocks (Sonoma Volcanics) and marine and
 10 terrestrial sedimentary from the Cretaceous to the Neogene period (Reclamation
 11 et al. 2010).

12 **11.3.2.1.1 Sacramento Valley Geological Setting**

13 Major watersheds within the Sacramento Valley that could be affected by CVP
 14 and SWP operations include the Sacramento River, Feather River, and the Lower
 15 American River watersheds.

16 *Sacramento River Watershed Geological Setting*

17 The Sacramento River flows from Shasta Lake to the Delta. The area along the
 18 Sacramento River from Shasta Lake to downstream of Red Bluff is characterized
 19 by loosely consolidated deposits of Pliocene and or Pleistocene age sandstone,
 20 shale, and gravel. Downstream of Red Bluff to the Delta, the river flows through
 21 Quaternary age alluvium, lake, playa, and terrace deposits that are unconsolidated
 22 or poorly consolidated with outcrops of resistant, cemented alluvial units such as
 23 the Modesto and Riverbank formations (CALFED 2000).

24 The active river channel maintains roughly constant dimensions as it migrates
 25 across the floodplain within the limits of the meander belt which is constrained
 26 only by outcrops of resistant units or artificial bank protection. Sediment loads in
 27 the tributary streams and lower reaches of the Sacramento River occur due to past
 28 and current land use practices on the tributary streams.

29 *Feather River Watershed Geological Setting*

30 Portions of the Feather River watershed analyzed in this EIS extend from
 31 Antelope Lake, Lake Davis, and Frenchman Lake upstream of Lake Oroville,
 32 through Lake Oroville and the Thermalito Reservoir complex, and along the
 33 Feather River to the confluence with the Sacramento River. The Yuba and Bear
 34 rivers are the major tributaries to the Feather River downstream of Thermalito
 35 Dam.

36 The Feather River watershed upstream of Thermalito Dam is located in the
 37 Cascade Range Geomorphic Province and the metamorphic belt of the Sierra
 38 Nevada Geomorphic Province. The lower watershed downstream of Thermalito
 39 Dam is located in the Great Valley Geomorphic Province.

40 West of Lake Oroville, scattered sedimentary and volcanic deposits cover the
 41 older bedrock, including (from oldest to youngest) the marine Chico formation
 42 from the upper Cretaceous; the auriferous gravels and mostly non-marine Ione

1 formation of the Eocene Epoch; the extrusive volcanic Lovejoy basalt of the late
2 Oligocene to early Miocene; and volcanic flows and volcanoclastic rocks of the
3 Tuscan formation of the late Pliocene. Late Tertiary and Quaternary units in this
4 area include alluvial terrace and fan deposits of the Plio-Pleistocene Laguna
5 formation, the Riverbank and Modesto formations of the Pleistocene, riverbed
6 sediments of the Holocene, and historical dredge and mine tailings from
7 20th century mining activities (DWR 2007).

8 Alluvium deposits occur in active channels of the Feather, Bear, and Yuba rivers
9 and tributary streams. These deposits contain clay, silt, sand, gravel, cobbles, and
10 boulders in various layers and mixtures. Historical upstream hydraulic mining
11 significantly increased the sediment covering the lower Feather River riverbed
12 with a thick deposit of fine clay-rich, light yellow-brown slickens (i.e., powdery
13 matter from a quartz mill or residue from hydraulic mining). More recent
14 floodplain deposits cover these slickens in the banks along most of the Feather
15 River. Cobbles and coarse gravel dredge tailings constitute most of the banks,
16 slowing the bank erosion process between the cities of Oroville and Gridley. The
17 river is wide and shallow, with low sinuosity and a sand bed between Honcut Creek
18 and the mouth of the Feather River.

19 *American River Watershed Geological Setting*

20 The Folsom Lake area is located within the Sierra Nevada and the Great Valley
21 Geomorphic Province at the confluence of the North and South Forks of the
22 American River. The Folsom Lake region primarily consists of rolling hills and
23 upland plateaus between major river canyons. Three major geologic divisions
24 within the area include a north-northwest trending belt of metamorphic rocks,
25 granitic plutons that have intruded and obliterated some of the metamorphic belt,
26 and deposits of volcanic ash, debris flows, and alluvial fans that are relatively flat
27 lying. These deposits overlie older rocks (Reclamation et al. 2006).

28 Igneous, metamorphic, and sedimentary rock types are present within the Folsom
29 Lake area. Major rock divisions are ultramafic intrusive rocks, metamorphic
30 rocks, granodiorite intrusive rocks, and volcanic mud flows and alluvial deposits.
31 Ultramafic rocks are most common on Flagstaff Mountain (Hill) on the Folsom
32 Reservoir Peninsula located on a peninsula between the North Fork American
33 River and South Fork American River. This rock division may contain trace
34 amounts of serpentine minerals, chromite, minor nickel, talc, and naturally
35 occurring asbestos (Reclamation et al. 2006).

36 Metamorphic rocks are found in a north-northwest trending band primarily on the
37 eastern portions of the Folsom Lake area through most of the peninsula between
38 the North Fork American River and South Fork American River (CGS 2010).

39 The Metamorphic rocks are mainly composed of Copperhill Volcanics
40 (metamorphosed basaltic breccia, pillow lava, and ash) and Ultramafic rocks, two
41 formations that may contain trace amounts of naturally occurring asbestos
42 (Reclamation et al. 2006).

43 Granodiorite intrusive rocks occur in the Rocklin Pluton on both sides of Folsom
44 Lake extending to Lake Natoma, and the Penryn Pluton upstream of the Rocklin

1 Pluton. Granodiorite intrusive rocks are composed of a coarse-grained crystalline
2 matrix with slightly more iron and magnesium-bearing minerals and less quartz
3 than granite. Of the granodiorite, the feldspar and hornblend are less resistant
4 than the quartz crystals and easily weathers. When weathering occurs, the
5 remaining feldspars separate from the quartz resulting in decomposed granite
6 (Reclamation et al. 2006).

7 Volcanic mud flows and alluvial deposits are present downstream of Folsom Lake
8 in the southwest corner of two major formations, the Mehrten and Laguna
9 Formation. The Mehrten Formation contains volcanic conglomerate, sandstone,
10 and siltstone; all derived from andesitic sources and portions are gravels deposited
11 by ancestral streams. The Laguna Formation, deposited predominately as debris
12 flow on the Mehrten Formation, is a sequence of gravel, sand and silt derived
13 from granitic sources (Reclamation et al. 2006).

14 The area along the American River downstream of Folsom Lake and Nimbus
15 Reservoir is located in the Great Valley Geomorphic Province. The area includes
16 several geomorphic land types including dissected uplands and low foothills, low
17 alluvial fans and plains, and river floodplains and channels. The dissected
18 uplands consist of consolidated and unconsolidated continental deposits of
19 Tertiary and Quaternary that have been slightly folded and faulted (Reclamation
20 2005).

21 The alluvial fans and plains consist of unconsolidated continental deposits that
22 extend from the edges of the valleys toward the valley floor (Reclamation 2005).
23 The alluvial plains in the American River watershed include older Quaternary
24 deposits (Sacramento County 2010). River flood plains and channels lay along
25 the American River and smaller streams that flow into the Sacramento River
26 south of the American River. Some floodplains are well-defined, where rivers are
27 incised into their alluvial fans. These deposits tend to be coarse and sandy in the
28 channels and finer and silty in the floodplains (Reclamation 2005; Sacramento
29 County 2010).

30 **11.3.2.1.2 Delta Geological Setting**

31 The Delta is a northwest-trending structural basin, separating the primarily
32 granitic rock of the Sierra Nevada from the primarily Franciscan Formation rock
33 of the California Coast Range (CWDD 1981). The Delta is a basin within the
34 Great Valley Geomorphic Province that is filled with a 3- to 6-mile thick layer of
35 sediment deposited by streams originating in the Sierra Nevada, Coast Ranges,
36 and South Cascade Range. Surficial geologic units throughout the Delta include
37 peat and organic soils, alluvium, levee and channel deposits, dune sand deposits,
38 older alluvium, and bedrock.

39 The historical delta at the confluence of the Sacramento River and San Joaquin
40 River is referred to as the Sacramento–San Joaquin Delta, or Delta. The Delta is a
41 flat-lying river delta that evolved at the inland margin of the San Francisco Bay
42 Estuary as two overlapping and coalescing geomorphic units: the Sacramento
43 River Delta to the north and the San Joaquin River Delta to the south. During
44 large river-flood events, silts and sands were deposited adjacent to the river

1 channel, formed as a tidal marsh with few natural levees, and was dominated by
2 tidal flows, allowing for landward accumulation of sediment behind the bedrock
3 barrier at the Carquinez Strait. The sediment formed marshlands, which consisted
4 of approximately 100 islands that were surrounded by hundreds of miles of
5 channels. Generally, mineral soils formed near the channels during flood
6 conditions and organic soils formed on marsh island interiors as plant residues
7 accumulated faster than they could decompose (Weir 1949).

8 In the past, because the San Joaquin River Delta had less well-defined levees than
9 under current conditions, sediments were deposited more uniformly across the
10 floodplain during high water, creating an extensive tule marsh with many small,
11 branching tributary channels. Because of the differential amounts of inorganic
12 sediment supply, the peat of the San Joaquin River Delta grades northward into
13 peaty mud and mud toward the natural levees and flood basins of the Sacramento
14 River Delta (Atwater et al. 1980).

15 The Delta has experienced several cycles of deposition, nondeposition, and
16 erosion that have resulted in the thick accumulation of poorly consolidated to
17 unconsolidated sediments overlying the Cretaceous and Tertiary formations since
18 late Quaternary time. Shlemon and Begg (1975) calculated that the peat and
19 organic soils in the Delta began to form about 11,000 years ago during an episode
20 of sea level rise. Tule marshes established on peat and organic soils in many
21 portions of the Delta. Additional peat and other organic soils formed from
22 repeated inundation and accumulation of sediment of the tules and other marsh
23 vegetation.

24 **11.3.2.1.3 Suisun Marsh Geological Setting**

25 The Suisun Marsh area is located within the Coast Ranges Geomorphic Province.
26 The Suisun Marsh is bounded by the steep Coast Range on the west and by the
27 rolling Montezuma Hills on the east. The Montezuma Hills consist of uplifted
28 Pleistocene sedimentary layers with active Holocene age alluvium in stream
29 drainages that divide the uplift. Low-lying flat areas of the marshland are covered
30 by Holocene age Bay Mud deposits. The topographically higher central portions
31 of Grizzly Island in the marshlands north of the Suisun Bay are formed by the
32 Potrero Hills. These hills primarily consist of folded and faulted Eocene marine
33 sedimentary rocks and late Pleistocene alluvial fan deposits
34 (Reclamation et al. 2010).

35 **11.3.2.1.4 San Joaquin Valley Geological Setting**

36 The San Joaquin Valley is located within the southern half of the Great Valley
37 Geomorphic Province. The 250-mile-long and 50-to-60-mile-wide valley lies
38 between the Coast Ranges on the west, the Sierra Nevada on the east, and extends
39 northwestward to the Delta near the City of Stockton. The San Joaquin Valley is
40 the southern portion of a large, northwest-to-southeast-trending asymmetric
41 trough filled with up to six vertical miles of Jurassic to Holocene age sediments.
42 The trough is primarily made up of Tertiary and Quaternary continental rocks,
43 and deposits, which become separated by lacustrine, marsh, and floodplain

1 deposits of varying thicknesses. The continental deposits, which include the
2 Mehrten, Kern River, Laguna, San Joaquin, Tulare, Tehama, Turlock, Riverbank,
3 and Modesto formations, form the San Joaquin Valley aquifer (Ferriz 2001,
4 Reclamation et al. 2011, Reclamation 2009).

5 Dissected uplands, low alluvial fans and plains, river floodplains and channels,
6 and overflow lands and lake bottoms are the several geomorphic land types within
7 the San Joaquin Valley. Dissected uplands consist of slightly folded and faulted,
8 consolidated and unconsolidated, Tertiary and Quaternary age continental
9 deposits. The alluvial fans and plains, which cover most of the valley floor,
10 consist of unconsolidated continental deposits that extend from the edges of the
11 valleys toward the valley floor. In general, alluvial sediments of the western and
12 southern parts of the San Joaquin Valley tend to have lower permeability than
13 deposits on the eastern side. River floodplains and channels lie along the major
14 rivers and are well-defined where rivers incise their alluvial fans. Typically, these
15 deposits are coarse and sandy in the channels and finer and silty in the floodplains
16 (Reclamation et al. 2011).

17 Lake bottoms of overflow lands in the San Joaquin Valley include historic beds of
18 Tulare Lake, Buena Vista Lake, and Kern Lake as well as other less defined areas
19 in the valley trough. Near the valley trough, fluvial deposits of the east and west
20 sides grade into fine-grained deposits. The largest lake deposits in the Central
21 Valley are found beneath the Tulare Lake bed where up to 3,600 feet of lacustrine
22 and marsh deposits form the Tulare Formation. This formation is composed of
23 widespread clay layers, the most extensive being the Cocoran Clay member which
24 also is found in the western and southern portions of the San Joaquin Valley. The
25 Cocoran Clay member is a confining layer that separates the upper semi-confined
26 to unconfined aquifer from the lower confined aquifer (Reclamation 1997).

27 The valley floor and foothills portions of the San Joaquin Valley and San Joaquin
28 River area, and the Stanislaus River watershed could be affected by CVP and
29 SWP operations. The Stanislaus River watershed originates in the Sierra Nevada
30 Geomorphic Province, including the area with New Melones Reservoir, and
31 extends into the Great Valley Geomorphic Province. New Melones Reservoir is
32 oriented along a northwest trend that is produced by the Foothill Metamorphic
33 Belt in the Sierra Nevada Geomorphic Province (Reclamation 2010). The area is
34 underlain by Cenozoic sedimentary rocks which dip towards the southwest and
35 overlies the Cretaceous sedimentary rocks of the Great Valley sequence and older
36 metamorphic basement rocks along the edges of the Sierra Nevada. Tertiary
37 sedimentary formations were deposited along the Stanislaus River from an area
38 east of Knights Ferry to Oakdale (CGS 1977). The oldest Tertiary geologic unit,
39 Eocene Ione Formation, primarily consists of quartz, sandstone, and interbedded
40 kaolinitic clays with a maximum thickness of about 200 feet near Knights Ferry.
41 The Oligocene-Miocene Valley Springs Formation of rhyolitic ash, sandy clay,
42 and gravel deposits overlay the Ione Formation. Andestic flows, lahars, and
43 volcanic sediments of the Mehrten Formation were deposited by volcanism,
44 especially from Table Mountain (CGS 1977; Reclamation 2010). Three major
45 alluvial fan deposits occurred along the Stanislaus River after deposition of the

1 Mehrten Formation, including the Turlock Lake Formation (between Orange
2 Blossom Road and Oakdale) composed of fine sand and silt with some clay, sand,
3 and gravel; Riverbank Formation (between Oakdale and Riverbank) composed of
4 silt and clay; and Modesto Formation (between Riverbank and the confluence
5 with the San Joaquin River) composed of sand, silt, clay, and gravel.

6 **11.3.2.2 Regional Seismicity**

7 Most of the areas in the Central Valley Region have been categorized as regions
8 that are distant from known, active faults and generally would experience
9 infrequent, low levels of shaking. However, infrequent earthquakes with stronger
10 shaking could occur (CGS 2008). Areas within and adjacent to the Delta Region
11 and along Interstate 5 in the San Joaquin Valley have a higher potential for
12 stronger ground shaking due to their close proximity to the San Andreas Fault
13 Zone.

14 The San Andreas Fault Zone is located to the west of the Central Valley Region
15 along a 150-mile northwest-trending fault zone (Reclamation 2013a). The fault
16 zone extends from the Gulf of California to Point Reyes where the fault extends
17 under the Pacific Ocean (CGS 2006). The fault zone is the largest active fault in
18 California (Reclamation 2005d).

19 In the Sacramento Valley, the major fault zones include the Battle Creek Fault
20 Zone located to the east of the Sacramento River, Corning Fault that extends from
21 Red Bluff to Artois parallel to the Corning Canal, Dunnigan Hills Fault located
22 west of Interstate 5 near Dunnigan, Cleveland Fault located near Oroville, and
23 Great Valley Fault system along the west side of the Sacramento Valley
24 (Reclamation 2005a, Reclamation 2013a).

25 The Delta and Suisun Marsh are located in proximity to several major fault
26 systems, including the San Andreas, Hayward-Rodgers Creek, Calaveras,
27 Concord-Green Valley, and Greenville faults (DWR et al. 2013a). There are also
28 many named and unnamed regional faults in the vicinity. The majority of seismic
29 sources underlying the Delta and Suisun Marsh are “blind” thrusts that are not
30 expected to rupture to the ground surface during an earthquake. The known blind
31 thrusts in the Delta and Suisun Marsh area include the Midland, Montezuma Hills,
32 Thornton Arch, Western Tracy, Midland, and Vernalis faults. Blind thrust faults
33 with discernible geomorphic expression/trace located at the surface occur near the
34 southwestern boundary of the Delta include Black Butte and Midway faults. Two
35 surface crustal fault zones (e.g., areas with localized deformation of geologic
36 features near the surface) are located within the Suisun Marsh, including the
37 Pittsburgh-Kirby Hills fault which occurs along an alignment between Fairfield
38 and Pittsburg, and Concord-Green Valley fault which crosses the western portion
39 of the Suisun Marsh. The Cordelia fault is a surface crustal fault zone that occurs
40 near the western boundary of the Suisun Marsh. Since 1800, no earthquakes with
41 a magnitude greater than 5.0 have been recorded in the Delta or Suisun Marsh.

42 In the San Joaquin Valley, the eastern foothills are characterized by strike-slip
43 faults that occur because the rock underlying the valley sediment is slowly
44 moving downward relative to the Sierra Nevada Block to the east. An example of

1 this type of faulting is the Kings Canyon lineament which crosses the valley north
 2 of Chowchilla and continues nearly to Death Valley in southeastern California
 3 (Reclamation et al. 2011). Uplift and tilting of the Sierra Nevada block towards
 4 the west and tilting of the Coast Ranges block to the east appear to be causing
 5 gradual downward movement of the valley basement rock, in addition to
 6 subsidence caused by aquifer compaction and soil compaction discussed below.
 7 The San Joaquin Valley is bounded by the Stockton Fault of the Stockton Arch on
 8 the north and the Bakersfield Arch on the south. Most of the fault zones in the
 9 San Joaquin Valley do not appear to be active. However, numerous faults may
 10 not be known until future seismic events, such as the Nunez reverse fault which
 11 was not known until the 1983 Coalinga earthquake. In areas adjacent to the San
 12 Joaquin Valley, the dominant active fault structure is the Great Valley blind thrust
 13 associated with San Andreas Fault. Other active faults occur along the western
 14 boundary of the San Joaquin Valley, including the Hayward, Concord-Green
 15 Valley, Coast Ranges-Sierra Block boundary thrusts, Mount Diablo, Greenville,
 16 Ortigalita, Rinconada, and Hosgri faults (Reclamation 2005d).

17 **11.3.2.3 Regional Volcanic Potential**

18 Active centers of volcanic activity occur in the vicinity of Mount Shasta and
 19 Lassen Peak in the Central Valley Region. Mount Shasta is located about 45
 20 miles north of Shasta Lake. Over the past 10,000 years, Mount Shasta erupted
 21 about once every 800 years. During the past 4,500 years, Mount Shasta erupted
 22 about once every 600 years with the last eruption in 1786. Lava flows, domes,
 23 and mudflows occurred during the eruptions (Reclamation 2013a).

24 Lassen Peak, located about 50 miles southeast of Shasta Lake, is a cluster of
 25 dacitic domes and vents that have formed during eruptions over the past
 26 250,000 years. The last eruptions were relatively small and occurred between
 27 1914 and 1917. The most recent large eruption occurred about 1,100 years ago.
 28 Large eruptions appear to occur about once every 10,000 years (USGS 2000a).

29 **11.3.2.4 Soil Characteristics**

30 The Central Valley Region includes the Sacramento Valley, Delta, Suisun Marsh,
 31 and San Joaquin Valley. The soil characteristics are similar in many aspects in
 32 the Sacramento and San Joaquin valleys; therefore, the descriptions are combined
 33 in the following sections.

34 **11.3.2.4.1 Sacramento Valley and San Joaquin Valley Soil Characteristics**

35 The Sacramento Valley and San Joaquin Valley contain terrace land and upland
 36 soils along the foothills; and alluvial, Aeolian, clayey, and saline/alkaline soils in
 37 various locations along the valley floors (CALFED 2000, Reclamation 1997).

38 Foothills soils, located on well-drained, hilly-to-mountainous terrain along the
 39 east side of the Central Valley, form through in-place weathering of the
 40 underlying rock. Soils in the northern Sacramento Valley near Shasta Lake are
 41 different than soils along other foothills in the Sacramento and San Joaquin
 42 valleys. The soils near Shasta Lake are related to the geologic formations of the
 43 Klamath Mountains, Cascade Ranges, and Sierra Nevada geomorphic provinces.

1 These soils are formed from weathered metavolcanic and metasedimentary rocks
2 and from intrusions of granitic rocks, serpentine, and basalt. These soils are
3 generally shallow with numerous areas of gravels, cobbles, and stones; therefore,
4 they do not have high water-holding capacity or support topsoil productivity for
5 vegetation (Reclamation 2013a). Soils derived from in-place weathering of
6 granitic rock, referred to as decomposed granite, are coarse-grained, quartz-rich
7 and erodible.

8 Upland soils along other foothills in the Sacramento and San Joaquin valleys are
9 formed from the Sierra Nevada and Coast ranges geomorphic provinces. Along
10 the western boundary of the Central Valley, the soils primarily are formed from
11 sedimentary rocks. Along the eastern boundary of the Central Valley, the soils
12 primarily are formed from igneous and metamorphic rock. The soils include
13 serpentine soils (which include magnesium, nickel, cobalt, chromium, iron, and
14 asbestos); sedimentary sandstones; shales; conglomerates; and sandy loam, loam,
15 and clay loam soils above bedrock (Reclamation 1997, Reclamation et al. 2011,
16 Reclamation 2013a, DWR 2007). Erosion occurs in the upland soils around
17 reservoirs and rivers especially downgradient of urban development where paving
18 increases the peak flow, volume, and velocity of precipitation runoff (GCI 2003).

19 Along the western boundary of the Sacramento Valley and the southeastern
20 boundary of the San Joaquin Valley, the terrace lands include brownish loam, silt
21 loam, and/or clayey loam soils. The soils are generally loamy along the
22 Sacramento Valley terraces, and more clayey along the San Joaquin Valley
23 terraces. Along the eastern boundaries of Sacramento and San Joaquin valleys,
24 the terraces are primarily red silica-iron cemented hardpan and clays, sometimes
25 with calcium carbonate (also known as “lime”) (DWR 2007, Reclamation 1997,
26 Reclamation 2005b, Reclamation 2012).

27 Surface soils of the Central Valley include alluvial and Aeolian soils. The alluvial
28 soils include calcic brown and noncalcic brown alluvial soils on deep alluvial fans
29 and floodplains. The calcic brown soil is primarily made of calcium carbonate
30 and alkaline (also known as “calcerous” soils). The noncalcic brown soils do not
31 contain calcium carbonate and are either slightly acidic or neutral in chemical
32 properties. In the western San Joaquin Valley, light colored calcerous soils occur
33 with less organic matter than the brown soils (Reclamation 1997).

34 Basin soils occur in the San Joaquin Valley and portions of the Delta. These soils
35 include organic soils, imperfectly drained soils, and saline alkali soils. The
36 organic soils are typically dark, acidic, high in organic matter, and generally
37 include peat. The organic soils occur in the Delta, as discussed below, and along
38 the lower San Joaquin River adjacent to the Delta. The poorly drained soils
39 contain dark clays and occur in areas with high groundwater in the San Joaquin
40 Valley trough and as lake bed deposits (Reclamation et al. 2011). One of the
41 most substantial stratigraphic features of the San Joaquin Valley and a major
42 aquitard is the Corcoran Clay, located in the western and central valley
43 (Galloway et al. 1999). The western boundary of the Corcoran Clay is generally
44 located along the Delta-Mendota Canal and California Aqueduct (as described in
45 Chapter 5, Surface Water Resources and Water Supply). The Corcoran Clay

1 generally extends from Mendota Pool area through the center of the valley to the
 2 Tehachapi Mountains. The depth to the Corcoran Clay varies from 160 feet under
 3 the Tulare Lake bed to less than a foot near the western edge of the Central
 4 Valley. The Corcoran Clay comprised of numerous aquitards and coarser
 5 interbeds.

6 Selenium salts and other salts occur naturally in the western and central San
 7 Joaquin Valley soils that are derived from marine sedimentary rocks of the Coast
 8 Ranges. Salts are leached from the soils by applied pre-irrigation and irrigation
 9 water and collected by a series of drains. The drains also reduce high
 10 groundwater elevations in areas with shallow clay soils. Reclamation and other
 11 agencies are implementing programs to reduce salinity issues in the San Joaquin
 12 Valley that will convey and dispose of drainage water in a manner that would
 13 protect the surface water and groundwater resources (Reclamation et al. 2011).
 14 As described in Chapter 12, Agricultural Resources, many portions of the western
 15 and central San Joaquin Valley are no longer supporting irrigated crops or are
 16 experiencing low crop yields due to the saline soils.

17 Soils in the eastern San Joaquin Valley come from the Sierra Nevada and contain
 18 low levels of salt and selenium. Most soils in the western and southern San
 19 Joaquin Valley are formed from Coast Range marine sediments, and contain
 20 higher concentrations of salts as well as selenium and molybdenum. Soluble
 21 selenium moves from soils into drainage water and groundwater, especially
 22 during agricultural operations to leach salts from the soils. As described in
 23 Chapter 3, Description of Alternatives, Reclamation and other agencies are
 24 implementing programs to reduce the discharge of selenium from the San Joaquin
 25 Valley into receiving waters (Reclamation 2005d, Reclamation et al. 2011,
 26 Reclamation 2009). Additional information related to concerns with salinity and
 27 selenium in the San Joaquin Valley is presented in Chapter 6, Surface Water
 28 Quality, and Chapter 12, Agricultural Resources.

29 Soil wind erosion is related to soil erodibility, wind speeds, soil moisture, surface
 30 roughness, and vegetative cover. Aeolian soils are more susceptible to wind
 31 erosion than alluvial soils. Non-irrigated soils that have been disturbed by
 32 cultivation or other activities throughout the Central Valley are more susceptible
 33 to wind erosion and subsequent blowing dust than soils with more soil moisture.
 34 Dust from eroding soils can create hazards due to soil composition (such as
 35 naturally-occurring asbestos), allergic reactions to dust, adverse impacts to plants
 36 due to dust, and increased risk of valley fever (as discussed in Chapter 18, Public
 37 Health) (Reclamation 2005d).

38 **11.3.2.4.2 Delta Soil Characteristics**

39 Soils in the Delta include organic and/or highly organic mineral soils; deltaic soils
 40 along the Sacramento and San Joaquin rivers; basin rim soils; floodplain and
 41 stream terrace soils; valley alluvial and low terrace soils; and upland and high
 42 terrace soils (Reclamation 1997). Basin, deltaic, and organic soils occupy the
 43 lowest elevation ranges and are often protected by levees. In many areas of the

1 western Delta, the soils contain substantial organic matter and are classified as
2 peat or muck.

3 Basin rim soils are found along the eastern edges (rims) of the Delta, and are
4 generally moderately deep or deep mineral soils that are poorly drained to well-
5 drained and have fine textures in surface horizons. Some areas contain soils with
6 a hardpan layer in the subsurface (SCS 1992, 1993). Floodplain and stream
7 terrace soils are mineral soils adjacent to the Sacramento and San Joaquin rivers
8 and other major tributaries. These soils are typically deep and stratified, with
9 relatively poor drainage and fine textures. Valley fill, alluvial fan, and low terrace
10 soils are typically very deep with variable texture and ability to transmit water
11 ranging from somewhat poorly drained fine sandy loams and silty clay loams to
12 well-drained silt loams and silty clay loams. Upland and high terrace soils are
13 generally well-drained ranging in texture from loams to clays and are primarily
14 formed in material weathered from sandstone, shale, and siltstone, and can occur
15 on dissected terraces or on mountainous uplands.

16 Soils within the Yolo Bypass area range from clays to silty clay loams and
17 alluvial soils (CALFED 2001, DFG et al. 2008). The higher clay content soils
18 occur in the western portion of the basin north of Interstate 80 and in the eastern
19 portion of the basin south of Interstate 80. The silty clay loams and alluvial soils
20 occur in the western portion of the basin south of Interstate 80, including soils
21 within the Yolo Bypass Wildlife Area.

22 Soil erosion by rainfall or flowing water occurs when raindrops detach soil
23 particles or when flowing water erodes and transports soil material. Sandy
24 alluvial soils, silty lacustrine soil, and highly organic soil are erodible. Organic
25 soil (peat) in the Delta is also susceptible to wind erosion (deflation). Clay soils
26 are erosion resistant.

27 **11.3.2.4.3 Suisun Marsh Soil Characteristics**

28 Soil within the Suisun Bay include the Joice muck, Suisun peaty muck, and
29 Tamba mucky clay; Reyes silty clay; and Valdez loam (SCS 1977a, Reclamation
30 et al. 2010). The Joice muck generally is poorly drained organic soils in saline
31 water areas interspersed with fine-grain sediment. Suisun peaty muck is formed
32 from dark colored organic soils and plant materials with high permeability. These
33 soils are generally located in areas with shallow surface water and groundwater;
34 therefore, surface water tends to accumulate on the surface. Tamba mucky clay
35 also are poorly drained organic soils formed from alluvial soils and plant
36 materials that overlays mucky clays. Reyes silty clays are poorly drained soils
37 formed from alluvium. The upper layers of the silty clays are acidic and saline.
38 The lower layers are alkaline that become acidic when exposed to air, especially
39 under wetting-drying conditions in tidal areas. Valdez loam soils are poorly
40 drained soils formed on alluvial fans.

41 Suisun Marsh soils have a low susceptibility to water and wind erosion
42 (SCS 1977a, Reclamation et al. 2010).

1 **11.3.2.5 Subsidence**

2 Land subsidence occurs for different reasons throughout the Central Valley as
3 described in the following sections.

4 **11.3.2.5.1 Sacramento and San Joaquin Valley Subsidence**

5 Land subsidence in the Sacramento Valley primarily occurs due to aquifer-system
6 compaction as groundwater elevations decline; weathering of underlying of some-
7 types of bedrock, such as limestone; decomposition of organic matter; and natural
8 compaction of soils (Reclamation 2013a). Historic subsidence of the Sacramento
9 Valley has been far less than that observed in the San Joaquin Valley. For
10 example, the range of recent historic subsidence in the Sacramento Valley is
11 generally less than 10 feet. Historical subsidence in the San Joaquin Valley has
12 caused changes in land elevations of more than 30 feet.

13 In the 1970s, land subsidence exceeded 1 foot near Zamora; however, additional
14 subsidence has not been reported since 1973 (Reclamation 2013a). Subsidence
15 has been reported of two feet near Davis and three to four feet over the last
16 several decades in the areas north of Woodland and east of Davis and Woodland
17 (Davis 2007).

18 San Joaquin Valley subsidence primarily occurs when groundwater elevations
19 decline which reduces water pressure in the soils and results in compressed clay
20 lenses and subsided land elevations. Other factors that may influence the rate of
21 subsidence in the San Joaquin Valley is the Sierran uplift, sediment loading and
22 compressional down-warping or thrust loading from the Coast Ranges, and near
23 surface compaction (Reclamation et al. 2011). Some of the first reports of land
24 subsidence in the San Joaquin Valley occurred in 1935 in the area near Delano
25 (Galloway et al. 1999). By the late 1960s, San Joaquin Valley subsidence had
26 occurred over 5,212 square miles, or almost 50 percent of the San Joaquin Valley
27 (Reclamation 2005d). During that period, some areas subsided over 33 vertical
28 feet since the late 1880s. The rate of subsidence reduced initially following
29 implementation of CVP and SWP water supplies in the San Joaquin Valley during
30 the 1970s and 1980s. The rate of subsidence for the next twenty years appeared
31 to continue at a rate of 0.008 to 0.016 inches/year in recent years (Reclamation et
32 al. 2011). However, the amount of water available for irrigation from the CVP
33 and SWP has declined more than 20 to 30 percent since the early 1980s due to
34 hydrologic, regulatory, and operational concerns, as described in Chapter 1,
35 Introduction. Due to the reduction in the availability of CVP and SWP water
36 supplies, many water users have increased groundwater withdrawal. A recent
37 study by the USGS of subsidence along the CVP Delta-Mendota Canal
38 (USGS 2013b) reported that in areas where groundwater levels fluctuated
39 consistently on a seasonal basis but were stable on a long-term basis, the land
40 elevations also were relatively stable. Subsidence occurred in portions of the
41 San Joaquin Valley where groundwater elevations below the Corcoran clay and in
42 the shallow groundwater declined on a long-term basis between 2003 and 2010.
43 The highest subsidence rates occurred along the Delta Mendota Canal between
44 Merced and Mendota with subsidence of 0.8 inches to 21 inches between 2003
45 and 2010.

1 Shallow subsidence, or hydrocompaction, occurs when low density, relatively
2 dry, fine-grained sediments soften and collapse upon wetting. Historically,
3 hydrocompaction has been most common along the western margin of the San
4 Joaquin Valley (Reclamation 2005c). In the southern San Joaquin Valley,
5 extraction of oil also can result in compaction. Changes in elevation, both
6 subsidence and uplift, occurred near Coalinga following the 1983 Coalinga
7 earthquake with uplift up to 1.6 feet and subsidence of 2 inches.

8 **11.3.2.5.2 Delta and Suisun Marsh Subsidence**

9 Land subsidence on the islands in the central and western Delta and Suisun Marsh
10 may be caused by the elimination of tidal inundation that formed the islands
11 through sediment deposition and transport, and the oxidation and decay of plant
12 materials that would compact to form soils. Following construction of levees,
13 subsidence initially occurred through the mechanical settling of peat as the soil
14 dried; and then, the dried peat and other soils shrunk (Reclamation et al. 2013,
15 Drexler et al. 2009). Agricultural burning of peat (which has been discontinued),
16 wind erosion, oxidation, and leaching of organic material. The rate of subsidence
17 has declined from a maximum of 1.1 to 4.6 inches/year in the 1950s to less than
18 0.2 to 1.2 inches/year in the western Delta (Drexler et al. 2009, Rojstaczer et al.
19 1991). Many of the islands in the western and central Delta have subsided to
20 elevations that are 10 to nearly 55 feet below sea level (USGS 2000b, Deverel and
21 Leighton 2010).

22 Recently, the California Department of Water Resources has implemented several
23 projects to reverse subsidence. The 274-acre Mayberry Farms Duck Club
24 Subsidence Reversal Project on Sherman Island includes creation of emergent
25 wetlands ponds and channels through excavation of peat soils, improving of water
26 movement, and waterfowl habitat. The facility was constructed in 2010 and is
27 being monitored to determine the effectiveness of subsidence reversal, methyl
28 mercury management, and carbon sequestration (DWR 2013). The Department of
29 Water Resources and USGS implemented wetlands restoration for about 15 acres
30 on Twitchell Island in 1997 (DWR et al. 2013b) to encourage tule and cattail
31 growth. After the growing season, the decomposed plant material accumulates
32 and increases the land elevation. Since 1997, elevations have increased at a rate
33 of 1.3 to 2.2 inches/year.

34 **11.3.3 San Francisco Bay Area Region**

35 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,
36 Santa Clara, San Benito, and Napa counties that are within the CVP and SWP
37 service areas. Portions of Napa County are within the SWP service area that use
38 water diverted from Barker Slough in the Sacramento River watershed for
39 portions of Solano and Napa counties. Solano County was discussed under the
40 Delta area of the Central Valley Region. Napa County is described under the
41 San Francisco Bay Area Region.

1 **11.3.3.1 Geologic Setting**

2 The San Francisco Bay Area Region primarily is located within the Coast Ranges
3 Geomorphic Province. Eastern Contra Costa and Alameda counties are located in
4 the Great Valley Geomorphic Province. The Coast Ranges and Great Valley
5 geomorphic provinces were described in Section 11.3.2, Central Valley Region.
6 San Francisco Bay is a structural trough formed as a gap in the Coast Range
7 down-dropped to allow the Sacramento, San Joaquin, Napa, Guadalupe, and
8 Coyote Rivers to flow into the Pacific Ocean. When the polar ice caps melted
9 10,000 to 25,000 years ago the ocean filled the inland valleys of the trough and
10 formed San Francisco Bay, San Pablo Bay, and Suisun Bay (CALFED 2000).
11 Initially, alluvial sands, silts, and clays filled the bays to form Bay Mud along the
12 shoreline areas. Sedimentation patterns have changed over the past 150 years due
13 to development of upstream areas of the watersheds which changed sedimentation
14 and hydraulic flow patterns, hydraulic mining, and formation of levees and dams.

15 The San Francisco Bay Area is formed from the Salinian block located west of the
16 San Andreas Fault; Mesozoic Franciscan complex located between the San
17 Andreas and Hayward faults; and the Great Valley sequence located to the east of
18 Hayward Fault (WTA 2003). The Salinian block generally is composed of
19 granitic plutonic rocks probably from the Sierra Nevada Batholith that was
20 displaced due to movement along the San Andreas Fault. The Franciscan
21 complex includes deep marine sandstone and shale formed from oceanic crust
22 with chert and limestone. The Great Valley sequence primarily includes marine
23 sedimentary rocks.

24 **11.3.3.2 Regional Seismicity**

25 Large earthquakes have occurred in the San Francisco Bay Area Region along the
26 San Andreas, Hayward, Calaveras, Greenville, Antioch, Concord-Green Valley,
27 Midway, Midland, and Black Butte fault zones over the past 10,000 years. The
28 San Francisco earthquake of 1906 took place as the result of movement along the
29 San Andreas Fault. The San Andreas Fault remains active, as does the Hayward
30 Fault, based on evidence of slippage along both (CALFED 2000).

31 **11.3.3.3 Soil Characteristics**

32 The San Francisco Bay Area Region soils include basin floor/basin rim,
33 floodplain/valley land, terrace, foothill, and mountain soils (CALFED 2000).
34 Basin floor/basin rim soils are organic-rich saline soils and poorly drained clays,
35 clay loams, silty clay loams, and muck along the San Francisco Bay shoreline
36 (SCS 1977b, 1981a; CALFED 2000). Well-drained sands and loamy sands and
37 poorly-drained silty loams, clay loams, and clays occur on gently sloping alluvial
38 fans of the San Francisco Bay Area Region that surround the floodplain and
39 valley lands. Drained loams, silty loams, silty clay loams, and clay loams
40 interbedded with sedimentary rock and some igneous rock occur in the foothills.
41 Terrace loams are located along the southeastern edge of the San Francisco Bay
42 Area Region above the valley land.

1 **11.3.3.4 Subsidence**

2 Subsidence in the San Francisco Bay Area Region primarily occurs in the Santa
3 Clara Valley of Santa Clara County. The Santa Clara Valley is characterized by a
4 groundwater aquifer with layers of non-consolidated porous soils interspersed
5 with clay lenses. Historically, when the groundwater aquifer was in overdraft, the
6 water pressure in the soils declined which resulted in compressed clay lenses and
7 subsided land elevations. Between 1940 and 1970, soils near San Francisco Bay
8 declined to elevations below sea level (SCVWD 2000). Under these conditions,
9 salt water intrusion and tidal flooding occurred in the tributary streams of
10 Guadalupe River and Coyote Creek. As of 2000, the land elevation in downtown
11 San Jose subsided 13 feet since 1915. In 1951, water deliveries from San
12 Francisco Water Department were initiated (Ingebritsen et al. 1999). In 1965,
13 SWP deliveries were initiated in Santa Clara County. CVP water deliveries were
14 initiated in 1987. The CVP and SWP water supplies are used to reduce
15 groundwater withdrawals when groundwater elevations are low to allow natural
16 recharge from local surface waters. The CVP and SWP also are used to directly
17 recharge the groundwater through spreading basins in Santa Clara Valley.

18 **11.3.3.5 Central Coast and Southern California Regions**

19 The Central Coast Region includes portions of San Luis Obispo and Santa
20 Barbara counties served by the SWP. The Southern California Region includes
21 portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San
22 Bernardino counties served by the SWP.

23 As described in Chapter 4, Approach to Environmental Analysis, the Southern
24 California Region includes areas affected by operations of the SWP, including the
25 Coachella Valley in Riverside County. The Coachella Valley Water District
26 receives water under a SWP entitlement contract; however, SWP water cannot be
27 conveyed directly to the Coachella Valley due to lack of conveyance facilities.
28 Therefore, Coachella Valley Water District receives water from the Colorado
29 River through an exchange agreement with the Metropolitan Water District of
30 Southern California, as described in Chapter 5, Surface Water Resources and
31 Water Supplies. The Imperial Valley, located to the southeast of the Southern
32 California Region, receives irrigation water from the Colorado River through
33 Reclamation canals; and does not use CVP or SWP water.

34 **11.3.3.6 Geologic Setting**

35 The Central Coast and Southern California Regions are located in the Coast
36 Ranges, Transverse Ranges, Peninsular Ranges, Colorado Desert, and Mojave
37 Desert geomorphic provinces (CGS 2002a).

38 The Central Coast Region includes portions of San Luis Obispo and Santa
39 Barbara counties that use SWP water supplies. These areas are located within the
40 Coast Ranges and Transverse Ranges geomorphic provinces. The Coast Ranges
41 Geomorphic Province was described in Section 11.3.2, Central Valley Region.
42 The Transverse Ranges Geomorphic Province consists of deeply folded and
43 faulted sedimentary rocks (CGS 2002a, SBCAG 2013). Bedrock along the stream
44 channels, coastal terraces, and coastal lowlands is overlain by alluvial and terrace

1 deposits; and, in some area, ancient sand dunes. The geomorphic province is
2 being uplifted at the southern border along San Andreas Fault and compressed at
3 the northern border along the Coast Ranges Geomorphic Province. Therefore, the
4 geologic structure of the ridges and valleys are oriented along an east-west
5 orientation, or in a “transverse” orientation, as compared to the north-south
6 orientation of the Coast Range.

7 The Southern California Region includes portions of Ventura, Los Angeles,
8 Orange, San Diego, Riverside, and San Bernardino counties that use SWP water
9 supplies. These areas are located within the Transverse Ranges, Peninsular
10 Ranges, Mojave Desert, and Colorado Desert geomorphic provinces. The
11 Transverse Ranges Geomorphic Province includes Ventura County and portions
12 of Los Angeles, San Bernardino, and Riverside counties. The Colorado Desert
13 Geomorphic Province is also known as the Salton Trough where the Pacific and
14 North American plants are separating.

15 The Peninsular Ranges Geomorphic Province is composed of granitic rock with
16 metamorphic rocks (CGS 2002a, SCAG 2011, San Diego County 2011). The
17 geologic structure is similar to the geology of the Sierra Nevada Geomorphic
18 Province. The faulting of this geomorphic province has resulted in northwest
19 trending valleys and ridges that extend into the Pacific Ocean to form the Santa
20 Catalina, Santa Barbara, San Clemente, and San Nicolas islands. The Peninsular
21 Ranges Geomorphic Province includes Orange County and portions of southern
22 Los Angeles County, western San Diego County, northwestern San Bernardino
23 County, and northern Riverside County (including the northern portion of the
24 Coachella Valley).

25 The Mojave Desert Geomorphic Province is located between the Garlock Fault
26 along the southern boundary of the Sierra Nevada Geomorphic Province and the
27 San Andreas Fault (CGS 2002a, SCAG 2011, RCIP 2000). This geomorphic
28 province includes extensive alluvial basins with non-marine sediments from the
29 surrounding mountains and foothills; and many isolated ephemeral lakebeds (also
30 known as “playas”) occur within this region with tributary streams from isolated
31 mountain ranges. The Mojave Desert Geomorphic Province includes portions of
32 Kern, Los Angeles, Riverside, and San Bernardino counties.

33 The Colorado Desert Geomorphic Province, or Salton Trough, is characterized by
34 a geographically-depressed desert that extends northward from the Gulf of
35 California (located at the mouth of the Colorado River) towards the Mojave
36 Desert Geomorphic Province where the Pacific and North American plants are
37 separating (CGS 2002a, SCAG 2011, RCIP 2000, San Diego County 2011).
38 Large portions of this geomorphic province were formed by the inundation of the
39 ancient Lake Cahuilla and are filled with sediments several miles thick from the
40 historic Colorado River overflows and erosion of the Peninsular Ranges uplands.
41 The Salton Trough is separated from the Gulf of California by a large ridge of
42 sediment. The Salton Sea occurs within the trough along an ancient playa. The
43 Colorado Desert Geomorphic Province includes portions of Riverside County in
44 the Coachella Valley; and portions of San Diego and Imperial counties that are
45 located outside of the study area.

1 **11.3.3.7 Regional Seismicity**

2 Most of the areas in the Central Coast and Southern California regions are
3 characterized by active faults that are capable of producing major earthquakes
4 with substantial ground displacement. The San Andreas Fault Zone extends from
5 the Gulf of California and extends in a northwest direction throughout the Central
6 Coast and Southern California regions (CGS 2006).

7 Within portions of San Luis Obispo County that use SWP water supplies, the
8 Nacimiento Fault also can result in major seismic events (CGS 2006, San Luis
9 Obispo County 2010a).

10 The northern portions of Santa Barbara County that use SWP water supplies
11 include Lion’s Head Fault along the Pacific Ocean shoreline to the southwest of
12 Santa Maria and along the northern boundary of Vandenberg Air Force Base
13 (CGS 2006, SBCAG 2013). The Big Pine Fault may extend into the Vandenberg
14 Air Force Base area. Areas near the mouth of the Santa Ynez River and Point
15 Arguello could be affected by Lompoc Terrace Fault and Santa Ynez-Pacifico
16 Fault Zone. The Santa Ynez Fault extends across this county and could affect
17 communities near Santa Ynez. Along the southern coast of Santa Barbara County
18 from Goleta to Carpinteria, the area includes many active faults, including More
19 Ranch, Mission Ridge, Arroyo Parida, and Red Mountain faults; and potentially
20 active faults, including Goleta, Mesa-Rincon, and Carpinteria faults.

21 Portions of Ventura County that use SWP water supplies are located in the
22 southern portion of the county adjacent to Los Angeles County. Major faults in
23 this area include the Oak Ridge Fault that extends into the Oxnard Plain along the
24 south side of the Santa Clara River Valley and may extend into San Fernando
25 Valley in Los Angeles County; Bailey Fault that extends from the Pacific Ocean
26 to the Camarillo Fault; Simi-Santa Rosa, Camarillo, and Springville faults in Simi
27 and Tierra Rejada valleys and near Camarillo; Sycamore Canyon and Boney
28 Mountain faults that extend from the Pacific Ocean towards Thousand Oaks
29 (CGS 2006, Ventura County 2011).

30 Los Angeles County major fault zones include Northridge Hills, San Gabriel,
31 San Fernando, Verduga, Sierra Madre, Raymond, Hollywood, Santa Monica, and
32 Malibu Coast fault zones; Elysian Park Fold and Thrust Belt in Los Angeles
33 County; and Newport, Inglewood, Whittier, and Palos Verdes fault zones that
34 extend into Los Angeles and Orange counties (CGS 2006, Los Angeles 2005).
35 Recent major seismic events that have occurred in Southern California along
36 faults in Los Angeles include the 1971 San Fernando, 1987 Whittier Narrows,
37 1991 Sierra Madre, and 1994 Northridge earthquakes.

38 Riverside and San Bernardino counties are characterized by the San Andreas
39 Fault Zone that extends from the eastern boundaries of these counties and crosses
40 to the western side of San Bernardino County (CGS 2006, RCIP 2000, Riverside
41 County 2000, SCAG 2011, DWR 2009). The San Jacinto Fault Zone also extends
42 through the center of Riverside County and along the western side of San
43 Bernardino County. The Elsinore Fault Zone extends along the western sides of
44 both counties. In San Bernardino County, the Cucamonga Fault extends into

1 Los Angeles County where it intersects with the Sierra Madre and Raymond
 2 faults. The Garlock and Lockhart fault zones extend into both San Bernardino
 3 and Kern counties. San Bernardino County also includes several other major fault
 4 zones, including North Frontal, and Helendale faults.

5 Portions of San Diego County that use SWP water supplies include the Rose
 6 Canyon Fault Zone located along the Pacific Ocean shoreline and extends into the
 7 City of San Diego (San Diego County 2011).

8 **11.3.3.8 Soil Characteristics**

9 In the Central Coast Region, areas within San Luis Obispo and Santa Barbara
 10 counties that use SWP water supplies are located within coastal valleys or along
 11 the Pacific Ocean shoreline. In San Luis Obispo County, Morro Bay, Pismo
 12 Beach, and Oceano areas are located along the coast with soils that range from
 13 sands and loamy sands in areas near the shoreline to shaly loams, clay loams, and
 14 clays in the terraces and foothills located along the eastern boundaries of these
 15 communities (SBCAG 2010b, NRCS 2014a, NRCS 2014b). In Santa Barbara
 16 County, the Santa Maria, Vandenberg Air Force Base, Santa Ynez, Goleta, Santa
 17 Barbara, and Carpinteria areas are located in alluvial plains, along stream
 18 channels with alluvium deposits, along the shoreline, or along marine terrace
 19 deposits above the Pacific Ocean. The soils range from sands, sandy loams,
 20 loams, shaly loams, and clay loams in the alluvial soils and along the shoreline.
 21 The terrace deposits include silty clays, clay loams, and clays (NRCS 2014c,
 22 NRCS 2014d, NRCS 2014e, SCS 1972, SCS 1981b).

23 Southern California Region soils include gravelly loams and gravelly sands,
 24 sands, sandy loams and loamy sands, and silty loams along the Pacific Coast
 25 shorelines and on alluvial plains. The mountains and foothills of the region
 26 include silty loams, cobbly silty loam, gravelly loam, sandy clay loams, clay
 27 loams, silty clays, and clays (SCAG 2011, UCCE 2014, SCS 1978, SCS 1986,
 28 SCS 1973). The inland region in Riverside and San Bernardino counties include
 29 sand to silty clays to cobbles and boulders on the alluvial fans, valley floor,
 30 terraces, and mountains, and dry lake beds (CVWD 2011).

31 **11.3.3.9 Subsidence**

32 Subsidence in the Central Coast and Southern California regions occur due to soil
 33 compaction following groundwater withdrawals at rates greater than groundwater
 34 recharge rates, oil and gas withdrawal, seismic activity, and hydroconsolidation of
 35 soils along alluvial fans (Los Angeles 2005). The USGS described areas with
 36 subsidence related to groundwater overdraft in the Central Coast and Southern
 37 California regions in San Luis Obispo, Santa Barbara, Los Angeles, Riverside,
 38 and Santa Bernardino counties (USGS 1999, Ventura County 2011, Los Angeles
 39 2005, RCIP 2000). Many of the areas with subsidence have alluvial
 40 unconsolidated sands and silty sands with lenses of silt and clayey silt.

41 A recent study by the USGS in the southern Coachella Valley portion of
 42 Riverside described land subsidence of about 0.5 feet between 1930 and 1996
 43 (USGS 2013c). Groundwater elevations in this area had declined since the early

1 1920s until 1949 when water from the Colorado River was provided to the area.
2 This area is served by Coachella Valley Water District; and as described in
3 Chapter 5, Surface Water Resources and Water Supply, the availability of surface
4 water has not always been available to this area in recent years. The recent USGS
5 study indicated that land subsidence of up to approximately 0.4 feet have occurred
6 at some locations between 1996 and 2005; and possibly greater subsidence at
7 other locations. A Coachella Valley Water District study indicated that up to
8 13 inches have occurred in parts of the valley between 1996 and 2005
9 (CVWD 2011).

10 **11.4 Impact Analysis**

11 This section describes the potential mechanisms and analytical methods for
12 change in soils resources, results of the impact analysis, potential mitigation
13 measures, and cumulative effects.

14 **11.4.1 Potential Mechanisms for Change in Soils Resources**

15 As described in Chapter 4, Approach to Environmental Analysis, the impact
16 analysis considers changes in soils resources conditions related to changes in CVP
17 and SWP operations under the alternatives as compared to the No Action
18 Alternative and Second Basis of Comparison.

19 Changes in CVP and SWP operations under the alternatives as compared to the
20 No Action Alternative and Second Basis of Comparison could change soil erosion
21 potential due to crop idling on lands irrigated with CVP and SWP water supplies
22 and along rivers downstream of CVP and SWP reservoirs, and potential changes
23 in soils as lands are converted to seasonal floodplain or tidal-influenced wetlands.

24 **11.4.1.1 Changes in Soil Erosion**

25 Changes in CVP and SWP operations under the alternatives could change the
26 extent of irrigated acreage and the potential for soil erosion on crop idled lands
27 over the long-term average condition and in dry and critical dry years as
28 compared to the No Action Alternative and the Second Basis of Comparison.

29 Changes in CVP and SWP operations under the alternatives also could change
30 peak flows in rivers downstream of CVP and SWP reservoirs in the Trinity River
31 and Central Valley regions as compared to historical conditions which could lead
32 to soil erosion during high peak flow events during storms in wet years along the
33 river banks as compared to the No Action Alternative and the Second Basis of
34 Comparison. However, as described in Chapter 5, Surface Water Resources and
35 Water Supplies, the results of the analysis indicate that peak flows would be
36 within historical range of peak flows in these rivers and would be similar under
37 Alternatives 1 through 5, No Action Alternative, and Second Basis of
38 Comparison. Therefore, changes in CVP and SWP operations would not result in
39 changes to peak flow events that could result in soil erosion along these rivers.
40 Therefore, these changes are not analyzed in this EIS.

1 **11.4.1.2 Changes in Soils at Restored Wetlands**

2 Restoration of seasonal floodplains and tidally-influenced wetlands would affect
3 soils resources at the restoration locations. However, these actions would occur in
4 a similar manner under the No Action Alternative, Alternatives 1 through 5, and
5 Second Basis of Comparison, as described in Chapter 3, Description of
6 Alternatives; in addition, the conditions of the soils would be the same under all
7 of the alternatives and the Second Basis of Comparison. Therefore, these changes
8 are not analyzed in this EIS.

9 **11.4.1.3 Effects Related to Water Transfers**

10 Historically water transfer programs have been developed on an annual basis.

11 The demand for water transfers is dependent upon the availability of water
12 supplies to meet water demands. Water transfer transactions have increased over
13 time as CVP and SWP water supply availability has decreased, especially during
14 drier water years.

15 Parties seeking water transfers generally acquire water from sellers who have
16 available surface water who can make the water available through releasing
17 previously stored water, pump groundwater instead of using surface water
18 (groundwater substitution), idle crops, or substitute crops that use less water in
19 order to reduce normal consumptive use of surface water.

20 Water transfers using CVP and SWP Delta pumping plants and south of Delta
21 canals generally occur when there is unused capacity in these facilities. These
22 conditions generally occur during drier water year types when the flows from
23 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento
24 Valley water demands and the CVP and SWP export allocations. In non-wet
25 years, the CVP and SWP water allocations would be less than full contract
26 amounts; therefore, capacity may be available in the CVP and SWP conveyance
27 facilities to move water from other sources.

28 Projecting future soil conditions related to water transfer activities is difficult
29 because specific water transfer actions required to make the water available,
30 convey the water, and/or use the water would change each year due to changing
31 hydrological conditions, CVP and SWP water availability, specific local agency
32 operations, and local cropping patterns. Reclamation recently prepared a long-
33 term regional water transfer environmental document which evaluated potential
34 changes in surface water conditions related to water transfer actions (Reclamation
35 2014c). Results from this analysis were used to inform the impact assessment of
36 potential effects of water transfers under the alternatives as compared to the
37 No Action Alternative and the Second Basis of Comparison.

38 **11.4.2 Conditions in Year 2030 without Implementation of**
39 **Alternatives 1 through 5**

40 This EIS includes two bases of comparison, as described in Chapter 3,
41 Description of Alternatives: the No Action Alternative and the Second Basis of
42 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that
43 would occur over the next 15 years without implementation of the alternatives are

1 not analyzed in this EIS. However, the changes to soils resources that are
2 assumed to occur by 2030 under the No Action Alternative and the Second Basis
3 of Comparison are summarized in this section. Many of the changed conditions
4 would occur in the same manner under both the No Action Alternative and the
5 Second Basis of Comparison.

6 **11.4.2.1 Common Changes in Conditions under the No Action Alternative**
7 **and Second Basis of Comparison**

8 Conditions in 2030 would be different than existing conditions due to:

- 9
- 10 • Climate change and sea-level rise
 - 11 • General plan development throughout California, including increased water
12 demands in portions of Sacramento Valley
 - 13 • Implementation of reasonable and foreseeable water resources management
14 projects to provide water supplies

14 It is anticipated that climate change would result in more short-duration high-
15 rainfall events and less snowpack in the winter and early spring months. The
16 reservoirs would be full more frequently by the end of April or May by 2030 than
17 in recent historical conditions. However, as the water is released in the spring,
18 there would be less snowpack to refill the reservoirs. This condition would
19 reduce reservoir storage and available water supplies to downstream uses in the
20 summer. The reduced end-of-September storage would also reduce the ability to
21 release stored water to downstream regional reservoirs. These conditions would
22 occur for all reservoirs in the California foothills and mountains, including non-
23 CVP and SWP reservoirs.

24 These changes would result in a decline of the long-term average CVP and SWP
25 water supply deliveries by 2030 as compared to recent historical long-term
26 average deliveries under the No Action Alternative and the Second Basis of
27 Comparison. However, the CVP and SWP water deliveries would be less under
28 the No Action Alternative as compared to the Second Basis of Comparison, as
29 described in Chapter 5, Surface Water Resources and Water Supplies, which
30 could result in more crop idling that could be subject to erosion.

31 Under the No Action Alternative and the Second Basis of Comparison, land uses
32 in 2030 would occur in accordance with adopted general plans. Development
33 under the general plans would result in disruption of soils resources; however, the
34 development of general plans includes preparation of environmental
35 documentation that would identify methods to minimize adverse impacts to soils
36 resources.

37 Under the No Action Alternative and the Second Basis of Comparison,
38 development of future water resources management projects by 2030 which
39 would result in disruption of soils resources. However, the development of these
40 future programs would include preparation of environmental documentation that
41 would identify methods to minimize adverse impacts to soils resources.

1 By 2030 under the No Action Alternative and the Second Basis of Comparison, it
 2 is assumed that ongoing programs would result in restoration of more than
 3 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and
 4 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the
 5 Yolo Bypass.

6 **11.4.3 Evaluation of Alternatives**

7 Alternatives 1 through 5 have been compared to the No Action Alternative; and
 8 the No Action Alternative and Alternatives 1 through 5 have been compared to
 9 the Second Basis of Comparison. The evaluation of alternatives is focused on
 10 portions of the Central Valley, San Francisco Bay Area, Central Coast, and
 11 Southern California regions that use CVP and SWP water for irrigation.

12 During review of the numerical modeling analyses used in this EIS, an error was
 13 determined in the CalSim II model assumptions related to the Stanislaus River
 14 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
 15 model runs. Appendix 5C includes a comparison of the CalSim II model run
 16 results presented in this chapter and CalSim II model run results with the error
 17 corrected. Appendix 5C also includes a discussion of changes in the comparison
 18 of groundwater conditions for the following alternative analyses.

- 19 • No Action Alternative compared to the Second Basis of Comparison
- 20 • Alternative 1 compared to the No Action Alternative
- 21 • Alternative 3 compared to the Second Basis of Comparison
- 22 • Alternative 5 compared to the Second Basis of Comparison

23 **11.4.3.1 No Action Alternative**

24 The No Action Alternative is compared to the Second Basis of Comparison.

25 **11.4.3.1.1 Central Valley Region**

26 *Potential Changes in Soil Erosion*

27 As described in Chapter 12, Agricultural Resources, the extent of irrigated
 28 acreage under the No Action Alternative would be similar (within 5 percent) to
 29 the conditions under the Second Basis of Comparison over long-term conditions
 30 (throughout the 81-year model simulation period) and during dry and critical dry
 31 years due to the increased use of groundwater.

32 *Effects Related to Cross Delta Water Transfers*

33 Potential effects to soils resources could be similar to those identified in a recent
 34 environmental analysis conducted by Reclamation for long-term water transfers
 35 from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential
 36 effects to soils resources were identified as increased erosion and shrinking of
 37 expansive soils in the seller's service areas if crop idling is used to provide water
 38 for transfers; and increased potential for shrinking of expansive soils and soil
 39 movement in areas that use the transferred water. The analysis indicated that
 40 these potential impacts would not be substantial because farmers manage idle
 41 fields as part of normal agricultural operations and they would continue to use the
 42 same practices to avoid erosion impacts. The analysis also indicated that

1 shrinking and soil movement occur as part of normal planting and harvesting
2 practices and the changes with the water transfer programs would not result in
3 substantial changes.

4 Under the No Action Alternative, the timing of cross Delta water transfers would
5 be limited to July through September and include annual volumetric limits, in
6 accordance with the 2008 U.S. Fish and Wildlife Service (USFWS) Biological
7 Opinion (BO) and the 2009 National Marine Fisheries Service (NMFS) BO.
8 Under the Second Basis of Comparison, water could be transferred throughout the
9 year without an annual volumetric limit. Overall, the potential for cross Delta
10 water transfers would be less under the No Action Alternative than under the
11 Second Basis of Comparison.

12 **11.4.3.1.2 San Francisco Bay Area, Central Coast, and Southern California** 13 **Regions**

14 *Potential Changes in Soil Erosion*

15 As described in Chapter 12, Agricultural Resources, the extent of irrigated
16 acreage under the No Action Alternative is anticipated to be similar as conditions
17 under the Second Basis of Comparison due to the increased use of groundwater.

18 **11.4.3.2 Alternative 1**

19 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is
20 compared to the No Action Alternative and the Second Basis of Comparison.
21 However, because CVP and SWP operations conditions under Alternative 1 are
22 identical to conditions under the Second Basis of Comparison; Alternative 1 is
23 only compared to the No Action Alternative.

24 **11.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

25 *Central Valley Region*

26 *Potential Changes in Soil Erosion*

27 As described in Chapter 12, Agricultural Resources, the extent of irrigated
28 acreage under Alternative 1 would be similar to conditions under the No Action
29 Alternative over long-term conditions and during dry and critical dry years due to
30 the increased availability of CVP and SWP water supplies.

31 *Effects Related to Cross Delta Water Transfers*

32 Potential effects to soils resources could be similar to those identified in a recent
33 environmental analysis conducted by Reclamation for long-term water transfers
34 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
35 above under the No Action Alternative compared to the Second Basis of
36 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
37 would occur during implementation of cross Delta water transfers under
38 Alternative 1 and the No Action Alternative, and that impacts on soils resources
39 would not be substantial in the seller's service area due to implementation
40 requirements of the transfer programs.

1 Under Alternative 1, water could be transferred throughout the year without an
 2 annual volumetric limit. Under the No Action Alternative, the timing of cross
 3 Delta water transfers would be limited to July through September and include
 4 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
 5 NMFS BO. Overall, the potential for cross Delta water transfers would be
 6 increased under Alternative 1 as compared to the No Action Alternative.

7 *San Francisco Bay Area, Central Coast, and Southern California Regions*
 8 *Potential Changes in Soil Erosion*

9 As described in Chapter 12, Agricultural Resources, the extent of irrigated
 10 acreage under Alternative 1 is anticipated to be similar as conditions under the
 11 No Action Alternative due to increased availability of CVP and SWP water
 12 supplies.

13 **11.4.3.2 Alternative 1 Compared to the Second Basis of Comparison**

14 Alternative 1 is identical to the Second Basis of Comparison.

15 **11.4.3.3 Alternative 2**

16 The CVP and SWP operations under Alternative 2 are identical to the CVP and
 17 SWP operations under the No Action Alternative; therefore, the soils resources
 18 conditions under Alternative 2 are only compared to the Second Basis of
 19 Comparison.

20 **11.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

21 Changes to soils resources under Alternative 2 as compared to the Second Basis
 22 of Comparison would be the same as the impacts described in Section 11.4.3.1,
 23 No Action Alternative.

24 **11.4.3.4 Alternative 3**

25 The CVP and SWP operations under Alternative 3 are similar to the Second Basis
 26 of Comparison and Alternative 1 with modified Old and Middle River flow
 27 criteria.

28 **11.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

29 *Central Valley Region*

30 *Potential Changes in Soil Erosion*

31 As described in Chapter 12, Agricultural Resources, the extent of irrigated
 32 acreage under Alternative 3 would be similar to the conditions under the No
 33 Action Alternative over long-term conditions and during dry and critical dry years
 34 due to the increased availability of CVP and SWP water supplies.

35 *Effects Related to Cross Delta Water Transfers*

36 Potential effects to soils resources could be similar to those identified in a recent
 37 environmental analysis conducted by Reclamation for long-term water transfers
 38 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
 39 above under the No Action Alternative compared to the Second Basis of
 40 Comparison. For the purposes of this EIS, it is anticipated that similar conditions

1 would occur during implementation of cross Delta water transfers under
2 Alternative 3 and the No Action Alternative, and that impacts on soils resources
3 would not be substantial in the seller's service area due to implementation
4 requirements of the transfer programs.

5 Under Alternative 3, water could be transferred throughout the year without an
6 annual volumetric limit. Under the No Action Alternative, the timing of cross
7 Delta water transfers would be limited to July through September and include
8 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
9 NMFS BO. Overall, the potential for cross Delta water transfers would be
10 increased under Alternative 3 as compared to the No Action Alternative.

11 *San Francisco Bay Area, Central Coast, and Southern California Regions*
12 *Potential Changes in Soil Erosion*

13 As described in Chapter 12, Agricultural Resources, the extent of irrigated
14 acreage under Alternative 3 is anticipated to be similar to conditions under the
15 No Action Alternative due to increased availability of CVP and SWP water
16 supplies.

17 **11.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**
18 *Central Valley Region*

19 *Potential Changes in Soil Erosion*

20 As described in Chapter 12, Agricultural Resources, the extent of irrigated
21 acreage under Alternative 3 would be similar to the conditions under the Second
22 Basis of Comparison over long-term conditions and during dry and critical dry
23 years due to the increased use of groundwater.

24 *Effects Related to Cross Delta Water Transfers*

25 Potential effects to soils resources could be similar to those identified in a recent
26 environmental analysis conducted by Reclamation for long-term water transfers
27 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
28 above under the No Action Alternative compared to the Second Basis of
29 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
30 would occur during implementation of cross Delta water transfers under
31 Alternative 3 and the Second Basis of Comparison, and that impacts on soils
32 resources would not be substantial in the seller's service area due to
33 implementation requirements of the transfer programs.

34 Under Alternative 3 and the Second Basis of Comparison, water could be
35 transferred throughout the year without an annual volumetric limit. Overall, the
36 potential for cross Delta water transfers would be similar under Alternative 3 and
37 the Second Basis of Comparison.

38 *San Francisco Bay Area, Central Coast, and Southern California Regions*
39 *Potential Changes in Soil Erosion*

40 As described in Chapter 12, Agricultural Resources, the extent of irrigated
41 acreage under Alternative 3 is anticipated to be similar to conditions under the
42 Second Basis of Comparison due to the increased use of groundwater.

1 **11.4.3.5 Alternative 4**

2 Soil resources conditions under Alternative 4 would be identical to the conditions
3 under the Second Basis of Comparison; therefore, Alternative 4 is only compared
4 to the No Action Alternative.

5 **11.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

6 The CVP and SWP operations under Alternative 4 are identical to the CVP and
7 SWP operations under the Second Basis of Comparison and Alternative 1.
8 Therefore, changes in soil resources conditions under Alternative 4 as compared
9 to the No Action Alternative would be the same as the impacts described in
10 Section 11.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

11 **11.4.3.6 Alternative 5**

12 The CVP and SWP operations under Alternative 5 are similar to the No Action
13 Alternative with modified Old and Middle River flow criteria and New Melones
14 Reservoir operations.

15 **11.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

16 *Central Valley Region*

17 *Potential Changes in Soil Erosion*

18 As described in Chapter 12, Agricultural Resources, the extent of irrigated
19 acreage under Alternative 5 would be similar to conditions under the No Action
20 Alternative over long-term conditions and during dry and critical dry years
21 because the availability of CVP and SWP water supplies would be similar.

22 *Effects Related to Cross Delta Water Transfers*

23 Potential effects to soils resources could be similar to those identified in a recent
24 environmental analysis conducted by Reclamation for long-term water transfers
25 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
26 above under the No Action Alternative compared to the Second Basis of
27 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
28 would occur during implementation of cross Delta water transfers under
29 Alternative 5 and the No Action Alternative, and that impacts on soils resources
30 would not be substantial in the seller’s service area due to implementation
31 requirements of the transfer programs.

32 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
33 water transfers would be limited to July through September and include annual
34 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
35 Overall, the potential for cross Delta water transfers would be similar under
36 Alternative 5 and the No Action Alternative.

37 *San Francisco Bay Area, Central Coast, and Southern California Regions*

38 *Potential Changes in Soil Erosion*

39 As described in Chapter 12, Agricultural Resources, the extent of irrigated
40 acreage under Alternative 5 is anticipated to be similar as conditions under the
41 No Action Alternative because CVP and SWP water deliveries would be similar.

1 **11.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Central Valley Region*

3 *Potential Changes in Soil Erosion*

4 As described in Chapter 12, Agricultural Resources, the extent of irrigated
 5 acreage under Alternative 5 would be similar to the conditions under the Second
 6 Basis of Comparison over long-term conditions and during dry and critical dry
 7 years due to increased use of groundwater.

8 *Effects Related to Cross Delta Water Transfers*

9 Potential effects to soils resources could be similar to those identified in a recent
 10 environmental analysis conducted by Reclamation for long-term water transfers
 11 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
 12 above under the No Action Alternative compared to the Second Basis of
 13 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
 14 would occur during implementation of cross Delta water transfers under
 15 Alternative 5 and the Second Basis of Comparison, and that impacts on soils
 16 resources would not be substantial in the seller’s service area due to
 17 implementation requirements of the transfer programs.

18 Under Alternative 5, the timing of cross Delta water transfers would be limited to
 19 July through September and include annual volumetric limits, in accordance with
 20 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,
 21 water could be transferred throughout the year without an annual volumetric limit.
 22 Overall, the potential for cross Delta water transfers would be less under
 23 Alternative 5 as compared to the Second Basis of Comparison.

24 *San Francisco Bay Area, Central Coast, and Southern California Regions*

25 *Potential Changes in Soil Erosion*

26 As described in Chapter 12, Agricultural Resources, the extent of irrigated
 27 acreage under Alternative 5 is anticipated to be similar to conditions under the
 28 Second Basis of Comparison due to the increased use of groundwater.

29 **11.4.3.7 Summary of Impact Analysis**

30 The results of the environmental consequences of implementation of Alternatives
 31 1 through 5 as compared to the No Action Alternative and the Second Basis of
 32 Comparison are presented in Tables 11.1 and 11.2, respectively.

33 **Table 11.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects on soils resources	None needed
Alternative 2	No effects on soils resources	None needed
Alternative 3	No effects on soils resources	None needed
Alternative 4	No effects on soils resources	None needed
Alternative 5	No effects on soils resources	None needed

1 **Table 11.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects on soils resources	Not considered for this comparison
Alternative 1	No effects on soils resources	Not considered for this comparison
Alternative 2	No effects on soils resources	Not considered for this comparison
Alternative 3	No effects on soils resources	Not considered for this comparison
Alternative 4	No effects on soils resources	Not considered for this comparison
Alternative 5	No effects on soils resources	Not considered for this comparison

3 **11.4.3.8 Potential Mitigation Measures**

4 Mitigation measures are presented in this section to avoid, minimize, rectify,
 5 reduce, eliminate, or compensate for adverse environmental effects of
 6 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation
 7 measures were not included to address adverse impacts under the alternatives as
 8 compared to the Second Basis of Comparison because this analysis was included
 9 in this EIS for information purposes only.

10 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared
 11 to the No Action Alternative would not result in changes in soils resources.
 12 Therefore, there would be no adverse impacts to soils resources as compared to
 13 the No Action Alternative; and no mitigation measures are required.

14 **11.4.3.9 Cumulative Effects Analysis**

15 As described in Chapter 3, the cumulative effects analysis considers projects,
 16 programs, and policies that are not speculative; and are based upon known or
 17 reasonably foreseeable long-range plans, regulations, operating agreements, or
 18 other information that establishes them as reasonably foreseeable.

19 The cumulative effects analysis for Alternatives 1 through 5 for Geology and
 20 Soils Resources are summarized in Table 11.3.

21 **Table 11.3 Summary of Cumulative Effects on Geology and Soils Resources with**
 22 **Implementation of Alternatives 1 through 5 as Compared to the No Action**
 23 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions	Consistent with Affected Environment conditions plus:	These effects would be the same under all alternatives.

Scenarios	Actions	Cumulative Effects of Actions
<p>included in the No Action Alternative and in All Alternatives in Year 2030</p>	<p>Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives) including climate change and sea level rise</p> <p>Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Climate Change and Sea Level Rise - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Folsom Dam Water Control Manual Update - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Grasslands Bypass Project - Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) - Future water supply projects, including water recycling, desalination, groundwater banks 	<p>Developments under the general plans and future water supply, water quality improvement, and restoration projects could affect soils resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.</p> <p>Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to soils resources.</p>

Scenarios	Actions	Cumulative Effects of Actions
	and wellfields, and conveyance facilities (projects with completed environmental documents)	
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan and California WaterFix - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program - San Luis Reservoir Low Point Improvement Project - Westlands Water District v. United States Settlement - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS) 	<p>These effects would be the same in all alternatives.</p> <p>Developments under the future projects are anticipated to potentially effect soils resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.</p> <p>Some of the future cumulative effects actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to soils resources.</p>
<p>No Action Alternative with Associated Cumulative Effects Actions in Year 2030</p>	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p>	<p>Implementation of the No Action Alternative with reasonably foreseeable actions would include developments under general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect soils resources. However,</p>

Scenarios	Actions	Cumulative Effects of Actions
		development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to soils resources.
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
2 with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions No implementation of structural improvements or other actions that require further study to develop a more detailed action description.	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Slight increase in positive Old and Middle River flows in the winter and spring months	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

2 **11.5 References**

3 Atwater, B. F. and D. F. Belknap. 1980. Tidal-wetland Deposits of the
4 Sacramento–San Joaquin Delta, California. In *Quaternary Depositional*

- 1 *Environments of the Pacific Coast*, 89–103. Proceedings of the Pacific
 2 Coast Paleogeography, Symposium 4, eds. M. E. Field, A. H. Bouma, I. P.
 3 Colburn, 7 R. G. Douglas, and J. C. Ingle. Society of Economic
 4 Paleontologists and Mineralogists, Pacific Section, Los Angeles.
- 5 CALFED (CALFED Bay-Delta Program). 2000. *Final Programmatic*
 6 *Environmental Impact Report/Environmental Impact Statement*. July.
 7 Sacramento.
- 8 _____. 2001. *A Framework for the Future: Yolo Bypass Management Strategy*.
 9 August.
- 10 CGS (California Department of Conservation, California Geologic Survey).
 11 2002a. *California Geomorphic Provinces Note 36*.
- 12 _____. 2002b. Interactive fault parameter map of California. Site accessed
 13 February 20,
 14 2013. [http://www.conservation.ca.gov/cgs/rghm/psha/fault_parameters/ht](http://www.conservation.ca.gov/cgs/rghm/psha/fault_parameters/htm/Pages/Index.aspx)
 15 [m/Pages/Index.aspx](http://www.conservation.ca.gov/cgs/rghm/psha/fault_parameters/htm/Pages/Index.aspx)
- 16 _____. 2006. *Simplified Geologic Map of California*.
- 17 _____. 2008. *Earthquake Shaking Potential*.
- 18 _____. 2010. 2010 Geologic Map of California. Site accessed March 21,
 19 2013. <http://www.quake.ca.gov/gmaps/GMC/stategeologicmap.html>.
- 20 _____. n.d. *Sacramento Probabilistic Seismic Hazards Map*. Site accessed
 21 March 21, 2013.
 22 [www.conservation.ca.gov/cgs/rghm/psha/Map_index/Pages/Sacramento.a](http://www.conservation.ca.gov/cgs/rghm/psha/Map_index/Pages/Sacramento.aspx)
 23 [spx](http://www.conservation.ca.gov/cgs/rghm/psha/Map_index/Pages/Sacramento.aspx)
- 24 CVWD (Coachella Valley Water District). 2011. *Coachella Valley Water*
 25 *Management Plan 2010 Update, Administrative Draft Subsequent*
 26 *Program Environmental Impact Report*. July.
- 27 CWDD (Converse Ward Davis Dixon). 1981. *Partial Technical Background*
 28 *Data for the Mokelumne Aqueduct Security Plan for EBMUD, Oakland,*
 29 *CA*.
- 30 Davis (City of Davis in association with University of California, Davis, and City
 31 of Woodland). 2007. *Davis-Woodland Water Supply Project, Draft*
 32 *Environmental Impact Report*. April.
- 33 Deverel, S. and D. Leighton. 2010. *Historic, recent, and future subsidence,*
 34 *Sacramento-San Joaquin Delta, California, USA. San Francisco Estuary*
 35 *and Watershed Science*. 8(2):23.
- 36 DFG et al. (California Department of Fish and Game [now known as Department
 37 of Fish and Wildlife] and Yolo Basin Foundation). 2008. *Yolo Bypass*
 38 *Wildlife Area*. June.
- 39 DOI and DFG (Department of the Interior and California Department of Fish and
 40 Game [now known as Department of Fish and Wildlife]). 2012. *Klamath*

- 1 *Facilities Removal Final Environmental Impact Statement/Environmental*
2 *Impact Report*. December.
- 3 Drexler, J.Z, C.S. de Fontaine, and S.J. Deverel. 2009. *The Legacy of Wetland*
4 *Drainage on the Remaining Peat in the Sacramento-San Joaquin Delta,*
5 *California, USA. Wetlands. Vol. 29, No. 1, March 2009, pp. 372-386.*
6 March.
- 7 DWR (California Department of Water Resources). 2007. *Draft Environmental*
8 *Impact Report Oroville Facilities Relicensing—FERC Project No. 2100.*
9 May.
- 10 _____. 2009. *East Branch Extension Phase II, Final Environmental Impact*
11 *Report*. January.
- 12 _____. 2013. Mayberry Farms Duck Club Subsidence Reversal Project (Sherman
13 Island). Site accessed January 19,
14 2014. <http://www.water.ca.gov/floodsafe/fessro/environmental/dee/mayberry.cfm>.
15 <http://www.water.ca.gov/floodsafe/fessro/environmental/dee/mayberry.cfm>.
- 16 DWR and Reclamation (California Department of Water Resources and Bureau of
17 Reclamation). 2014. *Draft Technical Information for Preparing Water*
18 *Transfer Proposals (Water Transfer White Paper), Information for Parties*
19 *Preparing Proposals for Water Transfers Requiring Department of Water*
20 *Resources or Bureau of Reclamation Approval*. November.
- 21 DWR et al. (Department of Water Resources, Bureau of Reclamation, U.S. Fish
22 and Wildlife Service, and National Marine Fisheries Service). 2013a. *Bay*
23 *Delta Conservation Plan, Draft Environmental Impact*
24 *Report/Environmental Impact Statement*. November.
- 25 DWR et al. (Department of Water Resources and U.S. Geological Survey).
26 2013b. Twitchell Wetlands. Site accessed January 19,
27 2014. http://www.water.ca.gov/floodsafe/fessro/levees/west_delta/twitchell.cfm.
28 http://www.water.ca.gov/floodsafe/fessro/levees/west_delta/twitchell.cfm.
- 29 Ferriz, H. 2001. Groundwater Resources of Northern California: An overview.
30 *Engineering Geology Practice in Northern California: Association of*
31 *Engineering Geologists Special Publication 12 and California Division of*
32 *Mines and Geology Bulletin 210*.
- 33 Galloway et al. (Galloway, D. and F.S. Riley, U.S. Geological Survey). 1999.
34 *San Joaquin Valley, California, Largest human alteration of the Earth's*
35 *surface*. In Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., eds., *Land*
36 *Subsidence in the United States: U.S. Geological Survey Circular 1182,*
37 p. 23–34.
- 38 GCI (Geotechnical Consultants, Inc.). 2003. *Environmental Conditions,*
39 *Geology, Folsom Lake State Recreation Area*. April.
- 40 Humboldt County. 2012. *Humboldt 21st Century General Plan Update, Draft*
41 *Environmental Impact Report*. April
42 2. <http://co.humboldt.ca.us/countycode/t6-div3.pdf>.

- 1 Ingebritsen (Ingebritsen, S.E. and D.R. Jones, U.S. Geological Survey). 1999.
 2 *Santa Clara Valley, California, A case of arrested subsidence*. In
 3 Galloway, D.L., Jones, D.R., and Ingebritsen, S.E., eds., *Land Subsidence*
 4 *in the United States: U.S. Geological Survey Circular 1182*, p. 23–34.
- 5 Los Angeles (City of Los Angeles, Department of Public Works). 2005.
 6 *Integrated Resources Plan, Draft Environmental Impact Report*.
 7 November.
- 8 NCRWQCB et al. (California North Coast Regional Water Quality Control Board
 9 and Bureau of Reclamation). 2009. *Channel Rehabilitation and Sediment*
 10 *Management for Remaining Phase 1 and Phase 2 Sites, Draft Master*
 11 *Environmental Impact Report and Environmental Assessment*. June.
- 12 NRCS (Natural Resources Conservation Service). 2014a. *Soil Map-San Luis*
 13 *Obispo County, California, Coastal Part* – focused on Morro Bay. Site
 14 accessed 012414. <http://websoilsurvey.sc.egov.usda.gov/App/HomePage>.
- 15 _____. 2014b. *Soil Map-San Luis Obispo County, California, Coastal Part* –
 16 focused on Pismo Beach_Oceano. Site accessed
 17 012414. <http://websoilsurvey.sc.egov.usda.gov/App/HomePage>.
- 18 _____. 2014c. *Soil Map-Santa Barbara County, California, Coastal Part* –
 19 focused on Santa Maria. Site accessed
 20 012414. <http://websoilsurvey.sc.egov.usda.gov/App/HomePage>.
- 21 _____. 2014d. *Soil Map-Santa Barbara County, California, Coastal Part* –
 22 focused on Vandenberg Air Force Base. Site accessed
 23 012414. <http://websoilsurvey.sc.egov.usda.gov/App/HomePage>.
- 24 _____. 2014e. *Soil Map-Santa Barbara County, California, Coastal Part* –
 25 focused on Goleta_Santa Barbara_Carpenteria. Site accessed
 26 012414. <http://websoilsurvey.sc.egov.usda.gov/App/HomePage>.
- 27 Placer County. 2007. *North Fork American River Trail Project Draft*
 28 *Environmental Impact Report*. August.
- 29 Reclamation (Bureau of Reclamation). 1997. *Central Valley Project*
 30 *Improvement Act, Draft Programmatic Environmental Impact Statement*.
 31 September.
- 32 _____. 2005a. *Long-Term Renewal of Water Service Contracts in the Black Butte*
 33 *Unit, Corning Canal Unit, and Tehama-Colusa Canal Unit of the*
 34 *Sacramento River Division, Central Valley Project, California, Final*
 35 *Environmental Assessment*. February.
- 36 _____. 2005b. *Central Valley Project Long-Term Water Service Contract*
 37 *Renewal American River Division Environmental Impact Statement*. June.
- 38 _____. 2005c. *San Luis Drainage Feature Re-evaluation Draft Environmental*
 39 *Impact Statement*. May.

- 1 _____. 2005d. *Central Valley Project Long-Term Water Service Contract*
2 *Renewal San Luis Unit, Public Draft Environmental Impact Statement and*
3 *Appendices*. September.
- 4 _____. 2009. *Delta-Mendota Canal/California Aqueduct Intertie Draft*
5 *Environmental Impact Statement*. July.
- 6 _____. 2010. *New Melones Lake Area, Final Resource Management Plan and*
7 *Environmental Impact Statement*. February.
- 8 _____. 2012. *San Luis Reservoir State Recreation Area, Final Resource*
9 *Management Plan/General Plan and Final Environmental Impact*
10 *Statement/Final Environment Impact Report*. August.
- 11 _____. 2013a. *Shasta Lake Water Resources Investigation Draft Environmental*
12 *Impact Statement*. June.
- 13 _____. 2013b. *Record of Decision, Water Transfer Program for the San Joaquin*
14 *River Exchange Contractors Water Authority, 2014-2038*. July 30.
- 15 _____. 2014a. *Findings of No Significant Impact, 2014 Tehama-Colusa Canal*
16 *Authority Water Transfers*. April 22.
- 17 _____. 2014b. *Findings of No Significant Impact, 2014 San Luis & Delta-*
18 *Mendota Water Authority Water Transfers*. April 22.
- 19 _____. 2014c. *Long-Term Water Transfers Environmental Impact*
20 *Statement/Environmental Impact Report, Public Draft*. September.
- 21 Reclamation et al. (Bureau of Reclamation, U.S. Army Corps of Engineers,
22 California Reclamation Board, Sacramento Area Flood Control Agency).
23 2006. *Folsom Dam Safety and Flood Damage Reduction Draft*
24 *Environmental Impact Statement/Environmental Impact Report*.
25 December.
- 26 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
27 Game [now known as Department of Fish and Wildlife], and U.S. Fish
28 and Wildlife Service). 2010. *Suisun Marsh Habitat Management,*
29 *Preservation, and Restoration Plan Draft Environmental Impact*
30 *Statement/Environmental Impact Report*.
- 31 Reclamation et al. (Bureau of Reclamation, and California Department of Water
32 Resources). 2011. *San Joaquin River Restoration Program*
33 *Environmental Impact Statement/Report*.
- 34 RCIP (Riverside County Integrated Project). 2000. *Existing Setting Report*.
35 March.
- 36 Riverside County (County of Riverside, Department of Regional Planning).
37 2000. *Natural Hazard Mapping, Analysis, and Mitigation: a Technical*
38 *Background Report in Support of the Safety Element of the New Riverside*
39 *County 2000 General Plan*. August.

- 1 Rojstaczer, S.A., Hamon, R.E., Deverel, S.J., and Massey, C.A. 1991.
 2 *Evaluation of selected data to assess the causes of subsidence in the*
 3 *Sacramento San Joaquin Delta. California: U.S. Geological Survey*
 4 *Open-File Report 91-193, 16 p.*
- 5 Sacramento County (County of Sacramento). 2010. *Sacramento County General*
 6 *Plan Update, Final Environmental Impact Report.* April.
- 7 San Diego County (County of San Diego). 2011. *San Diego County General*
 8 *Plan Update, Final Environmental Impact Report.* August.
- 9 San Luis Obispo County (County of San Luis Obispo). 2010a. *County of San*
 10 *Luis Obispo General Plan, Conservation and Open Space Element,*
 11 *Appendix 7, Open Space Resources.* May.
- 12 _____. 2010b. *County of San Luis Obispo General Plan, Conservation and Open*
 13 *Space Element, Appendix 8, Soil Resources.* May.
- 14 SBCAG (Santa Barbara County Association of Governments). 2013. *2040 Santa*
 15 *Barbara County Regional Transportation Plan and Sustainable*
 16 *Communities Strategy, Draft Environmental Impact Report.* May.
- 17 SCAG (Southern California Association of Governments). 2011. *2012-2035*
 18 *Regional Transportation Plan/Sustainable Communities Strategy Draft*
 19 *Program Environmental Impact Report.*
- 20 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
 21 with University of California Agricultural Experiment Station). 1972.
 22 *Soil Survey of Northern Santa Barbara Area, California.*
- 23 SCS (Soil Conservation Service and Forest Service, U.S. Department of
 24 Agriculture, in cooperation with University of California Agricultural
 25 Experiment Station, U.S. Department of the Interior Bureau of Indian
 26 Affairs, Department of the Navy, U.S. Marine Corps). 1973. *Soil Survey*
 27 *San Diego Area, California.* December.
- 28 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
 29 with University of California Agricultural Experiment Station). 1977a.
 30 *Soil Survey of Solano County, California.*
- 31 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
 32 with University of California Agricultural Experiment Station). 1977b.
 33 *Soil Survey of Contra Costa County, California.*
- 34 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
 35 with University of California Agricultural Experiment Station). 1978.
 36 *Soil Survey of Orange County and Western Part of Riverside County,*
 37 *California.*
- 38 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
 39 with University of California Agricultural Experiment Station). 1981a.
 40 *Soil Survey of Alameda County, California, Western Part.*

- 1 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
2 with University of California Agricultural Experiment Station). 1981b.
3 *Soil Survey of Santa Barbara County, California, South Coastal Part.*
- 4 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
5 with University of California Agricultural Experiment Station). 1986.
6 *Soil Survey of San Bernardino County, California, Mojave River Area.*
- 7 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
8 with University of California Agricultural Experiment Station and
9 California Department of Conservation). 1992. *Soil Survey of San*
10 *Joaquin County, California.* October.
- 11 SCS (Soil Conservation Service, U.S. Department of Agriculture, in cooperation
12 with University of California Agricultural Experiment Station). 1993.
13 *Soil Survey of Sacramento County, California.* April.
- 14 SCVWD (Santa Clara Valley Water District). 2000. *Relationship Between*
15 *Groundwater Elevations and Land Subsidence in Santa Clara County.*
16 May.
- 17 Shlemon, R. J., and E. L. Begg. 1975. *Ho66locene Evolution of the Sacramento–*
18 *San Joaquin Delta, California. International Union for Quaternary*
19 *Research Sponsored by the Royal Society of New Zealand.*
- 20 TCDOT (Trinity County Department of Transportation). 2003. *Trinity County*
21 *Hyampom Road Improvements Project, PM 6.8-9.3 Draft Environmental*
22 *Impact Report.* Weaverville.
- 23 UCCE (University of California Cooperative Extension). 2014. *University of*
24 *California Cooperative Extension, Agricultural and Natural Resources*
25 *Ventura County, General Soil Map.* Site accessed January 23,
26 2014. http://ceventura.ucanr.edu/Com_Ag/Soils.
- 27 USGS (U.S. Geological Survey). 1999. *Land Subsidence in the United States.*
28 Circular 1182.
- 29 _____. 2000a. *Volcano Hazards of the Lassen Volcanic National Park Area,*
30 *California.*
- 31 _____. 2000b. *Delta Subsidence in California: The sinking heart of the State.*
32 April.
- 33 _____. 2013a. *Quaternary Fault and Fold Database of the United States.* Site
34 accessed February 20, 2013. <http://earthquake.usgs.gov/hazards/qfaults/>.
- 35 _____. 2013b. *Land Subsidence along the Delta-Mendota Canal in the Northern*
36 *Part of the San Joaquin Valley, California, 2003-10, Scientific*
37 *Investigations Report 2013-5142.*
- 38 _____. 2013c. *Detection and Measurement of Land Subsidence Using Global*
39 *Positioning System Surveying and Interferometric Synthetic Aperture*
40 *Radar, Coachella Valley, California, 1996-2005. Scientific Investigations*
41 *Report 2007-5251. Version 2.0.* June.

- 1 Ventura County (County of Ventura). 2011. *Ventura County General Plan,*
- 2 *Hazards Appendix.* June.
- 3 Weir, Walter W. 1949. *Peat Lands of the Delta.* California Agriculture. July.
- 4 WTA (Water Transit Authority). 2003. *Final Program Environmental Impact*
- 5 *Report Expansion of Ferry Transit Service in the San Francisco Bay Area.*
- 6 June.



Figure 11.1 Geomorphic Provinces in California

Chapter 12**1 Agricultural Resources****2 12.1 Introduction**

3 This chapter describes agricultural resources in the study area, and potential
4 changes that could occur as a result of implementing the alternatives evaluated in
5 this Environmental Impact Statement (EIS). Implementation of the alternatives
6 could affect land use through potential changes in operation of the Central Valley
7 Project (CVP) and State Water Project (SWP) and ecosystem restoration.

8 Changes in non-agricultural land use and resources are described in Chapter 13,
9 Land Use.

10 12.2 Regulatory Environment and Compliance
11 Requirements

12 Potential actions that could be implemented under the alternatives evaluated in
13 this EIS could affect agricultural resources served by CVP and SWP water
14 supplies. Actions located on public agency lands; or implemented, funded, or
15 approved by Federal and state agencies would need to be compliant with
16 appropriate Federal and state agency policies and regulations, as summarized in
17 Chapter 4, Approach to Environmental Analyses.

18 12.3 Affected Environment

19 This section describes agricultural resources that could be potentially affected by
20 the implementation of the alternatives considered in this EIS. Changes in
21 agricultural resources due to changes in CVP and SWP operations may occur in
22 the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and
23 Southern California regions. Direct or indirect agricultural resource effects due to
24 implementation of the alternatives analyzed in this EIS are related to changes in
25 agricultural land uses due to the availability and reliability of CVP and SWP
26 water supplies.

27 Changes in agricultural resources can affect agriculture throughout the state. An
28 overview of California agriculture is presented prior to discussions of agricultural
29 resources in each of the regions.

30 12.3.1 Overview of California Agriculture

31 California agriculture is an important resource that produces over 400 types of
32 crops. California is the nation's leading producer of nearly 80 commodities; and
33 produces more than 99 percent of the nation's almonds, artichokes, dates, figs,
34 raisins, kiwifruit, olives, clingstone peaches, pistachios, prunes, pomegranates,

1 and walnuts (USDA-NASS 2012). In 2011, cultivation of 25.4 million acres of
2 agricultural land contributed about \$43.5 billion to California's economy and
3 11.6 percent of total agricultural revenues in the United States. This section
4 provides:

- 5 • Recent trends in California agricultural resources
- 6 • Crop production practices
- 7 • Cropping pattern changes in response to water supply availability
- 8 • Water supply and crop acreage relationships in the San Joaquin Valley

9 **12.3.1.1 Recent Trends in Agricultural Production**

10 The United States Department of Agriculture (USDA) National Agricultural
11 Statistics Service (NASS) California Field Office publishes annual reports
12 containing data from County Agricultural Commissioners and periodic statewide
13 census of agricultural producers. County Agricultural Commissioners' data
14 covers acres planted, total production, prices, yield per acre, and value of
15 production across crop groups and counties.

16 From 1960 to 2012, total acreage in production fluctuated between eight and nine
17 million acres, as summarized in Figure 12.1. Over the last fifteen years, total
18 acreage has trended down. Most of the variability over time, and the more recent
19 downward trend, are largely attributable to changes in field and forage crop
20 acreage. The percentage of field and forage acreage decreased from 77 percent of
21 total acreage in 1960 to 48 percent in 2012. The proportion of acreage of
22 permanent crops (e.g. orchards and vine) has steadily increased from 1960 to
23 2012. Orchard and vine acreage rose from 14 percent of total acreage in 1960 to
24 38 percent in 2012.

25 From 1960 to 2012, statewide annual value of production rose from \$20 billion
26 (all values are in 2012 US dollars) to \$45 billion, as summarized in Figure 12.2.
27 Of the crop categories, orchard and vine values grew the fastest over this period,
28 from around \$3 billion in annual value of production in 1960 to over \$17 billion
29 in 2012. This increase may be attributable to both the expansion of acreage
30 planted, as shown in Figure 12.1, as well as price and yield increases. Orchard
31 and vine values of production rose from 17 percent of the total statewide value of
32 production in 1960 to 38 percent in 2012. Other crop categories that have also
33 experienced an increase in value of production over this time period are:
34 vegetable, livestock, dairy and poultry, and nursery. Field crops have shown a
35 downward trend. The percentage from field and forage crops decreased from the
36 peak of 28 percent of state value of production in 1980 to 11 percent in 2012.
37 Total value of production is influenced by both the acreage planted each year as
38 well as market prices and yields.

39 **12.3.1.2 Crop Production Practices**

40 Crop production practices vary by crop and locational differences such as soil,
41 slope, local climate, and water source and reliability. Production practices
42 discussed in this subsection include:

- 43 • Crop rotation and fallowing.

- 1 • Crop water use.
- 2 • Crop irrigation methods.
- 3 • Crop responses to water quality.
- 4 • Crop drainage methods.
- 5 • Crop adaptation to changes in water supply availability.

6 **12.3.1.2.1 Crop Rotation and Fallowing**

7 Crop rotation is the planned variation in the crop grown on a given field. Growers
8 rotate annual crops and some forage crops in order to control plant pests, diseases,
9 and weeds, and to improve soil structure, microbial diversity, and nutrient and
10 mineral availability. Growers select a series of crops that are compatible for
11 rotation that are planned to be grown in a field in a succession of years and plan
12 their operations schedule and build their on-farm infrastructure (e.g., equipment,
13 facilities and staffing) to a scale that meets the production needs of those crop
14 acreage mixes (Baldwin 2006).

15 Field fallowing is the practice of not planting a crop in a field for one or more
16 growing seasons. Fallowing can be a planned part of the rotation, or may be a
17 consequence of another event like water supply shortage, flooding, land
18 improvement, or poor crop prices. Rotations are not fixed, so changes in market
19 conditions or Federal farm programs can affect crop mix and the pattern and
20 magnitude of fallowing.

21 Fallowed fields without cover crops can lose topsoil to surface drainage and wind
22 erosion. Loss of topsoil to erosion reduces land productivity, and can reduce
23 nearby crop yields and marketability.

24 **12.3.1.2.2 Crop Water Use**

25 Crop irrigation water use depends on crop type, stage of crop growth, soil
26 moisture profile from winter rains, soil moisture holding capacity (total amount of
27 water in the soil potentially available to plants), management of plant pests and
28 diseases, weather conditions (solar radiation, temperature and humidity) and
29 irrigation water use efficiency. Irrigation water use efficiency can be defined in
30 different ways. The California Department of Water Resources (DWR) defines
31 the agronomic water use fraction as the irrigation water beneficially used for
32 necessary agronomic functions (e.g., transpiration, leaching, frost protection,
33 germination) divided by the total applied water (DWR 2012). Applied irrigation
34 water is transpired by plants (crops and weeds), percolates into the groundwater
35 below the root zone (necessary salt leaching component or over-irrigation loss to
36 groundwater), evaporates directly from water or soil surfaces, or runs off the field
37 as surface drainage (Edinger-Marshall and Letey 1997).

38 Reuse of water from fields to irrigate other fields, often multiple times, occurs
39 throughout California. As a result, relatively low field-level efficiency
40 (agronomic water use fraction) can result in relatively high efficiency from a
41 regional or basin perspective (DWR 2013a).

1 **12.3.1.2.3 Crop Irrigation**

2 Agricultural irrigation needs vary by season. In the winter, rainfall refills the soil
3 moisture profile that was depleted from the crop root zone the previous summer
4 and fall. If soil moisture is not adequate for planting of annual crops,
5 pre-irrigation water is applied. Pre-irrigation and early growing season irrigations
6 generally occur in the time period from March through May. Peak agricultural
7 irrigation water supply demand generally occurs from the late spring through late
8 summer. Permanent crops are irrigated post-harvest to refill the root zone. Post-
9 harvest irrigation of annual crop land is sometimes used to help break down crop
10 residue and suppress some pests and diseases, especially in rice fields.

11 Irrigation methods vary by area, soil, crop type, and existing facilities. Annual
12 row crops are often sprinkler irrigated for crop germination and furrow irrigated
13 for the rest of the season. Permanent crops are typically irrigated with drip,
14 sprinkler, furrow, border, or flood irrigation methods. Irrigated pasture and
15 alfalfa are typically irrigated with sprinkler or flood irrigation methods. Rice is
16 generally irrigated with flood irrigation. Irrigation methods utilized in the Central
17 Valley include:

- 18 • **Flood and Border Irrigation:** Water is released into a leveled field or block
19 that is segmented into “checks” with a small berm to contain the water. Water
20 applied to the check until it is flooded and the water seeps into the ground or
21 some is allowed to drain off the lower elevation end of the field.
- 22 • **Furrow Irrigation:** Water is released into furrows at the higher side of the
23 field and flows down to the lower end of the field. To provide adequate water
24 to the low end of the field, surface irrigation requires that a certain amount of
25 water be spilled or drained off as tailwater. Recycling the tailwater to the
26 head of the field or to an adjacent field can significantly increase overall
27 efficiency. Furrow irrigation is used on annual row crops and on some
28 vineyards.
- 29 • **Sprinkler Irrigation:** Sprinkler irrigation uses pressurized water through
30 movable or solid set pipe to a sprinkler. Sprinklers lose some irrigation water
31 to evaporation in the air before the water reaches the ground. Sprinklers also
32 apply water to ground that does not have crop roots, and this applied water
33 goes to surface evaporation, weed transpiration, or percolation to groundwater
34 leaching. Sprinklers are often used during the germination stage of
35 vegetables, and can also be used for frost control on orchards, especially
36 citrus. Sprinkler irrigation can be used on most crops except those for which
37 direct contact with the water drops could cause fruit cracking, fungal growth,
38 or other issues.
- 39 • **Surface Drip and Micro-sprinkler Irrigation:** Surface drip and micro-
40 sprinkler irrigation also use pressurized water that is delivered through
41 flexible tubes to drip emitters or micro-sprinkler heads. Surface drip irrigation
42 generally applies water only to the crop root areas. Drip irrigation and
43 micro-sprinklers are used on most orchards and vineyards.

- 1 • **Subsurface Drip Irrigation:** Subsurface drip irrigation is similar to the drip
 2 irrigation described above, but the tubing or drip tape is buried a few inches to
 3 several feet, depending on the crop. Subsurface drip irrigation generally
 4 applies water only to crop root areas and reduces surface evaporation.
 5 Subsurface drip is used on some row crops and vineyards.
- 6 Flood and furrow irrigated acreage has declined over time, especially for trees and
 7 vines by drip and micro-sprinkler irrigation (NCWA 2011). Crops that continue
 8 to rely upon flood irrigation, such as rice, have improved irrigation efficiency
 9 through the use of laser leveling of the fields. The use of furrow and flood
 10 irrigation has declined in California from 67 percent of the total irrigated acreage
 11 in 1991 to 43 percent in 2010 (DWR 2013a). During this same time period, the
 12 use of drip, micro-sprinkler, and subsurface drip irrigation increased from
 13 16 percent of total irrigated acreage in 1991 to 42 percent in 2010.

14 **12.3.1.2.4 Crop Response to Water Quality**

15 Water quality of the surface water streams in the Central Valley is generally very
 16 suitable for agricultural production with low salinity, neutral acidity/alkalinity
 17 (i.e., pH), minerals, nutrients, and dissolved metal concentrations that are
 18 appropriate for agricultural uses. However, groundwater quality varies
 19 substantially across California, as described in Chapter 7, Groundwater Resources
 20 and Groundwater Quality.

21 Agricultural production can be affected by high salinity, minerals, and boron in
 22 the irrigation water and the soils. In the Sacramento Valley, water temperature
 23 can reduce crop yields; cold water is a particular concern for rice production
 24 (Roel et al., 2005). Irrigation water can carry debris and biological contaminants
 25 that affect agricultural operations and the value of crop production (USDA 2006).

26 High salinity concerns occur on agricultural lands receiving CVP and SWP water
 27 from the Delta. As described in Chapter 6, Surface Water Quality, surface waters
 28 in the Delta and lower San Joaquin River water frequently are characterized by
 29 high salinity. These waters are used by agricultural water users in the Delta and
 30 CVP and SWP water users located within and to the south of the Delta.

31 Evaporation and transpiration of irrigation water cause salts to accumulate in soils
 32 unless adequate leaching and drainage are provided (Reclamation 2005). High
 33 water tables with elevated concentrations of salts can draw the salinity vertically
 34 through the soil by capillary action into the plant root zone and cause damage to
 35 the plant. Excessive irrigation water salinity and accumulated soil salinity can
 36 adversely affect soil structure, reduce water infiltration rates, reduce seed
 37 germination, increase seedling mortality, impede root growth, impede water
 38 uptake by the plant (from increased osmotic pressure), reduce plant growth rate,
 39 and reduce yields.

40 All irrigation water adds soluble salts to the soil, including sodium, calcium,
 41 magnesium, potassium, sulfate, and chlorides (Grattan 2002). Salinity is usually
 42 measured either in parts per million of total dissolved solids or by electrical
 43 conductivity (EC). Water salinity of irrigation water is measured as “EC_w.”

1 Accumulated salts in the soil are measured as “EC_e.” The strength of the
 2 electrical conductivity depends upon the water temperature, types of salts, and salt
 3 concentrations.

4 High salinity can affect the amount of irrigation water applied for crop irrigation
 5 and necessary soil leaching component (washing soil salts out of the plant root
 6 zone) compared to the total quantity of irrigation water applied (Reclamation
 7 2005). Irrigation in the San Joaquin Valley typically includes a salt leaching
 8 component. The leaching water generally conveys the salts into installed drains
 9 in the fields or into the groundwater. Therefore, in locations where adequate
 10 drainage does not exist, continued irrigation with high salinity water has increased
 11 groundwater salinity, as described in Chapter 7, Groundwater Resources and
 12 Groundwater Quality.

13 Table 12.1 presents EC_e and EC_w values for salinity tolerances of a range of crops
 14 grown in the Central Valley.

15 **Table 12.1 Salinity Tolerance of Selected Crops (as percent of maximum yield)**

Crops ^{a, b}	Crop Tolerance based on Soil Salinity (measured as EC _e)			Crop Tolerance based on Water Salinity (measured as EC _w)		
	100%	50%	0% ^c	100%	50%	0% ^c
Alfalfa	2.0	8.8	16	1.3	5.9	10
Almond ^d	1.5	4.1	6.8	1.0	2.8	4.5
Apricot ^d	1.6	3.7	5.8	1.1	2.5	3.8
Bean	1.0	3.6	6.3	0.7	2.4	4.2
Corn, sweet	1.7	5.9	10	1.1	3.9	6.7
Cucumber	2.5	6.3	10	1.7	4.2	6.8
Grape ^e	1.5	6.7	12	1.0	4.5	7.9
Peach	1.7	4.1	6.5	1.1	2.7	4.3
Rice (paddy)	3.0	7.2	11	2.0	4.8	7.6
Squash, Zucchini	4.7	10	15	3.1	6.7	10
Sudan Grass	2.8	14	26	1.9	9.6	17
Sugar Beet ^e	7.0	15	24	4.7	10	16
Tomato	2.5	7.6	13	1.7	5.0	8.4

16 Sources: Ayers and Westcot 1994; Grattan 2002; Maas and Hoffman 1977

17 Notes:

18 a. These data should be used as a guide to relative tolerances among crops. Absolute
 19 tolerances will change based upon climate, soil conditions, and cultural practices.
 20 Plants will tolerate about 2 deciSiemens per meter (dS/m) higher soil salinity (EC_e)
 21 than indicated if soils have high gypsum, however the water salinity (EC_w) tolerances
 22 do not change.

23 b. EC_e is average root zone salinity as measured by electrical conductivity of the
 24 saturation extract of the soil, and EC_w is electrical conductivity of the irrigation water,

- 1 both reported in dS/m) at 25°C. The data is based upon a relationship between soil
 2 salinity and water salinity of $EC_e = 1.5 EC_w$ with a 15 to 20 percent leaching fraction
 3 and a 40-30-20-10 percent water use pattern for the upper to lower quarters of the
 4 root zone.
- 5 c. The zero yield potential or maximum EC_e indicates the theoretical soil salinity (EC_e) at
 6 which crop growth ceases.
- 7 d. Tolerance evaluations are based on tree growth and not on yield.
- 8 e. For beets, which are more sensitive during germination, the EC_e should not exceed
 9 3 dS/m in the seeding area for garden beets and sugar beets.

10 The most sensitive crops are affected when EC_e values exceed 1 dS/m, and
 11 include the following crops with threshold values: beans (1.0 dS/m); walnuts
 12 1.1 dS/m), bulb onions (1.2 dS/m); grapes, peppers and almonds (1.5 dS/m);
 13 apricots (1.6 dS/m); corn and peaches (1.7 dS/m); alfalfa (2.0 dS/m); and
 14 cucumbers and tomatoes (2.5 dS/m).

15 In addition to salinity, boron is also a concern in some areas. Dry beans are one
 16 of the more boron sensitive crops with a threshold value of 0.75 to 1.0 mg/l in the
 17 soil water within the crop root zone.

18 **12.3.1.2.5 Crop Drainage Methods**

19 Agricultural crop surface and subsurface drainage is important for the suitability
 20 of agricultural production (DWR 2013a; Reclamation 2005; SJVDIP 1998).
 21 Drainage of most agricultural fields occurs by a combination of surface drainage
 22 and subsurface drainage. Poor drainage can lead to crop loss or damage from lack
 23 of soil oxygen availability for plant roots, pest infestations (e.g., pathogenic root
 24 fungi, such as *phytothora*), and salt accumulation in the root zone. High water
 25 tables, high salinity, and poor drainage can limit crop selection and limit the
 26 ability of farmers to use irrigation water to leach excess salts out of the crop root
 27 zone.

28 Surface water drainage from agricultural fields is collected in on-farm drainage
 29 ditches which are typically connected to larger drainage facilities. The drainage
 30 water either flows by gravity or is pumped into adjacent water bodies. Water
 31 quality issues related to disposal of surface water drainage can include high
 32 concentrations of sediment; nutrients from fertilizers; or residual organic carbon
 33 constituents from herbicides, pesticides, or nematicides. On-farm surface
 34 drainage systems sometimes include local methods to remove sediment or
 35 nutrients, such as the inclusion of vegetative strips to remove sediment and
 36 improve drain water quality (CALFED 2000). During the irrigation season,
 37 surface drainage water collected from irrigation can be recirculated for subsequent
 38 irrigation; however, this can lead to a long-term increase in soil salinity
 39 (DWR 2013a; SJVDIP 1998).

40 Subsurface drainage is used to control groundwater depth to avoid or limit its
 41 encroachment into the root zone of crops (Panuska 2011). For example in the
 42 Delta, subsurface and surface drainage is used not only to control groundwater
 43 depths related to irrigation practices, but also to control groundwater that seeps

1 into the soils from the surface water that surrounds the islands and tracts. Areas
2 in the western and southern San Joaquin Valley are affected by shallow, saline
3 groundwater that accumulates due to irrigation; and the shallow groundwater is
4 underlain by soils with poor drainage (CALFED 2000; DWR 2013a; SJVDP
5 1990; SJVDIP 1998; WWD 2013a, 2013b). Some areas of northern San Joaquin,
6 Valley collect and discharge subsurface drainage to the San Joaquin River
7 (Reclamation, 2013). Areas in the central and southern San Joaquin Valley
8 manage poor drainage conditions by careful and integrated management of crop
9 patterns, land retirement, irrigation methods and application rates, and/or drainage
10 water reuse and blending, (USGS 2008; WRCD 2004).

11 **12.3.1.2.6 Crop Adaptation in Response to Changes in Water Supply**
12 **Availability**

13 Farmers and water suppliers can react to changes in water supply in a range of
14 ways. Some farmers adapt to variability by maintaining a mix of crops that can
15 be shifted or fallowed in response to water supply changes. Some farmers have
16 groundwater wells that can be used to replace surface water in times of shortage.
17 Short term responses can also include reducing irrigation water application below
18 what is needed to maintain full crop yield (water stressing). Over the long term,
19 irrigation systems and management can be changed to apply less water.
20 Decisions that farmers make in response to changes in water supply affect other
21 aspects of their operations, and affect the economy of the surrounding
22 community. For example, crop mix and irrigation methods affect the kinds of
23 tractors and other equipment used on the farm.

24 Some types of on-farm infrastructure also are specialized for the crops grown
25 including: grain driers and storage, hullers, fruit sorting and packing, fruit driers,
26 cotton gins and cold storage plants. Crop-specific equipment, infrastructure, and
27 marketing agreements may prevent a grower from change crops quickly due to
28 changes in water supply availability.

29 Input suppliers, equipment dealers, labor force, and processing facilities are also
30 dependent on, and affected by, cropping decisions. As crop types change, the mix
31 of these related economic activities also change. This can happen over a period of
32 time, but is difficult to achieve in the short term.

33 *Response to Variability in CVP and SWP Water Supplies*

34 Water availability provided by the CVP and SWP varies each year based upon
35 hydrologic conditions and regulatory requirements, as described in Chapter 5,
36 Surface Water Resources and Water Supplies. The CVP and SWP water supply
37 allocations are initially announced in the late winter. The allocations can be
38 revised throughout the spring months as the hydrologic conditions become more
39 certain. Growers often delay finalizing some of their crop decisions until water
40 supply allocations are announced as late as April or May. Delays in finalizing
41 crop decisions also can result in delays in finalizing crop financing and orders to
42 suppliers (e.g., seed, fertilizer), and contracting with labor suppliers and crop
43 processors. Responses to variations in water allocations depend on many factors,
44 including but not limited to: feasibility of alternative water supplies (availability,

1 suitability of water quality, cost); types of crops grown and need for changes in
 2 equipment, processing, and labor; and long-term crop supply contracts and
 3 obligations, (WWD 2013a, 2013b). A study of changes that occurred during the
 4 1986 through 1992 drought indicated that implementation of the changes will
 5 probably occur over a longer period of time and not necessarily during the water
 6 supply shortage, especially if groundwater or other surface water supplies can be
 7 obtained within the growing season (Dale et al. 1998).

8 The effects on the surrounding communities of the variability of CVP and SWP
 9 water supplies are discussed in Chapter 19, Socioeconomics, and Chapter 21,
 10 Environmental Justice.

11 Typical responses of a farmer or water supplier to increasing shortage of water
 12 supplies include the following actions.

- 13 • **Increase the use of groundwater:** Reduction in surface water supplies can
 14 induce substitution with groundwater using new or existing wells. Water
 15 supplies are used conjunctively in some areas with groundwater storage so
 16 that during surface water shortages, water historically used to recharge
 17 groundwater can be used for applied irrigation uses.
- 18 • **Use alternative/supplemental surface water supplies:** Alternative water
 19 supplies may include local exchanges or transfers of surface water, water
 20 transfers/purchases from more distant areas, and/or use of water stored in
 21 surface water reservoirs or groundwater banks. These all depend on the
 22 infrastructure to convey the water and the financial ability to pay for the
 23 alternatives water supplies.
- 24 • **Increased water use efficiency:** Reduced use of irrigation water may be
 25 achieved by on-farm system and irrigation management improvements, water
 26 reuse, water source blending, and delivery system improvements. Specific
 27 on-farm and delivery system improvements can include irrigation scheduling,
 28 field leveling, application system changes, and conveyance system loss
 29 reduction such as canal lining, spill reduction, and automation. Some of the
 30 changes require only management changes, such as irrigation scheduling, and
 31 can occur within the growing season. Other changes, such as conveyance
 32 system modifications, require capital investments and generally require
 33 several years to implement.
- 34 • **Field fallowing or changing to lower-water-use crops:** Fallowing, or
 35 temporary idling, reduces gross water use by the entire applied water amount,
 36 and reduces net water use by at least the evapotranspiration of the crop not
 37 planted. Typically fields with higher water use crops or lower value rotation
 38 crops would be the first fields to be fallowed. Farmers generally would avoid
 39 or minimize fallowing permanent crops or crops with long-term obligations
 40 (e.g., cannery contracts). A farmer receiving a partial allocation of water
 41 could decide to reduce irrigated acreage and transfer that acreage's water
 42 allocation to the remaining fields in production or sell the water to other water
 43 users. A smaller reduction in water use can be achieved by switching from a
 44 crop using more water to one using less water (Dale et al. 1998). Permanent

1 crops, such as trees and vines, that are the least economically viable or that are
2 approaching the end of their lifespan can be removed or abandoned, and the
3 land fallowed until adequate water is available. In extreme dry periods, such
4 as 2014 when there were no deliveries of CVP water to San Joaquin Valley
5 water supply agencies with CVP water service contracts, permanent crops
6 were removed because the plants would not survive the stress of no water or
7 saline groundwater (Fresno Bee 2014).

- 8 • **Stress Irrigation:** Farmers generally try to irrigate to achieve maximum
9 economic yield. For some permanent crops, severe pruning could reduce
10 water use, but could reduce yield over multiple years (AgAlert 2010).

11 **12.3.1.3 Cropping Pattern Changes in Response to Water Supply** 12 **Availability**

13 Conversion of farm lands to other land uses has occurred historically and
14 continues to occur. Agricultural lands have been converted to different crop
15 patterns, urban areas, habitat restoration, off-farm infrastructure (e.g., utilities and
16 transportation), and on-farm infrastructure (e.g., storage, maintenance, and
17 processing facilities). Crop conversions occur in response to changes in water
18 supply reliability, changes in market demand for specific crops, and decisions to
19 convert lands to urban or infrastructure land uses.

20 One method used to indicate changes in California agricultural acreage is related
21 to a loss of the value of production on “Important Farmland” and “Grazing Land”
22 acreages, as reported by the California Department of Conservation since 1988
23 (CDOC 2004). The comparison of the acreage of lands within each category can
24 be used to identify trends in agricultural land conversions. This information is
25 provided in the following subsections for the years 2000 and 2010 for counties
26 within the study area.

27 Another factor to be considered prior to crop conversion is the costs related to
28 crop establishment. Costs of irrigated crop production include labor, purchased
29 inputs (e.g., seed, fertilizer, chemicals), custom services, investment in growing
30 stock, other capital (including machinery and structures), and other overhead
31 costs.

32 Reliability of water supply can be especially important for maintaining substantial
33 investments in growing stock of perennial and multi-year crops. Perennial crops
34 include orchards and vineyards that may have useful lives of 25 years or more.
35 Multiyear forage crops, such as alfalfa and irrigated pasture, also may be in
36 production for years. Investment in growing stock may be expressed as the
37 accumulated costs incurred during the period when the crop is planted and
38 brought to bearing age, called the establishment period. Establishment costs for
39 perennial crops can range up to \$15,000 per acre in total costs (including cash
40 outlays plus noncash and allocated overhead costs). The example establishment
41 costs provided in Table 12.2 are for the Central Valley, but are generally
42 representative of establishment costs in other regions.

1 **Table 12.2 Typical Establishment Costs for Some Perennial Crops in the Central**
 2 **Valley**

Example Crop	Establishment Period (years)	Assumed Life of Stand (years)	Accumulated Total Cost during Establishment (\$ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	1	4	534	Sacramento Valley, 2013
Almonds	4	25	10,117	San Joaquin Valley North, 2011
Irrigated Pasture	1	20	408	Sacramento Valley, 2003
Walnuts	5	25	14,133	San Joaquin Valley North, 2013
Wine Grapes	3	25	18,495	Cabernet Sauvignon, SJ Valley North, 2012

3 Sources: UCCE 2003, 2011, 2012a, 2013a

4 Notes: All costs are converted to 2012 dollar equivalent values using the Gross Domestic
 5 Product Implicit Price Deflator (USDOC 2014). Assumed stand life is the financial life
 6 used for the cost and budget analysis. Individual growers may decide to keep stands in
 7 production longer or to remove them sooner.

8 Farm expenditures are largely spent in the surrounding community in the form of
 9 input purchases, hired labor, rents paid to landlords, well drilling, and custom
 10 consulting services. Total labor in the agricultural production sector is discussed
 11 in relation to the regional economy in Chapter 19, Socioeconomics. Labor hours
 12 and input purchases vary substantially among crops, as shown in Table 12.3.

13 **Table 12.3 Land Rent, Labor Hours, and Custom Services for Example Crops in the**
 14 **Central Valley**

Example Crop	Typical Rent (\$ per acre)	Typical Annual Labor (hours per acre)	Custom Services Purchased (\$ per acre)	University of California Cooperative Extension Cost of Production Study
Alfalfa Hay	284	2	368	Sacramento Valley, 2013
Almonds	763	31	828	San Joaquin Valley North, 2011
Corn, Grain	147	3	324	San Joaquin Valley South, 2012
Irrigated Pasture	63	3	159	Sacramento Valley, 2003
Rice	280	5	329	Sacramento Valley, 2012
Walnuts	690	8	1,203	San Joaquin Valley North, 2013
Wheat	246	2	57	San Joaquin Valley South, 2013
Wine Grapes	633	68	505	Cabernet Sauvignon, SJ Valley North, 2012

15 Sources: UCCE 2003, 2011, 2012a, 2012b, 2012c, 2013a, 2013b, 2013c

16 Notes: All costs are converted to 2012 dollar equivalent values using the Gross Domestic
 17 Product Implicit Price Deflator (USDOC 2014).

1 **12.3.1.4 Water Supply and Crop Acreage Relationships in the San**
2 **Joaquin Valley**

3 Most publically-available information on irrigated acreage and crop types is
4 compiled at the county level, not the water district level. Water availability for
5 CVP and SWP water is provided at a smaller geographic level, such as a water
6 supply entity or several adjacent entities. Therefore, it is difficult to analyze the
7 correlation of water supply availability, irrigated acreage, and crop types.
8 However, the Westlands Water District does provide more detailed information
9 related to water availability, irrigated acreage, and crop types in their publically-
10 available reports, as summarized in this sub-section of Chapter 12. The purpose
11 of this summary is to describe the relationships between cropping patterns,
12 irrigation methods, and water supply availability. Due to the increased frequency
13 of water supply reductions, especially in drier years (as described in Chapter 5,
14 Surface Water Resources and Water Supplies), the amount of fallowed and
15 non-harvested lands has increased as a percentage of total lands within Westlands
16 Water District. The trend observed in Westlands Water District of using
17 additional groundwater and crop idling land when CVP and SWP water supplies
18 are reduced; and reducing groundwater use and increasing irrigated acreage when
19 CVP and SWP become more available occurs throughout the San Joaquin Valley.

20 **12.3.1.4.1 Water Supplies in Westlands Water District**

21 Formed in 1952, Westlands Water District currently serves over 700 farmers
22 across 604,000 acres located on the west side of Fresno and Kings Counties, as
23 described in Chapter 5, Surface Water Resources and Water Supplies
24 (WWD 2013a, 2013b). There are approximately 568,000 irrigable acres in the
25 district.

26 Westlands Water District began receiving CVP water in 1968. In the first
27 10 years of operations, irrigation water conveyance facilities were completed and
28 cropping patterns became established. The CVP water supplies were reduced
29 during the 1976 to 1977 drought. Crop acreage and water supply information are
30 available for Westlands Water District from 1978 through 2013 (WWD 2013a,
31 2014b, 2014c).

32 This time period includes several major happenings and/or changes in the CVP
33 water supplies, as described in Chapter 5, Surface Water Resources and Water
34 Supplies, and Chapter 6, Surface Water Quality.

- 35 • In 1978, the CVP water supplies were recovering from the 1976 to
36 1977 drought.
- 37 • In the late 1980s, high selenium concentrations were detected in subsurface
38 drainage flows from areas on the west side of the San Joaquin Valley where
39 naturally occurring selenium deposits are located. Subsequently, farmers in
40 these areas changed irrigation practices and in some cases, eliminated
41 irrigation of some lands.
- 42 • Between 1987 and 1992, another drought occurred.

- 1 • In mid-1990s, the CVP water supplies recovered from a six year drought;
2 however, CVP water supplies available to the district were limited due to
3 initial restrictions on CVP operations to protect winter-run Chinook salmon
4 and delta smelt and to provide refuge water supplies in accordance with the
5 federal Central Valley Project Improvement Act (Public Law 102-575).
- 6 • By 2000, the CVP was initially operated under the requirements of State
7 Water Resources Control Board Decision 1641 and the federal Central Valley
8 Project Improvement Act which reduced the long-term availability of CVP
9 water as compared to the 1980s.
- 10 • In 2007, the CVP operations were modified in accordance with the Interim
11 Remedial Order issued by the U.S. District Court for the Eastern District of
12 California in *Natural Resources Defense Council, et al. v. Kempthorne*.
- 13 • In 2009, the CVP operations were modified in accordance with the 2008
14 U.S. Fish and Wildlife Service and 2009 National Marine Fisheries Services
15 biological opinions.
- 16 • Between 2007 and 2013, six of the seven years were designated as Below
17 Normal, Dry, or Critical Dry water years, which reduced CVP water supplies.

18 As CVP water supplies have declined over the past 35 years, Westland Water
19 District has needed to implement major conservation programs and purchase
20 water from other CVP and SWP water users and water rights holders.
21 Concurrently, growers have increased groundwater pumping, as illustrated in
22 Figure 12.3. Total supply over this time period ranges from a low of
23 787,554 acre-feet in 2010 to a high of 1,546,883 acre-feet in 1984
24 (WWD 2013a, 2014a).

25 **12.3.1.4.2 Cropping Patterns in Westlands Water District**

26 In response to varying water supplies and market factors, farmers in Westlands
27 Water District have changed cropping patterns. In 1978, the predominant crops
28 were cotton and grain crops, including wheat and barley, with some vegetables,
29 including tomatoes and cantaloupe, as summarized in Figure 12.4 (WWD 2013a).
30 Between 1980 and 1996, grain crops were replaced by vegetable crops because
31 other areas in California that traditionally grew crops were experiencing
32 urbanization and groundwater shortages, including southern Santa Clara County
33 and Monterey County (WWD 2008). Planting of permanent crops, including
34 orchards and grapevines, increased between 1978 and 2013 as the markets factors
35 became favorable (WWD 2013a, 2014b, 2014c). Total cotton acreage remained
36 stable between 1978 and 2000, with Acala cotton as the primary crop (WWD No
37 Date-a, No Date-b). After 2000, the total acreage of cotton declined and the
38 primary crop was Pima cotton due to higher market price for this crop; however,
39 cotton prices declined in the early 2000s.

40 **12.3.1.4.3 Irrigation Methods in Westlands Water District**

41 Conversion of the major crops from annual grains to more orchards and vines
42 resulted in Westlands Water District modifying water conveyance facilities

1 because the water demand patterns changed both in quantities and seasonal timing
 2 (WWD No Date-c). The change in cropping patterns and the concurrent emphasis
 3 on water conservation also resulted in changes in irrigation methods within the
 4 district, as summarized in Table 12.4.

5 **Table 12.4 Irrigation Methods Used in Westlands Water District, as a percentage of**
 6 **total irrigation methods**

Years	Furrow or Border Strip Irrigation	Sprinkler Irrigation	Drip or Trickle Irrigation	Sprinkler and Furrow Irrigation
1985	63%	21%	1%	15%
1990	43%	16%	3%	38%
1995	36%	15%	6%	43%
2000	30%	13%	13%	44%
2005	23%	10%	33%	34%
2010	11%	11%	67%	22%
2011	13%	12%	65%	22%

7 Source: WWD 2013a

8 These changes represent a major investment by the farmers and are considered in
 9 the cost of crop establishment costs, a consideration described in above in
 10 subsection 12.32.3.1, Crop Establishment Costs. The lower-valued grain and
 11 forage crops generally use furrow or border strip irrigation (WWD 2013a).
 12 Shallow-rooted vegetables frequently are irrigated with sprinklers or a
 13 combination of sprinklers and furrow irrigation. Recently, tomatoes for
 14 fresh-pack have been grown with drip irrigation. New orchard and vines have
 15 been planted with pressurized drip or trickle irrigation. Other methods, including
 16 leveling lands with lasers guided by global positioning satellites and aerated
 17 irrigation to introduce air to plant roots, are used to increase irrigation efficiency
 18 and improve crop yield (WWD No Date-a).

19 **12.3.1.4.4 Response to Reduced Water Supplies in Westlands Water**
 20 **District**

21 Westlands Water District acquired over 95,000 acres of land with inadequate
 22 drainage and the water supplies allocated to these lands are now available for
 23 other lands in the district (WWD 2008, 2013a, No Date-c). Much of the
 24 purchased land is leased to farmers for non-irrigated crops, or made available for
 25 buildings or other economic development, including about 600 acres to the
 26 U.S. Bureau of Prisons and about 1,250 acres to Pacific Gas & Electric Company
 27 for solar projects.

28 Frequently, the amount of available surface water is not adequate to meet the
 29 irrigation water demand. For example in the drier years of 1991, 1992, 2009, and
 30 2013, groundwater provided more than 50 percent of the irrigation water supply.
 31 This extensive reliance on groundwater can substantially reduce groundwater

1 elevations, as described in Chapter 7, Groundwater Resources and Groundwater
2 Quality.

3 The Westlands Water District *Water Management Handbook* discusses that
4 during droughts, water supplies are reduced and the cost of available water
5 supplies are generally high due to costs of water transfers and/or implementing
6 new or expanded groundwater facilities (WWD 2013b). At the farm level,
7 Westlands' growers use a mix of methods to respond to reduced water supplies:
8 groundwater pumping, land fallowing, and stress irrigation. The decision to
9 fallow land or stress crops by applying less than full irrigation depends upon the
10 crop. Some crops require full irrigation in order to produce a profitable yield, so
11 stress irrigation is not practical – if water is short, acreage of these crops is
12 reduced. Other crops may be able to withstand some stress and produce profitable
13 yield. In the most severe shortage years, such as 2014, even some orchards and
14 vineyards may be stressed or removed from production. From 1978 through the
15 late 1990s when the primary crops were grains and cotton, those crops continued
16 to be grown under stressed conditions and the fallowed and non-harvested land
17 ranged from 3 to 16 percent of the total land in the district, as summarized in
18 Figure 12.5 (WWD 2013a, 2014b, 2014c). However, since 2000, over 40 to
19 55 percent of the total land in the district is planted in high value orchards, vine,
20 and vegetable crops which cannot sustain stress. Therefore, farmers have
21 increased the amount of fallowed and non-harvested acres to 10 to 34 percent of
22 the total land in the district. When permanent orchards and vines are removed
23 from production, the overall value of production in the district declines for
24 number of years as the permanent crops require several years to become
25 established.

26 **12.3.2 Trinity River Region**

27 The Trinity River Region includes the area in Trinity County along the Trinity
28 River from Trinity Lake to the confluence with the Klamath River; and in
29 Humboldt and Del Norte counties along the Klamath River from the confluence
30 with the Trinity River to the Pacific Ocean.

31 Agriculture in the Trinity River Region is primarily related to timber products and
32 cattle ranching which generally do not rely upon irrigation. Small farms and
33 vineyards are located adjacent to or near the Trinity River rely primarily upon
34 groundwater that is recharged by precipitation and infiltration from local streams,
35 as described in Chapter 7, Groundwater Resources and Groundwater Quality. No
36 lands in Trinity River Region are irrigated with water supplies delivered through
37 the CVP or SWP.

38 Total value of production and acreage by crop category in the counties that
39 include portions of the Trinity River Region are listed in Table 12.5.

1 **Table 12.5 Average Annual Agricultural Acreage and Value of Production in Trinity,**
 2 **Humboldt, and Del Norte Counties from 2007 through 2012**

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	114	30,846	N/A	231	–	31,191
Value ^b	\$1.8	\$8.1	\$108.2	\$64.5	\$1.7	\$184

3 Sources: USDA-NASS2008, 2009, 2010, 2011a, 2012a, 2013a

4 Notes:

- 5 a. Not all acreages and/or production values are reported for every crop in every county.
 6 Therefore the implied value of production per acre may be misleading for some crop
 7 categories.
 8 b. Values in million dollars, 2012 basis.

9 **12.3.3 Central Valley Region**

10 The Central Valley Region extends from above Shasta Lake to the Tehachapi
 11 Mountains, and includes the Sacramento Valley and San Joaquin Valley. In this
 12 chapter, the counties within the Delta and Suisun Marsh area are included in the
 13 description of the Sacramento and San Joaquin valleys or the San Francisco Bay
 14 Area Region. The Delta counties of Sacramento, Yolo, and Solano counties are
 15 included within the Sacramento Valley discussion. Solano County also includes
 16 the Suisun Marsh. San Joaquin County is included within the San Joaquin Valley
 17 discussion. Contra Costa County is included within the San Francisco Bay Area
 18 Region discussion.

19 Central Valley agriculture is highly productive due to favorable climate, adequate
 20 supplies of good quality irrigation water, and deep, fertile soils. Most of the
 21 Central Valley receives rainfall in the late fall through the winter months. Very
 22 little of the annual rainfall occurs during the peak agricultural irrigation season
 23 which extends from early spring through fall. The seasonality of rainfall in the
 24 Central Valley is important for agricultural resources, as the timing of
 25 precipitation does not reliably support dryland (non-irrigated) farming. Lower
 26 value over-winter non-irrigated crops (e.g., winter wheat) can be grown
 27 economically in many years but higher value row crops and permanent crops
 28 require substantial supplemental irrigation (DWR 2009). Irrigation water
 29 provided by the CVP and SWP, local surface water, and groundwater have
 30 transformed lands in the Central Valley into some of the most productive and
 31 diverse agricultural lands in the United States.

32 **12.3.3.1 Sacramento Valley Crop Patterns**

33 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,
 34 Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, Sacramento, Yolo, and
 35 Solano counties. Other counties in Sacramento Valley are not anticipated to be
 36 affected by changes in CVP and SWP operations, and are not discussed here,
 37 including: Alpine, Sierra, Lassen, and Amador counties.

1 Field and forage crops dominate the irrigated acreage in Sacramento Valley with
 2 over 1.4 million acres irrigated and about 38 percent of crop value produced, as
 3 summarized in Table 12.6. Rice, irrigated pasture, and hay are the largest
 4 acreages. Second to field and forage are orchard and vine crops, making up
 5 roughly 21 percent of total acreage, but providing more than 38 percent crop
 6 value produced. Almonds and walnuts are the largest acreages in this category.
 7 Crop establishment and production costs are as summarized in Tables 12.2 and
 8 12.3. In total, the Sacramento Valley contains nearly two million agricultural
 9 acres generating over four billion dollars per year in value of production.

10 **Table 12.6 Sacramento Valley Average Annual Agricultural Acreage and Value of**
 11 **Production from 2007 through 2012**

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	419,263	1,435,923	N/A	1,658	91,684	1,948,527
Value ^b	\$1,569	\$1,581	\$506	\$135	\$322	\$4,113

12 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

13 Notes:

- 14 a. Not all acreages and/or production values are reported for every crop in every county.
 15 Therefore the implied value of production per acre may be misleading for some crop
 16 categories.
 17 b. Values in million dollars, 2012 basis

18 Most of the counties within the Sacramento Valley have experienced losses in
 19 Important Farmland between 2000 and 2010, as summarized in Table 12.7.

20 **Table 12.7 Farmland Mapping and Monitoring Program Acreages in the**
 21 **Sacramento Valley in 2000 and 2010**

County	Total ^a	Important Farmland ^b			Grazing Land		
		2000	2010	Change	2000	2010	Change
Butte	1.08	257,316	237,351	-19,965	264,982	402,999	138,017
Colusa	0.72	565,890	554,695	-11,195	7,526	9,161	1,635
El Dorado	1.1	68,292	64,259	-4,033	203,798	193,883	-9,915
Glenn	0.84	407,906	348,147	-59,759	176,072	226,837	50,765
Nevada	0.64	21,973	25,934	3,961	129,758	116,808	-12,950
Placer	0.96	156,701	132,741	-23,960	23,708	24,193	485
Sacramento	1.1	227,931	211,744	-16,187	168,144	155,822	-12,322
Shasta	2.4	35,349	19,716	-15,633	409,479	414,052	4,573
Solano	0.58	169,934	147,464	-22,470	201,813	209,195	7,382
Sutter	0.39	301,176	285,820	-15,356	50,958	53,538	2,580
Tehama	1.7	244,782	231,592	-13,190	706,027	1,547,951	841,924
Yolo	0.65	409,796	374,534	-35,262	143,365	160,450	17,085
Yuba	0.41	90,173	82,538	-7,635	144,519	141,509	-3,010

1 Sources: Butte County 2010; CDOC 2013; Colusa County 2011; El Dorado County 2003;
2 Glenn County 1993; Nevada County 1995; Placer County 2011; Sacramento County
3 2010; Shasta County 2004; Solano County 2008; Sutter County 2010; Tehama County
4 2008; Yolo County 2009; Yuba County 2011

5 Notes:

6 a. Total acreage of county in million acres

7 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland.

8 No data was reported by California Department of Conservation for Plumas County.

9 **12.3.3.2 San Joaquin Valley**

10 The San Joaquin Valley includes the counties of Stanislaus, Merced, Madera,
11 San Joaquin, Fresno, Kings, Tulare, and Kern counties. Other counties in the San
12 Joaquin Valley are not anticipated to be affected by changes in CVP and SWP
13 operations, and are not discussed here, including: Calaveras, Mariposa, and
14 Tuolumne counties.

15 Field and forage crops are also the largest category in by acreage in this region, as
16 summarized in Table 12.8. Hay, cotton, and silage have the largest acreage in this
17 category. Second to field and forage is orchard and vine crops with almost two
18 million acres, but providing more than three times the value of production.

19 Almonds and grapes are the two largest acreages of orchard and vine crops in the
20 San Joaquin Valley. Crop establishment and production costs are as summarized
21 in Tables 12.2 and 12.3. In total, the San Joaquin Valley contains over 5.5 million
22 irrigated acres, generating over twenty-six billion dollars in value of production.

23 Important differences exist in water supply mix and reliability within the San
24 Joaquin Valley. The CVP water users that are located on the west side of the
25 valley and the SWP water users in Kings and Kern counties rely primarily on
26 surface water conveyed through the Delta and groundwater, as discussed in
27 Chapter 5, Surface Water Resources and Water Supplies. Agricultural producers
28 within these CVP water service contractors and SWP entitlement holders are
29 especially susceptible to large variation in available surface water supplies. The
30 San Joaquin River Exchange Contractors receive CVP water supplies in exchange
31 for their water rights on the San Joaquin River; and therefore, have much higher
32 water supply reliability than CVP water service contractors or SWP entitlement
33 holders, as described in Chapter 5, Surface Water Resources and Water Supplies.

34 On the east side of the San Joaquin Valley at the base of the Sierra Nevada,
35 surface water is delivered under senior water rights on streams from the Sierra
36 Nevada, or by the CVP from Millerton Lake at Friant Dam, as described in
37 Chapter 5, Surface Water Resources and Water Supplies. The reliability of CVP
38 water supplies from Friant Dam have generally been similar to or higher than that
39 of CVP water supplies conveyed through the Delta. However, in 2014, the
40 allocations were reduced to zero and available water from Friant Dam was
41 provided to the water rights holders along the San Joaquin River (e.g., San
42 Joaquin River Exchange Contractors).

1 A number of agricultural areas throughout the valley have no or very low priority
 2 surface water rights. Growers in these areas rely on groundwater for irrigation
 3 water.

4 **Table 12.8 San Joaquin Valley Average Annual Agricultural Acreage and Value of**
 5 **Production from 2007 through 2012**

	Orchards, Vineyards, and Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	1,943,549	3,078,803	N/A	3,838	510,370	5,536,560
Value ^b	\$10,915	\$3,049	\$9,429	\$469	\$2,789	\$26,651

6 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

7 Notes:

8 a. Not all acreages and/or production values are reported for every crop in every county.
 9 Therefore the implied value of production per acre may be misleading for some crop
 10 categories.

11 b. Values in million dollars, 2012 basis.

12 Most counties within the San Joaquin Valley Region have experienced losses in
 13 Important Farmland between 2000 and 2010, as summarized in Table 12.9. The
 14 acreage of Important Farmland in Kern County grew substantially due to
 15 reclassification of lands in the foothills of the county.

16 **Table 12.9 Farmland Mapping and Monitoring Program Acreages in the San**
 17 **Joaquin Valley in 2000 and 2010**

County	Total ^a	Important Farmland ^b			Grazing Land		
		2000	2010	Change	2000	2010	Change
Fresno	3.8	1,400,535	1,370,273	-30,262	835,870	825,752	-10,118
Kern	5.3	990,422	914,084	-76,338	1,777,640	1,827,391	49,751
Kings	0.82	607,274	552,087	-55,187	238,485	271,831	33,346
Madera	1.4	60,617	39,812	-20,805	216,795	231,475	14,680
Merced	1.3	374,762	361,582	-13,180	401,592	400,604	-988
San Joaquin	0.91	630,990	614,994	-15,996	150,341	139,235	-11,106
Stanislaus	0.94	386,534	403,802	17,268	375,367	429,544	54,177
Tulare	3.1	880,604	859,991	-20,613	434,047	440,042	5,995

18 Sources: CDOC 2013; Fresno County 2000; Kern County 2004; Kings County 2009;
 19 Madera County 1995; Merced County 2012; San Joaquin 2009; Stanislaus County 2010;
 20 Tulare County 2010

21 Notes:

22 a. Total acreage of county in million acres

23 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

1 **12.3.4 San Francisco Bay Area Region**

2 The San Francisco Bay Area Region includes portions of Napa, Contra Costa,
3 Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP
4 service areas.

5 Crops grown in the San Francisco Bay Area Region include berries, vegetables,
6 orchards, nursery plants, and irrigated and non-irrigated pasture. Permanent crops
7 (orchards, vineyards, and berries) cover the largest acreage in this region with
8 around 60,000 acres planted, as summarized in Table 12.10. Field and forage
9 crops and vegetables also cover substantial acreage. Crop establishment and
10 production costs are generally similar to those shown in Tables 12.2 and 12.3,
11 except that land costs and rent may be substantially higher in this region. In total,
12 the San Francisco Bay Area Region contains about 150,000 acres planted,
13 creating over one billion dollars per year in value of production.

14 **Table 12.10 San Francisco Bay Area Average Annual Agricultural Acreage and**
15 **Value from 2007 through 2012**

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	60,239	50,715	N/A	942	41,564	153,460
Value ^b	\$589	\$22	\$62	\$145	\$329	\$1,148

16 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

17 Notes:

- 18 a. Not all acreages and/or production values are reported for every crop in every county.
19 Therefore the implied value of production per acre may be misleading for some crop
20 categories.
21 b. Values in million dollars, 2012 basis

22 Changes in farmland in the San Francisco Bay Area Region counties are
23 summarized in Table 12.11.

24 **Table 12.11 Farmland Mapping and Monitoring Program Acreages in the San**
25 **Francisco Bay Area Region in 2000 and 2010**

County	Total^a	Important Farmland^b			Grazing Land		
		2000	2010	Change	2000	2010	Change
Alameda	0.47	10,346	7,566	-2,780	247,218	244,033	-3,185
Contra Costa	0.52	102,294	90,148	-12,146	172,053	168,646	-3,407
Napa	0.51	78,406	76,210	-2,196	180,920	179,029	-1,891
San Benito	0.89	81,701	57,460	-24,241	595,537	614,821	19,284
Santa Clara	0.84	44,025	27,751	-16,274	389,210	392,777	3,567

26 Sources: Alameda County 2000; CDOC 2013; Contra Costa County 2005; Napa County
27 2007; San Benito County 2013; Santa Clara County 1994

- 28 a. Total acreage of county in million acres
29 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

12.3.5 Central Coast Region

The Central Coast Region includes portions of San Luis Obispo and Santa Barbara counties served by the SWP.

Crops grown in this region include orchards and vineyards, berries, vegetables, and irrigated pasture. Permanent crops and vegetables dominate the irrigated acreage in this region, accounting for about eighty percent of both the acres planted and the annual value of production, as summarized in Table 12.12. Crop establishment and production costs are generally similar to those shown in Tables 12.2 and 12.3, except that land costs and rent may be higher in this region. On average, the Central Coast Region contains almost 230,000 acres planted and almost two billion dollars per year in value of production.

Table 12.12 Central Coast Region Average Annual Agricultural Acreage and Value from 2007 through 2012

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	86,394	43,078	N/A	1,749	97,17	228,397
Value ^b	\$874	\$22	\$98	\$268	\$641	\$1,904

Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

Notes:

a. Not all acreages and/or production values are reported for every crop in every county. Therefore the implied value of production per acre may be misleading for some crop categories.

b. Values in million dollars, 2012 basis

Changes in farmland in the Central Coast Region between 2000 and 2010 are summarized in Table 12.13.

Table 12.13 Farmland Mapping and Monitoring Program Acreages in the Central Coast and Southern California Regions in 2000 and 2010

County	Total ^a	Important Farmland ^b			Grazing Land		
		2000	2010	Change	2000	2010	Change
San Luis Obispo	2.3	496,116	409,726	-86,390	1,105,169	1,181,015	75,846
Santa Barbara	1.8	139,810	125,292	-14,518	583,709	581,642	-2,067

Sources: CDOC 2013; San Luis Obispo County 2013; Santa Barbara County 2009

Notes:

a. Total acreage of county in million acres

b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

12.3.6 Southern California Region

The Southern California Region includes portions of Ventura, Los Angeles, Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.

1 Two crop categories, orchards, vineyards, and berries; and field and forage,
 2 account for more than three quarters of the irrigated acreage and about sixty
 3 percent of the annual value of production in the Southern California Region, as
 4 summarized in Table 12.14). Vegetables account for about one fifth of the
 5 irrigated acreage and production value. Crop establishment and production costs
 6 are generally similar to those shown in Tables 12.2 and 12.3, except that land
 7 costs and rent may be higher in parts of this region. In total, the Southern
 8 California Region contains almost 380,000 acres irrigated and generates over five
 9 billion dollars per year in value of production.

10 **Table 12.14 Southern California Average Annual Agricultural Acreage and Value**
 11 **from 2007 through 2012**

	Orchards, Vineyards, Berries	Field and Forage	Livestock, Dairy, Poultry	Nursery, Other	Vegetable	Total
Acreage ^a	141,447	143,747	N/A	10,143	81,306	376,642
Value ^b	\$1,693	\$161	\$809	\$1,851	\$925	\$5,439

12 Sources: USDA-NASS 2008, 2009, 2010, 2011a, 2012a, 2013a

13 Notes:

14 a. Not all acreages and/or production values are reported for every crop in every county.
 15 Therefore the implied value of production per acre may be misleading for some crop
 16 categories.

17 b. Values in million dollars, 2012 basis

18 Changes in farmland in the Southern California Region between 2000 and 2010
 19 are summarized in Table 12.15.

20 **Table 12.15 Farmland Mapping and Monitoring Program Acreages in the Southern**
 21 **California Region in 2000 and 2010**

		Important Farmland ^b			Grazing Land		
County	Total ^a	2000	2010	Change	2000	2010	Change
Los Angeles	2.6	60,617	39,812	-20,805	216,795	231,475	14,680
Orange	0.61	16,953	7,264	-9,689	37,963	37,639	-324
Riverside	4.7	484,821	428,989	-55,832	124,714	110,841	-13,873
San Bernardino	12.9	44,738	22,761	-21,977	936,090	902,590	-33,500
San Diego	2.9	193,103	218,921	25,818	137,619	126,496	-11,123
Ventura	1.2	131,512	119,683	-11,829	208,752	197,278	-11,474

22 Sources: CDOC 2013; Los Angeles County 2011; Orange County 2005; RCIP 2000; San
 23 Bernardino County 2007; San Diego County 2011; Ventura County 2005

24 Notes:

25 a. Total acreage of county in million acres

26 b. Includes Prime Farmland, Farmland of Statewide Importance, and Unique Farmland

1 **12.4 Impact Analysis**

2 This section describes the potential mechanisms and analytical methods for
3 change in agricultural resources; results of the impact analysis; potential
4 mitigation measures; and cumulative effects.

5 **12.4.1 Potential Mechanisms for Change in Agricultural** 6 **Resources**

7 As described in Chapter 4, Approach to Environmental Analysis, the impact
8 analysis considers changes in agricultural resources related to changes in CVP
9 and SWP operations under the alternatives as compared to the No Action
10 Alternative and Second Basis of Comparison.

11 Changes in CVP and SWP operations under the alternatives as compared to the
12 No Action Alternative and Second Basis of Comparison could change irrigated
13 acreage and total production value in areas that use CVP and SWP water supplies
14 under long-term conditions (based upon the 81-year model simulation period) and
15 dry and critical dry years.

16 This chapter only includes the analysis of economic changes in agricultural
17 revenues. Chapter 19, Socioeconomics, includes economic changes related to
18 municipal and industrial water supplies and changes in regional economics.

19 **12.4.1.1 Changes in Irrigated Agricultural Acreage and Total Production** 20 **Value**

21 Changes in CVP and SWP operations under the alternatives could change the
22 extent of irrigated acreage and total production value over the long-term average
23 condition and in dry and critical dry years as compared to the No Action
24 Alternative and Second Basis of Comparison.

25 The results of the impact analysis represents comparison of long-term changes
26 that would occur between alternatives by 2030. The impact analysis does not
27 represent short-term responses, especially during one to five years, in response to
28 emergency flood or drought conditions.

29 Agricultural impacts were evaluated using a regional agricultural production
30 model developed for large-scale analysis of irrigation water supply and cost
31 changes. The Statewide Agricultural Production (SWAP) model is a regional
32 model of irrigated agricultural production and economics that simulates the
33 decisions of producers (farmers) in 27 agricultural subregions in the Central
34 Valley Region, as described in Appendix 12A. The model selects the crops, water
35 supplies, and other inputs that maximize profit subject to constraints on water and
36 land, and subject to economic conditions regarding prices, yields, and costs.

37 The SWAP model incorporates CVP and SWP water supplies, other local water
38 supplies represented in the CalSim II model, and groundwater. As conditions
39 change within a SWAP subregion (e.g., the quantity of available project water
40 supply declines), the model optimizes production by adjusting the crop mix, water

1 sources and quantities used, and other inputs. The model also follows land when
2 that appears to be the most cost-effective response to resource conditions.

3 SWAP was used to compare the long-run agricultural economic responses to
4 potential changes in CVP and SWP irrigation water delivery and to changes in
5 groundwater conditions associated with the alternatives. Results from the surface
6 water analysis that used the CalSim II model, as described in Chapter 5, Surface
7 Water Resources and Water Supplies, were provided as inputs into SWAP
8 through a standardized data linkage procedure. Results from the groundwater
9 analysis that used the CVHM model, as described in Chapter 7, Groundwater
10 Resources and Groundwater Quality, were used to develop changes in pumping
11 lift in SWAP. SWAP produces estimates of the change in value and costs of
12 agricultural production.

13 The analysis only reduces groundwater withdrawals based upon an optimization
14 of agricultural production costs. The analysis does not restrict groundwater
15 withdrawals based upon groundwater overdraft or groundwater quality conditions.
16 As described in Chapter 7, Groundwater Resources and Groundwater Quality, the
17 Sustainable Groundwater Management Act requires preparation of Groundwater
18 Sustainability Plans (GSPs) by 2020 or 2022 for most of the groundwater basins
19 in the Central Valley Region. The GSPs will identify methods to implement
20 measures that will achieve sustainable groundwater operations by 2040 or 2042.
21 The analysis in this chapter is focused on conditions that would occur in 2030. If
22 local agencies fully implement GSPs prior to the regulatory deadline, increasing
23 groundwater use would be less of an option for agricultural water users.
24 However, to achieve sustainable conditions, some measures could require several
25 years to design and construct new water supply facilities, and sustainable
26 groundwater conditions are not required until the 2040s. Therefore, it was
27 assumed that Central Valley agriculture water users would not reduce
28 groundwater use by 2030, and that groundwater use would change in response to
29 changes in CVP and SWP water supplies.

30 **12.4.1.2 Effects Related to Water Transfers**

31 Historically water transfer programs have been developed on an annual basis.
32 The demand for water transfers is dependent upon the availability of water
33 supplies to meet water demands. Water transfer transactions have increased over
34 time as CVP and SWP water supply availability has decreased, especially during
35 drier water years.

36 Parties seeking water transfers generally acquire water from sellers who have
37 available surface water who can make the water available through releasing
38 previously stored water, pump groundwater instead of using surface water
39 (groundwater substitution); idle crops; or substitute crops that uses less water in
40 order to reduce normal consumptive use of surface water.

41 Water transfers using CVP and SWP Delta pumping plants and south of Delta
42 canals generally occur when there is unused capacity in these facilities. These
43 conditions generally occur in drier water year types when the flows from
44 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento

1 Valley water demands and the CVP and SWP export allocations. In non-wet
 2 years, the CVP and SWP water allocations would be less than full contract
 3 amounts; therefore, capacity may be available in the CVP and SWP conveyance
 4 facilities to move water from other sources.

5 Projecting future agricultural resources conditions related to water transfer
 6 activities is difficult because specific water transfer actions required to make the
 7 water available, convey the water, and/or use the water would change each year
 8 due to changing hydrological conditions, CVP and SWP water availability,
 9 specific local agency operations, and local cropping patterns. Reclamation
 10 recently prepared a long-term regional water transfer environmental document
 11 which evaluated potential changes in agricultural resources conditions related to
 12 water transfer actions (Reclamation 2014c). Results from this analysis were used
 13 to inform the impact assessment of potential effects of water transfers under the
 14 alternatives as compared to the No Action Alternative and the Second Basis of
 15 Comparison.

16 **12.4.2 Conditions in Year 2030 without Implementation of** 17 **Alternatives 1 through 5**

18 This EIS includes two bases of comparison, as described in Chapter 3,
 19 Description of Alternatives: the No Action Alternative and the Second Basis of
 20 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that
 21 would occur over the next 15 years without implementation of the alternatives are
 22 not analyzed in this EIS. However, the changes to agricultural resources that are
 23 assumed to occur by 2030 under the No Action Alternative and the Second Basis
 24 of Comparison are summarized in this section. Many of the changed conditions
 25 would occur in the same manner under both the No Action Alternative and the
 26 Second Basis of Comparison.

27 **12.4.2.1 Common Changes in Conditions under the No Action Alternative** 28 **and Second Basis of Comparison**

29 Conditions in 2030 would be different than existing conditions due to:

- 30 • Climate change and sea level rise
- 31 • General plan development throughout California, including increased water
 32 demands in portions of Sacramento Valley
- 33 • Implementation of reasonable and foreseeable water resources management
 34 projects to provide water supplies

35 It is anticipated that climate change would result in more short-duration
 36 high-rainfall events and less snowpack in the winter and early spring months. The
 37 reservoirs would be full more frequently by the end of April or May by 2030 than
 38 in recent historical conditions. However, as the water is released in the spring,
 39 there would be less snowpack to refill the reservoirs. These changes would result
 40 in a decline of the long-term average CVP and SWP water supply deliveries by
 41 2030 as compared to recent historical long-term average deliveries under the
 42 No Action Alternative and the Second Basis of Comparison. However, the CVP

1 and SWP water deliveries would be less under the No Action Alternative as
2 compared to the Second Basis of Comparison, as described in Chapter 5, Surface
3 Water Resources and Water Supplies, which could result in more crop idling.

4 Under the No Action Alternative and the Second Basis of Comparison, land uses
5 in 2030 would occur in accordance with adopted general plans. Development
6 under the general plans would result in disruption of agricultural resources;
7 however, the development of general plans includes preparation of environmental
8 documentation that would identify methods to minimize adverse impacts to
9 agricultural resources.

10 Under the No Action Alternative and the Second Basis of Comparison,
11 development of future water resources management projects by 2030 which
12 would result in improved water supply flexibility and availability, including water
13 supplies for agricultural resources, as described in Chapter 3, Description of
14 Alternatives.

15 By 2030 under the No Action Alternative and the Second Basis of Comparison, it
16 is assumed that ongoing programs would result in restoration of more than
17 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and
18 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the
19 Yolo Bypass. The restoration programs could disrupt agricultural resources
20 depending upon the location of the restoration.

21 **12.4.3 Evaluation of Alternatives**

22 Alternatives 1 through 5 have been compared to the No Action Alternative; and
23 the No Action Alternative and Alternatives 1 through 5 have been compared to
24 the Second Basis of Comparison.

25 During review of the numerical modeling analyses used in this EIS, an error was
26 determined in the CalSim II model assumptions related to the Stanislaus River
27 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
28 model runs. Appendix 5C, Revised Second Basis of Comparison, includes a
29 comparison of the CalSim II model run results presented in this chapter and
30 CalSim II model run results with the error corrected.

31 Chapter 7, Groundwater Resources and Groundwater Quality, includes a
32 discussion of changes in the comparison of groundwater conditions for the
33 following alternative analyses.

- 34 • No Action Alternative compared to the Second Basis of Comparison
- 35 • Alternative 1 compared to the No Action Alternative
- 36 • Alternative 3 compared to the Second Basis of Comparison
- 37 • Alternative 5 compared to the Second Basis of Comparison.

38 The results of the impact analysis represents comparison of long-term changes
39 that would occur between alternatives by 2030. The impact analysis does not
40 represent short-term responses, especially during one to five years, in response to
41 emergency flood or drought conditions.

1 **12.4.3.1 No Action Alternative**

2 The No Action Alternative is compared to the Second Basis of Comparison.

3 **12.4.3.1.1 Trinity River Region**

4 *Potential Changes in Irrigated Agricultural*

5 There are no agricultural lands irrigated with CVP and SWP water supplies in the
6 Trinity River Region. Therefore, there would be no changes in irrigated lands
7 under the No Action Alternative as compared to the Second Basis of Comparison.

8 **12.4.3.1.2 Central Valley Region**

9 *Potential Changes in Irrigated Agriculture.*

10 *Sacramento Valley*

11 Results of the SWAP analysis indicated that agricultural crop patterns in the
12 Sacramento Valley would be similar (less than 5 percent change) under the
13 No Action Alternative and the Second Basis of Comparison over long-term
14 average conditions and in dry and critical dry years, as summarized in
15 Tables 12.16 and 12.17.

16 **Table 12.16 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
17 **Average Conditions under the No Action Alternative as Compared to the Second**
18 **Basis of Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	154	1
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	199	200	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	0
Total	1,537	1,537	0

19 Notes:

20 Grain crops include corn, dry beans, and grain.

21 Field crops include cotton, grass, hay, safflower, and sugar beets.

22 Forage crops include alfalfa and pasture.

23 **Table 12.17 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
24 **Years under the No Action Alternative as Compared to the Second Basis of**
25 **Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	544	548	-4
Field Crops	59	59	0
Forage Crops	197	198	-1

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	-1
Total	1,529	1,536	-7

- 1 Notes:
 2 Grain crops include corn, dry beans, and grain.
 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
 4 Forage crops include alfalfa and pasture.

5 Agricultural production in the Sacramento Valley would be similar (less than
 6 5 percent change) under the No Action Alternative and the Second Basis of
 7 Comparison over long-term average conditions and in dry and critical dry years
 8 due to increased use of groundwater, as summarized in Tables 12.18 and 12.19.

9 **Table 12.18 Changes in Sacramento Valley Agricultural Production over the**
 10 **Long-term Average Conditions under the No Action Alternative as Compared to the**
 11 **Second Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	149	0.8
Rice	1,114	1,115	-0.9
Field Crops	77	77	0.1
Forage Crops	246	246	-0.7
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,193	-0.9
Total	5,745	5,747	-1.6

- 12 Notes:
 13 Grain crops include corn, dry beans, and grain.
 14 Field crops include cotton, grass, hay, safflower, and sugar beets.
 15 Forage crops include alfalfa and pasture.
 16 All values of production are in 2012 dollar equivalent values.

17 **Table 12.19 Changes in Sacramento Valley Agricultural Production in Dry and**
 18 **Critical Dry Years under the No Action Alternative as Compared to the Second**
 19 **Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.5
Rice	1,107	1,114	-7.3

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Field Crops	77	77	-0.1
Forage Crops	243	245	-1.4
Vegetables and Truck Crops	967	967	-0.2
Orchards and Vineyards	3,191	3,193	-1.7
Total	5,735	5,746	-11.3

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.
- 5 All values of production are in 2012 dollar equivalent values.

6 *San Joaquin Valley*

7 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin
 8 Valley, including the Tulare Lake area, would be similar under the No Action
 9 Alternative as compared to the Second Basis of Comparison over long-term
 10 average conditions and in dry and critical dry years, as summarized in
 11 Tables 12.20 and 12.21.

12 **Table 12.20 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**
 13 **Average Conditions under the No Action Alternative as Compared to the Second**
 14 **Basis of Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	0

- 15 Notes:
- 16 Grain crops include corn, dry beans, and grain.
- 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 18 Forage crops include alfalfa and pasture.

1 **Table 12.21 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**
 2 **Dry Years under the No Action Alternative as Compared to the Second Basis of**
 3 **Comparison**

Crops	No Action Alternative (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,010	1,024	-14
Rice	17	17	0
Field Crops	827	828	0
Forage Crops	735	735	-1
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,154	2,156	-2
Total	5,375	5,392	-17

- 4 Notes:
 5 Grain crops include corn, dry beans, and grain.
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.
 7 Forage crops include alfalfa and pasture.

8 Agricultural production in the Sacramento Valley would be similar under the
 9 No Action Alternative and the Second Basis of Comparison over long-term
 10 average conditions and in dry and critical dry years due to increased use of
 11 groundwater, as summarized in Tables 12.22 and 12.23.

12 **Table 12.22 Changes in San Joaquin Valley Agricultural Production over the Long-**
 13 **term Average Conditions under the No Action Alternative as Compared to the**
 14 **Second Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	-0.2
Rice	31	31	0.0
Field Crops	1,436	1,437	-0.4
Forage Crops	1,426	1,426	-0.1
Vegetables and Truck Crops	4,623	4,623	0.1
Orchards and Vineyards	16,547	16,547	0.0
Total	25,437	25,438	-0.5

- 15 Notes:
 16 Grain crops include corn, dry beans, and grain.
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
 18 Forage crops include alfalfa and pasture.
 19 All values of production are in 2012 dollar equivalent values.

1 **Table 12.23 Changes in San Joaquin Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under the No Action Alternative as Compared to the Second**
 3 **Basis of Comparison**

Crops	No Action Alternative (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,359	1,373	-14.4
Rice	31	31	0.0
Field Crops	1,436	1,437	-0.9
Forage Crops	1,426	1,426	-0.4
Vegetables and Truck Crops	4,623	4,623	-0.2
Orchards and Vineyards	16,542	16,547	-4.4
Total	25,417	25,437	-20.3

- 4 Notes:
 5 Grain crops include corn, dry beans, and grain.
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.
 7 Forage crops include alfalfa and pasture.
 8 All values of production are in 2012 dollar equivalent values.

9 *Effects Related to Cross Delta Water Transfers*

10 Potential effects to agricultural resources could be similar to those identified in a
 11 recent environmental analysis conducted by Reclamation for long-term water
 12 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c).
 13 Potential effects to agricultural resources were identified as reduced cultivation of
 14 agricultural lands over the term of the transfer in the seller’s service area.
 15 However, the amount of land effected by the water transfers would be relatively
 16 small as compared to the total cultivated acreage within a region. Beneficial
 17 changes would occur related to agricultural resources in the purchaser’s service
 18 areas. The analysis indicated that these potential impacts would not be
 19 substantial.

20 Under the No Action Alternative, the timing of cross Delta water transfers would
 21 be limited to July through September and include annual volumetric limits, in
 22 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second
 23 Basis of Comparison, water could be transferred throughout the year without an
 24 annual volumetric limit. Overall, the potential for cross Delta water transfers
 25 would be less under the No Action Alternative than under the Second Basis of
 26 Comparison.

27 **12.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California**
 28 **Regions**

29 *Potential Changes in Irrigated Agricultural*

30 It is anticipated that reductions in CVP and SWP water supplies within the
 31 San Francisco Bay Area, Central Coast, and Southern California regions would

1 not result in reductions in irrigated acreage or land use changes due to the use of
 2 other water supplies in the same manner that is projected to occur in the Central
 3 Valley Region.

4 **12.4.3.2 Alternative 1**

5 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is
 6 compared to the No Action Alternative and the Second Basis of Comparison.
 7 However, because agricultural resource conditions under Alternative 1 are
 8 identical to agricultural resource conditions under the Second Basis of
 9 Comparison; Alternative 1 is only compared to the No Action Alternative.

10 **12.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

11 *Trinity River Region*

12 *Potential Changes in Irrigated Agricultural*

13 There are no agricultural lands irrigated with CVP and SWP water supplies in the
 14 Trinity River Region. Therefore, there would be no changes in irrigated lands
 15 under Alternative 1 as compared to the No Action Alternative.

16 *Central Valley Region*

17 *Potential Changes in Irrigated Agricultural*

18 *Sacramento Valley*

19 Results of the SWAP analysis indicated that agricultural crop patterns in the
 20 Sacramento Valley would be similar under Alternative 1 as compared to the No
 21 Action Alternative over long-term average conditions and in dry and critical dry
 22 years, as summarized in Tables 12.24 and 12.25.

23 **Table 12.24 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
 24 **Average Conditions under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	154	155	-1
Rice	549	548	0
Field Crops	59	59	0
Forage Crops	200	199	1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	457	456	0
Total	1,537	1,537	0

25 Notes:

26 Grain crops include corn, dry beans, and grain.

27 Field crops include cotton, grass, hay, safflower, and sugar beets.

28 Forage crops include alfalfa and pasture.

1 **Table 12.25 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
 2 **Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	548	544	4
Field Crops	59	59	0
Forage Crops	198	197	1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	457	456	1
Total	1,536	1,529	7

- 3 Notes:
 4 Grain crops include corn, dry beans, and grain.
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.
 6 Forage crops include alfalfa and pasture.

7 Agricultural production in the Sacramento Valley would be similar (less than
 8 5 percent change) under Alternative 1 as compared to the No Action Alternative
 9 over long-term average conditions and in dry and critical dry years due to reduced
 10 use of groundwater, as summarized in Tables 12.26 and 12.27.

11 **Table 12.26 Changes in Sacramento Valley Agricultural Production over the**
 12 **Long-term Average Conditions under Alternative 1 as Compared to the No Action**
 13 **Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	149	150	-0.8
Rice	1,115	1,114	0.9
Field Crops	77	77	-0.1
Forage Crops	246	246	0.7
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,193	3,192	0.9
Total	5,747	5,745	1.6

- 14 Notes:
 15 Grain crops include corn, dry beans, and grain.
 16 Field crops include cotton, grass, hay, safflower, and sugar beets.
 17 Forage crops include alfalfa and pasture.
 18 All values of production are in 2012 dollar equivalent values.

1 **Table 12.27 Changes in Sacramento Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	0.5
Rice	1,114	1,107	7.3
Field Crops	77	77	0.1
Forage Crops	245	243	1.4
Vegetables and Truck Crops	967	967	0.2
Orchards and Vineyards	3,193	3,191	1.7
Total	5,746	5,735	11.3

- 3 Notes:
 4 Grain crops include corn, dry beans, and grain.
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.
 6 Forage crops include alfalfa and pasture.
 7 All values of production are in 2012 dollar equivalent values.

8 *San Joaquin Valley*

9 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin
 10 Valley, including the Tulare Lake area, would be similar under Alternative 1 as
 11 compared to the No Action Alternative over long-term average conditions and in
 12 dry and critical dry years, as summarized in Tables 12.28 and 12.29.

13 **Table 12.28 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**
 14 **Average Conditions under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	0

- 15 Notes:
 16 Grain crops include corn, dry beans, and grain.
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
 18 Forage crops include alfalfa and pasture.

1 **Table 12.29 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**
 2 **Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,010	14
Rice	17	17	0
Field Crops	828	827	0
Forage Crops	735	735	1
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,154	2
Total	5,392	5,375	17

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 Agricultural production in the San Joaquin Valley would be similar under
 8 Alternative 1 as compared to the No Action Alternative over long-term average
 9 conditions and in dry and critical dry years due to reduced use of groundwater, as
 10 summarized in Tables 12.30 and 12.31.

11 **Table 12.30 Changes in San Joaquin Valley Agricultural Production over the**
 12 **Long-term Average Conditions under Alternative 1 as Compared to the No Action**
 13 **Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	0.2
Rice	31	31	0.0
Field Crops	1,437	1,436	0.4
Forage Crops	1,426	1,426	0.1
Vegetables and Truck Crops	4,623	4,623	-0.1
Orchards and Vineyards	16,547	16,547	0.0
Total	25,438	25,437	0.5

14 Notes:

15 Grain crops include corn, dry beans, and grain.

16 Field crops include cotton, grass, hay, safflower, and sugar beets.

17 Forage crops include alfalfa and pasture.

18 All values of production are in 2012 dollar equivalent values.

1 **Table 12.31 Changes in San Joaquin Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 1 as Compared to the No Action Alternative**

Crops	Alternative 1 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,359	14.4
Rice	31	31	0.0
Field Crops	1,437	1,436	0.9
Forage Crops	1,426	1,426	0.4
Vegetables and Truck Crops	4,623	4,623	0.2
Orchards and Vineyards	16,547	16,542	4.4
Total	25,437	25,417	20.3

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 All values of production are in 2012 dollar equivalent values.

8 *Effects Related to Water Transfers*

9 Potential effects to agricultural resources could be similar to those identified in a
 10 recent environmental analysis conducted by Reclamation for long-term water
 11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as
 12 described above under the No Action Alternative compared to the Second Basis
 13 of Comparison. For the purposes of this EIS, it is anticipated that similar
 14 conditions would occur during implementation of cross Delta water transfers
 15 under Alternative 1 and the No Action Alternative, and that impacts on
 16 agricultural resources would not be substantial in the seller's service area due to
 17 implementation requirements of the transfer programs.

18 Under Alternative 1, water could be transferred throughout the year without an
 19 annual volumetric limit. Under the No Action Alternative, the timing of cross
 20 Delta water transfers would be limited to July through September and include
 21 annual volumetric limits, in accordance with the 2008 USFWS BO and
 22 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be
 23 increased under Alternative 1 as compared to the No Action Alternative.

24 *San Francisco Bay Area, Central Coast, and Southern California Regions*

25 *Potential Changes in Irrigated Agricultural*

26 It is anticipated that reductions in CVP and SWP water supplies within the San
 27 Francisco Bay Area, Central Coast, and Southern California regions would not
 28 result in reductions in irrigated acreage or land use changes due to the use of other
 29 water supplies in the same manner that is projected to occur in the Central Valley
 30 Region.

1 **12.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

2 Alternative 1 is identical to the Second Basis of Comparison.

3 **12.4.3.3 Alternative 2**

4 The agricultural resources under Alternative 2 would be identical to the conditions
5 under the No Action Alternative; therefore, Alternative 2 is only compared to the
6 Second Basis of Comparison.

7 **12.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

8 Changes to agricultural resources under Alternative 2 as compared to the Second
9 Basis of Comparison would be the same as the impacts described in Section
10 12.4.3.1, No Action Alternative.

11 **12.4.3.4 Alternative 3**

12 The CVP and SWP operations under Alternative 3 are similar to the Second Basis
13 of Comparison with modified Old and Middle River flow criteria and New
14 Melones Reservoir operations.

15 **12.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

16 *Trinity River Region*

17 *Potential Changes in Irrigated Agricultural*

18 There are no agricultural lands irrigated with CVP and SWP water supplies in the
19 Trinity River Region. Therefore, there would be no changes in irrigated lands
20 under Alternative 3 as compared to the No Action Alternative.

21 *Central Valley Region*

22 *Potential Changes in Irrigated Agricultural*

23 *Sacramento Valley*

24 Results of the SWAP analysis indicated that agricultural crop patterns in the
25 Sacramento Valley would be similar under Alternative 3 as compared to the No
26 Action Alternative over long-term average conditions and in dry and critical dry
27 years, as summarized in Tables 12.32 and 12.33.

28 **Table 12.32 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
29 **Average Conditions under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	154	155	-1
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	200	199	1
Vegetables and Truck Crops	119	119	0

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Orchards and Vineyards	457	456	0
Total	1,537	1,537	0

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.

5 **Table 12.33 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
 6 **Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	547	544	3
Field Crops	59	59	0
Forage Crops	197	197	1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	456	1
Total	1,533	1,529	4

- 7 Notes:
- 8 Grain crops include corn, dry beans, and grain.
- 9 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 10 Forage crops include alfalfa and pasture.

11 Agricultural production in the Sacramento Valley would be similar under
 12 Alternative 3 as compared to the No Action Alternative over long-term average
 13 conditions and in dry and critical dry years due to reduced use of groundwater, as
 14 summarized in Tables 12.34 and 12.35.

15 **Table 12.34 Changes in Sacramento Valley Agricultural Production over the**
 16 **Long-term Average Conditions under Alternative 3 as Compared to the No Action**
 17 **Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	149	150	-0.7
Rice	1,115	1,114	0.6
Field Crops	77	77	-0.1

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Forage Crops	246	246	0.5
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,192	0.9
Total	5,746	5,745	1.2

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.
- 5 All values of production are in 2012 dollar equivalent values.

6 **Table 12.35 Changes in Sacramento Valley Agricultural Production in Dry and**
 7 **Critical Dry Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	0.2
Rice	1,112	1,107	5.8
Field Crops	77	77	0.1
Forage Crops	244	243	0.8
Vegetables and Truck Crops	967	967	0.1
Orchards and Vineyards	3,193	3,191	2.2
Total	5,744	5,735	9.2

- 8 Notes:
- 9 Grain crops include corn, dry beans, and grain.
- 10 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 11 Forage crops include alfalfa and pasture.
- 12 All values of production are in 2012 dollar equivalent values.

13 *San Joaquin Valley*

14 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin
 15 Valley, including the Tulare Lake area, would be similar under Alternative 3 as
 16 compared to the No Action Alternative over long-term average conditions and in
 17 dry and critical dry years, as summarized in Tables 12.36 and 12.37.

1 **Table 12.36 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**
 2 **Average Conditions under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	0

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 **Table 12.37 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**
 8 **Dry Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,021	1,010	11
Rice	17	17	0
Field Crops	828	827	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,154	2,154	0
Total	5,387	5,375	12

9 Notes:

10 Grain crops include corn, dry beans, and grain.

11 Field crops include cotton, grass, hay, safflower, and sugar beets.

12 Forage crops include alfalfa and pasture.

13 Agricultural production in the San Joaquin Valley would be similar under
 14 Alternative 3 as compared to the No Action Alternative over long-term average
 15 conditions and in dry and critical dry years due to reduced use of groundwater, as
 16 summarized in Tables 12.38 and 12.39.

1 **Table 12.38 Changes in San Joaquin Valley Agricultural Production over the**
 2 **Long-term Average Conditions under Alternative 3 as Compared to the No Action**
 3 **Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	0.1
Rice	31	31	0.0
Field Crops	1,437	1,436	0.3
Forage Crops	1,426	1,426	0.1
Vegetables and Truck Crops	4,623	4,623	-0.1
Orchards and Vineyards	16,547	16,547	-0.1
Total	25,437	25,437	0.3

- 4 Notes:
 5 Grain crops include corn, dry beans, and grain.
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.
 7 Forage crops include alfalfa and pasture.
 8 All values of production are in 2012 dollar equivalent values.

9 **Table 12.39 Changes in San Joaquin Valley Agricultural Production in Dry and**
 10 **Critical Dry Years under Alternative 3 as Compared to the No Action Alternative**

Crops	Alternative 3 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,370	1,359	11.5
Rice	31	31	0.0
Field Crops	1,436	1,436	0.4
Forage Crops	1,426	1,426	-0.1
Vegetables and Truck Crops	4,623	4,623	0.0
Orchards and Vineyards	16,542	16,542	-0.3
Total	25,428	25,417	11.4

- 11 Notes:
 12 Grain crops include corn, dry beans, and grain.
 13 Field crops include cotton, grass, hay, safflower, and sugar beets.
 14 Forage crops include alfalfa and pasture.
 15 All values of production are in 2012 dollar equivalent values.

1 *Effects Related to Water Transfers*

2 Potential effects to agricultural resources could be similar to those identified in a
3 recent environmental analysis conducted by Reclamation for long-term water
4 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as
5 described above under the No Action Alternative compared to the Second Basis
6 of Comparison. For the purposes of this EIS, it is anticipated that similar
7 conditions would occur during implementation of cross Delta water transfers
8 under Alternative 3 and the No Action Alternative, and that impacts on
9 agricultural resources would not be substantial in the seller's service area due to
10 implementation requirements of the transfer programs.

11 Under Alternative 3, water could be transferred throughout the year without an
12 annual volumetric limit. Under the No Action Alternative, the timing of cross
13 Delta water transfers would be limited to July through September and include
14 annual volumetric limits, in accordance with the 2008 USFWS BO and
15 2009 NMFS BO. Overall, the potential for cross Delta water transfers would be
16 increased under Alternative 3 as compared to the No Action Alternative.

17 *San Francisco Bay Area, Central Coast, and Southern California Regions*

18 *Potential Changes in Irrigated Agricultural*

19 It is anticipated that reductions in CVP and SWP water supplies within the
20 San Francisco Bay Area, Central Coast, and Southern California regions would
21 not result in reductions in irrigated acreage or land use changes due to the use of
22 other water supplies in the same manner that is projected to occur in the Central
23 Valley Region.

24 **12.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

25 *Trinity River Region*

26 *Potential Changes in Irrigated Agricultural*

27 There are no agricultural lands irrigated with CVP and SWP water supplies in the
28 Trinity River Region. Therefore, there would be no changes in irrigated lands
29 under Alternative 3 as compared to the Second Basis of Comparison.

30 *Central Valley Region*

31 *Potential Changes in Irrigated Agricultural*

32 *Sacramento Valley*

33 Results of the SWAP analysis indicated that agricultural crop patterns in the
34 Sacramento Valley would be similar under Alternative 3 as compared to the
35 Second Basis of Comparison over long-term average conditions and in dry and
36 critical dry years, as summarized in Tables 12.40 and 12.41.

1 **Table 12.40 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
 2 **Average Conditions under Alternative 3 as Compared to the Second Basis of**
 3 **Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	154	154	0
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	200	200	0
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	457	457	0
Total	1,537	1,537	0

4 Notes:

5 Grain crops include corn, dry beans, and grain.

6 Field crops include cotton, grass, hay, safflower, and sugar beets.

7 Forage crops include alfalfa and pasture.

8 **Table 12.41 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
 9 **Years under Alternative 3 as Compared to the Second Basis of Comparison**

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	547	548	-1
Field Crops	59	59	0
Forage Crops	197	198	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	-1
Total	1,533	1,536	-3

10 Notes:

11 Grain crops include corn, dry beans, and grain.

12 Field crops include cotton, grass, hay, safflower, and sugar beets.

13 Forage crops include alfalfa and pasture.

1 The agricultural production value under long-term average conditions and dry and
 2 critical dry conditions would be similar under Alternative 3 and Second Basis of
 3 Comparison, as summarized in Tables 12.42 and 12.43, primarily due to a
 4 decrease in groundwater pumping.

5 **Table 12.42 Changes in Sacramento Valley Agricultural Production over the**
 6 **Long-term Average Conditions under Alternative 3 as Compared to the Second**
 7 **Basis of Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	149	149	0.1
Rice	1,115	1,115	-0.3
Field Crops	77	77	0.0
Forage Crops	246	246	-0.1
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,193	-0.1
Total	5,746	5,747	-0.3

8 Notes:
 9 Grain crops include corn, dry beans, and grain.
 10 Field crops include cotton, grass, hay, safflower, and sugar beets.
 11 Forage crops include alfalfa and pasture.
 12 All values of production are in 2012 dollar equivalent values.

13 **Table 12.43 Changes in Sacramento Valley Agricultural Production in Dry and**
 14 **Critical Dry Years under Alternative 3 as Compared to the Second Basis of**
 15 **Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.3
Rice	1,112	1,114	-1.5
Field Crops	77	77	0.0
Forage Crops	244	245	-0.6
Vegetables and Truck Crops	967	967	-0.1
Orchards and Vineyards	3,193	3,193	0.4
Total	5,744	5,746	-2.1

16 Notes:
 17 Grain crops include corn, dry beans, and grain.
 18 Field crops include cotton, grass, hay, safflower, and sugar beets.
 19 Forage crops include alfalfa and pasture.
 20 All values of production are in 2012 dollar equivalent values.

San Joaquin Valley

Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin Valley, including the Tulare Lake area, would be similar under Alternative 3 as compared to the Second Basis of Comparison over long-term average conditions and in dry and critical dry years, as summarized in Tables 12.44 and 12.45.

Table 12.44 Changes in San Joaquin Valley Irrigated Acreage over the Long-term Average Conditions under Alternative 3 as Compared to the Second Basis of Comparison

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	0

Notes:

Grain crops include corn, dry beans, and grain.

Field crops include cotton, grass, hay, safflower, and sugar beets.

Forage crops include alfalfa and pasture.

Table 12.45 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical Dry Years under Alternative 3 as Compared to the Second Basis of Comparison

Crops	Alternative 3 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,021	1,024	-3
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	-1
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,154	2,156	-2
Total	5,387	5,392	-5

Notes:

Grain crops include corn, dry beans, and grain.

Field crops include cotton, grass, hay, safflower, and sugar beets.

Forage crops include alfalfa and pasture.

1 The agricultural production value under long-term average conditions would be
 2 similar under Alternative 3 and the Second Basis of Comparison, as summarized
 3 in Tables 12.46 and 12.47, primarily due to an increase in groundwater pumping.

4 **Table 12.46 Changes in San Joaquin Valley Agricultural Production over the**
 5 **Long-term Average Conditions under Alternative 3 as Compared to the Second**
 6 **Basis of Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	-0.1
Rice	31	31	0.0
Field Crops	1,437	1,437	-0.1
Forage Crops	1,426	1,426	0.0
Vegetables and Truck Crops	4,623	4,623	0.0
Orchards and Vineyards	16,547	16,547	-0.1
Total	25,437	25,438	-0.3

7 Notes:
 8 Grain crops include corn, dry beans, and grain.
 9 Field crops include cotton, grass, hay, safflower, and sugar beets.
 10 Forage crops include alfalfa and pasture.
 11 All values of production are in 2012 dollar equivalent values.

12 **Table 12.47 Changes in San Joaquin Valley Agricultural Production in Dry and**
 13 **Critical Dry Years under Alternative 3 as Compared to the Second Basis of**
 14 **Comparison**

Crops	Alternative 3 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,370	1,373	-2.9
Rice	31	31	0.0
Field Crops	1,436	1,437	-0.6
Forage Crops	1,426	1,426	-0.5
Vegetables and Truck Crops	4,623	4,623	-0.2
Orchards and Vineyards	16,542	16,547	-4.7
Total	25,428	25,437	-8.9

15 Notes:
 16 Grain crops include corn, dry beans, and grain.
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
 18 Forage crops include alfalfa and pasture.
 19 All values of production are in 2012 dollar equivalent values.

1 *Effects Related to Water Transfers*

2 It is anticipated that water would be transferred between subbasins in the same
3 manner under Alternative 3 as compared to the Second Basis of Comparison. If
4 the water to be transferred is made available through crop idling, there would be a
5 reduction in irrigated acreage. If the water is used to reduce crop idling in dry and
6 critical dry years, there would be an increase in irrigated acreage. Therefore, the
7 changes in agricultural resources would need to be determined for each water
8 transfer program.

9 Potential effects to agricultural resources could be similar to those identified in a
10 recent environmental analysis conducted by Reclamation for long-term water
11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as
12 described above under the No Action Alternative compared to the Second Basis
13 of Comparison. For the purposes of this EIS, it is anticipated that similar
14 conditions would occur during implementation of cross Delta water transfers
15 under Alternative 3 as compared to the Second Basis of Comparison, and that
16 impacts on agricultural resources would not be substantial in the seller's service
17 area due to implementation requirements of the transfer programs.

18 Under Alternative 3 and the Second Basis of Comparison, water could be
19 transferred throughout the year without an annual volumetric limit. Overall, the
20 potential for cross Delta water transfers would be similar under Alternative 3 as
21 compared to the Second Basis of Comparison.

22 *San Francisco Bay Area, Central Coast, and Southern California Regions*

23 *Potential Changes in Irrigated Agricultural*

24 It is anticipated that reductions in CVP and SWP water supplies within the San
25 Francisco Bay Area, Central Coast, and Southern California regions would not
26 result in reductions in irrigated acreage or land use changes due to the use of other
27 water supplies in the same manner that is projected to occur in the Central Valley
28 Region.

29 **12.4.3.5 Alternative 4**

30 The agricultural resources under Alternative 4 would be identical to the
31 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only
32 compared to the No Action Alternative.

33 **12.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

34 The CVP and SWP operations under Alternative 4 are identical to the CVP and
35 SWP operations under the Second Basis of Comparison and Alternative 1.
36 Therefore, changes in agricultural resources under Alternative 4 as compared to
37 the No Action Alternative would be the same as the impacts described in
38 Section 12.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

39 **12.4.3.6 Alternative 5**

40 The CVP and SWP operations under Alternative 5 are similar to the No Action
41 Alternative with modified Old and Middle River flow criteria and New Melones
42 Reservoir operations.

1 **12.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

2 *Trinity River Region*

3 *Potential Changes in Irrigated Agricultural*

4 There are no agricultural lands irrigated with CVP and SWP water supplies in the
 5 Trinity River Region. Therefore, there would be no changes in irrigated lands
 6 under Alternative 5 as compared to the No Action Alternative.

7 *Central Valley Region*

8 *Potential Changes in Irrigated Agricultural*

9 *Sacramento Valley*

10 Results of the SWAP analysis indicated that agricultural crop patterns in the
 11 Sacramento Valley would be similar under Alternative 5 as compared to the
 12 No Action Alternative over long-term average conditions and in dry and critical
 13 dry years, as summarized in Tables 12.48 and 12.49.

14 **Table 12.48 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
 15 **Average Conditions under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	548	548	0
Field Crops	59	59	0
Forage Crops	199	199	0
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	456	0
Total	1,537	1,537	0

16 Notes:

17 Grain crops include corn, dry beans, and grain.

18 Field crops include cotton, grass, hay, safflower, and sugar beets.

19 Forage crops include alfalfa and pasture.

20 **Table 12.49 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
 21 **Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	0
Rice	544	544	0
Field Crops	59	59	0
Forage Crops	197	197	0

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	456	0
Total	1,529	1,529	0

- 1 Notes:
- 2 Grain crops include corn, dry beans, and grain.
- 3 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 4 Forage crops include alfalfa and pasture.

5 The agricultural production value under long-term average conditions and dry and
 6 critical dry conditions would be similar under Alternative 5 and the No Action
 7 Alternative, as summarized in Tables 12.50 and 12.51.

8 **Table 12.50 Changes in Sacramento Valley Agricultural Production over the**
 9 **Long-term Average Conditions under Alternative 5 as Compared to the No Action**
 10 **Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	0.0
Rice	1,114	1,114	0.1
Field Crops	77	77	0.0
Forage Crops	246	246	0.0
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,192	0.1
Total	5,745	5,745	0.1

- 11 Notes:
- 12 Grain crops include corn, dry beans, and grain.
- 13 Field crops include cotton, grass, hay, safflower, and sugar beets.
- 14 Forage crops include alfalfa and pasture.
- 15 All values of production are in 2012 dollar equivalent values.

1 **Table 12.51 Changes in Sacramento Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.1
Rice	1,107	1,107	0.2
Field Crops	77	77	0.0
Forage Crops	243	243	0.1
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,191	0.7
Total	5,736	5,735	0.8

- 3 Notes:
 4 Grain crops include corn, dry beans, and grain.
 5 Field crops include cotton, grass, hay, safflower, and sugar beets.
 6 Forage crops include alfalfa and pasture.
 7 All values of production are in 2012 dollar equivalent values.

8 *San Joaquin Valley*

9 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin
 10 Valley, including the Tulare Lake area, would be similar under Alternative 5 as
 11 compared to the No Action Alternative over long-term average conditions and dry
 12 and critical dry years, as summarized in Tables 12.52 and 12.53.

13 **Table 12.52 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**
 14 **Average Conditions under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	0

- 15 Notes:
 16 Grain crops include corn, dry beans, and grain.
 17 Field crops include cotton, grass, hay, safflower, and sugar beets.
 18 Forage crops include alfalfa and pasture.

1 **Table 12.53 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**
 2 **Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (1000s acres)	No Action Alternative (1000s acres)	Changes (1000s acres)
Grain Crops	1,010	1,010	0
Rice	17	17	0
Field Crops	827	827	0
Forage Crops	734	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,153	2,154	-1
Total	5,374	5,375	-1

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 The agricultural production value under long-term average conditions and dry and
 8 critical dry year conditions would be similar under Alternative 5 and the No
 9 Action Alternative, as summarized in Tables 12.54 and 12.55.

10 **Table 12.54 Changes in San Joaquin Valley Agricultural Production over the**
 11 **Long-term Average Conditions under Alternative 5 as Compared to the No Action**
 12 **Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	0.0
Rice	31	31	0.0
Field Crops	1,436	1,436	0.0
Forage Crops	1,426	1,426	0.0
Vegetables and Truck Crops	4,623	4,623	0.0
Orchards and Vineyards	16,547	16,547	-0.1
Total	25,437	25,437	-0.1

13 Notes:

14 Grain crops include corn, dry beans, and grain.

15 Field crops include cotton, grass, hay, safflower, and sugar beets.

16 Forage crops include alfalfa and pasture.

17 All values of production are in 2012 dollar equivalent values.

1 **Table 12.55 Changes in San Joaquin Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 5 as Compared to the No Action Alternative**

Crops	Alternative 5 (\$ millions)	No Action Alternative (\$ millions)	Changes (\$ millions)
Grain Crops	1,359	1,359	-0.1
Rice	31	31	0.0
Field Crops	1,435	1,436	-0.2
Forage Crops	1,426	1,426	-0.1
Vegetables and Truck Crops	4,622	4,623	-0.2
Orchards and Vineyards	16,540	16,542	-2.0
Total	25,414	25,417	-2.7

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 All values of production are in 2012 dollar equivalent values.

8 *Effects Related to Water Transfers*

9 Potential effects to agricultural resources could be similar to those identified in a
 10 recent environmental analysis conducted by Reclamation for long-term water
 11 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as
 12 described above under the No Action Alternative compared to the Second Basis
 13 of Comparison. For the purposes of this EIS, it is anticipated that similar
 14 conditions would occur during implementation of cross Delta water transfers
 15 under Alternative 5 and the No Action Alternative, and that impacts on
 16 agricultural resources would not be substantial in the seller's service area due to
 17 implementation requirements of the transfer programs.

18 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
 19 water transfers would be limited to July through September and include annual
 20 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
 21 Overall, the potential for cross Delta water transfers would be similar under
 22 Alternative 5 and the No Action Alternative.

23 *San Francisco Bay Area, Central Coast, and Southern California Regions*

24 *Potential Changes in Irrigated Agricultural*

25 It is anticipated that reductions in CVP and SWP water supplies within the San
 26 Francisco Bay Area, Central Coast, and Southern California regions would not
 27 result in reductions in irrigated acreage or land use changes due to the use of other
 28 water supplies in the same manner that is projected to occur in the Central Valley
 29 Region.

1 **12.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 *Potential Changes in Irrigated Agricultural*

4 There are no agricultural lands irrigated with CVP and SWP water supplies in the
 5 Trinity River Region. Therefore, there would be no changes in irrigated lands
 6 under Alternative 5 as compared to the Second Basis of Comparison.

7 *Central Valley Region*

8 *Potential Changes in Irrigated Agricultural*

9 *Sacramento Valley*

10 Results of the SWAP analysis indicated that agricultural crop patterns in the
 11 Sacramento Valley would be similar under Alternative 5 as compared to the
 12 Second Basis of Comparison over long-term average conditions and in dry and
 13 critical dry years, as summarized in Tables 12.56 and 12.57.

14 **Table 12.56 Changes in Sacramento Valley Irrigated Acreage over the Long-term**
 15 **Average Conditions under Alternative 5 as Compared to the Second Basis of**
 16 **Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	154	1
Rice	548	549	0
Field Crops	59	59	0
Forage Crops	199	200	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	0
Total	1,537	1,537	0

17 Notes:

18 Grain crops include corn, dry beans, and grain.

19 Field crops include cotton, grass, hay, safflower, and sugar beets.

20 Forage crops include alfalfa and pasture.

21 **Table 12.57 Changes in Sacramento Valley Irrigated Acreage in Dry and Critical Dry**
 22 **Years under Alternative 5 as Compared to the Second Basis of Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	155	155	-1
Rice	544	548	-4
Field Crops	59	59	0

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Forage Crops	197	198	-1
Vegetables and Truck Crops	119	119	0
Orchards and Vineyards	456	457	-1
Total	1,529	1,536	-7

1 Notes:

2 Grain crops include corn, dry beans, and grain.

3 Field crops include cotton, grass, hay, safflower, and sugar beets.

4 Forage crops include alfalfa and pasture.

5 The agricultural production value under long-term average conditions and in dry
6 and critical dry conditions would be similar under Alternative 5 and Second Basis
7 of Comparison, as summarized in Tables 12.58 and 12.59.

8 **Table 12.58 Changes in Sacramento Valley Agricultural Production over the**
9 **Long-term Average Conditions under Alternative 5 as Compared to the Second**
10 **Basis of Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	149	0.8
Rice	1,114	1,115	-0.8
Field Crops	77	77	0.1
Forage Crops	246	246	-0.6
Vegetables and Truck Crops	967	967	0.0
Orchards and Vineyards	3,192	3,193	-0.9
Total	5,745	5,747	-1.5

11 Notes:

12 Grain crops include corn, dry beans, and grain.

13 Field crops include cotton, grass, hay, safflower, and sugar beets.

14 Forage crops include alfalfa and pasture.

15 All values of production are in 2012 dollar equivalent values.

1 **Table 12.59 Changes in Sacramento Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 5 as Compared to the Second Basis of**
 3 **Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	150	150	-0.6
Rice	1,107	1,114	-7.1
Field Crops	77	77	-0.1
Forage Crops	243	245	-1.3
Vegetables and Truck Crops	967	967	-0.3
Orchards and Vineyards	3,192	3,193	-1.1
Total	5,736	5,746	-10.5

- 4 Notes:
 5 Grain crops include corn, dry beans, and grain.
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.
 7 Forage crops include alfalfa and pasture.
 8 All values of production are in 2012 dollar equivalent values.

9 *San Joaquin Valley*

10 Results of the SWAP analysis indicated that irrigated acreage in the San Joaquin
 11 Valley, including the Tulare Lake area, would be similar under Alternative 5 as
 12 compared to the Second Basis of Comparison over long-term average conditions
 13 and in dry and critical dry years, as summarized in Tables 12.60 and 12.61.

14 **Table 12.60 Changes in San Joaquin Valley Irrigated Acreage over the Long-term**
 15 **Average Conditions under Alternative 5 as Compared to the Second Basis of**
 16 **Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,024	1,024	0
Rice	17	17	0
Field Crops	828	828	0
Forage Crops	735	735	0
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,156	2,156	0
Total	5,392	5,392	-1

- 17 Notes:
 18 Grain crops include corn, dry beans, and grain.
 19 Field crops include cotton, grass, hay, safflower, and sugar beets.
 20 Forage crops include alfalfa and pasture.

1 **Table 12.61 Changes in San Joaquin Valley Irrigated Acreage in Dry and Critical**
 2 **Dry Years under Alternative 5 as compared to the Second Basis of Comparison**

Crops	Alternative 5 (1000s acres)	Second Basis of Comparison (1000s acres)	Changes (1000s acres)
Grain Crops	1,010	1,024	-14
Rice	17	17	0
Field Crops	827	828	0
Forage Crops	734	735	-1
Vegetables and Truck Crops	633	633	0
Orchards and Vineyards	2,153	2,156	-3
Total	5,374	5,392	-18

3 Notes:

4 Grain crops include corn, dry beans, and grain.

5 Field crops include cotton, grass, hay, safflower, and sugar beets.

6 Forage crops include alfalfa and pasture.

7 The agricultural production value under long-term average conditions and in dry
 8 and critical dry conditions would be similar, as summarized in Tables 12.62 and
 9 12.63, primarily due to an increase in groundwater pumping.

10 **Table 12.62 Changes in San Joaquin Valley Agricultural Production over the**
 11 **Long-term Average Conditions under Alternative 5 as Compared to the Second**
 12 **Basis of Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,373	1,373	-0.2
Rice	31	31	0.0
Field Crops	1,436	1,437	-0.5
Forage Crops	1,426	1,426	-0.1
Vegetables and Truck Crops	4,623	4,623	0.2
Orchards and Vineyards	16,547	16,547	-0.1
Total	25,437	25,438	-0.7

13 Notes:

14 Grain crops include corn, dry beans, and grain.

15 Field crops include cotton, grass, hay, safflower, and sugar beets.

16 Forage crops include alfalfa and pasture.

17 All values of production are in 2012 dollar equivalent values.

1 **Table 12.63 Changes in San Joaquin Valley Agricultural Production in Dry and**
 2 **Critical Dry Years under Alternative 5 as Compared to the Second Basis of**
 3 **Comparison**

Crops	Alternative 5 (\$ millions)	Second Basis of Comparison (\$ millions)	Changes (\$ millions)
Grain Crops	1,359	1,373	-14.5
Rice	31	31	0.0
Field Crops	1,435	1,437	-1.2
Forage Crops	1,426	1,426	-0.5
Vegetables and Truck Crops	4,622	4,623	-0.5
Orchards and Vineyards	16,540	16,547	-6.4
Total	25,414	25,437	-22.9

- 4 Notes:
 5 Grain crops include corn, dry beans, and grain.
 6 Field crops include cotton, grass, hay, safflower, and sugar beets.
 7 Forage crops include alfalfa and pasture.
 8 All values of production are in 2012 dollar equivalent values.

9 *Effects Related to Water Transfers*

10 Potential effects to agricultural resources could be similar to those identified in a
 11 recent environmental analysis conducted by Reclamation for long-term water
 12 transfers from the Sacramento to San Joaquin valleys (Reclamation 2014c) as
 13 described above under the No Action Alternative compared to the Second Basis
 14 of Comparison. For the purposes of this EIS, it is anticipated that similar
 15 conditions would occur during implementation of cross Delta water transfers
 16 under Alternative 5 and the Second Basis of Comparison, and that impacts on
 17 agricultural resources would not be substantial in the seller’s service area due to
 18 implementation requirements of the transfer programs.

19 Under Alternative 5, the timing of cross Delta water transfers would be limited to
 20 July through September and include annual volumetric limits, in accordance with
 21 the 2008 USFWS BO and 2009 NMFS BO. Under Second Basis of Comparison,
 22 water could be transferred throughout the year without an annual volumetric limit.
 23 Overall, the potential for cross Delta water transfers would be reduced under
 24 Alternative 5 as compared to the Second Basis of Comparison.

25 *San Francisco Bay Area, Central Coast, and Southern California Regions*

26 *Potential Changes in Irrigated Agricultural*

27 It is anticipated that reductions in CVP and SWP water supplies within the San
 28 Francisco Bay Area, Central Coast, and Southern California regions would not
 29 result in reductions in irrigated acreage or land use changes due to the use of other
 30 water supplies in the same manner that is projected to occur in the Central Valley
 31 Region.

1 **12.4.3.7 Summary of Environmental Consequences**

2 The results of the environmental consequences of implementation of
 3 Alternatives 1 through 5 as compared to the No Action Alternative and the
 4 Second Basis of Comparison are presented in Tables 12.64 and 12.65. The results
 5 of the impact analysis represents comparison of long-term changes that would
 6 occur between alternatives by 2030. The impact analysis does not represent
 7 short-term responses, especially during one to five years, in response to
 8 emergency flood or drought conditions.

9 **Table 12.64 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects on agricultural resources.	None needed
Alternative 2	No effects on agricultural resources.	None needed
Alternative 3	No effects on agricultural resources.	None needed
Alternative 4	No effects on agricultural resources.	None needed
Alternative 5	No effects on agricultural resources.	None needed

10 **Table 12.65 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 11 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects on agricultural resources.	Not considered for this comparison.
Alternative 1	No effects on agricultural resources.	Not considered for this comparison.
Alternative 2	No effects on agricultural resources.	Not considered for this comparison.
Alternative 3	No effects on agricultural resources.	Not considered for this comparison.
Alternative 4	No effects on agricultural resources.	Not considered for this comparison.
Alternative 5	No effects on agricultural resources.	Not considered for this comparison.

12 **12.4.3.8 Potential Mitigation Measures**

13 Mitigation measures are presented in this section to avoid, minimize, rectify,
 14 reduce, eliminate, or compensate for adverse environmental effects of
 15 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation
 16 measures were not included to address adverse impacts under the alternatives as
 17 compared to the Second Basis of Comparison because this analysis was included
 18 in this EIS for information purposes only.

1 Changes in CVP and SWP operations under Alternatives 1 through 5 as compared
 2 to the No Action Alternative, would not result in changes in agricultural
 3 resources. Therefore, there would be no adverse impacts to agricultural
 4 resources; and no mitigation measures are required.

5 **12.4.3.9 Cumulative Effects Analysis**

6 As described in Chapter 3, the cumulative effects analysis considers projects,
 7 programs, and policies that are not speculative; and are based upon known or
 8 reasonably foreseeable long-range plans, regulations, operating agreements, or
 9 other information that establishes them as reasonably foreseeable.

10 The cumulative effects analysis Alternatives 1 through 5 for Agricultural
 11 Resources are summarized in Table 12.66.

12 **Table 12.66 Summary of Cumulative Effects on Agricultural Resources of**
 13 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): <ul style="list-style-type: none"> - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site - Nimbus Fish Hatchery Fish Passage Project - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project - Dutch Slough Tidal Marsh Restoration 	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions. Some future water quality and habitat projects could modify surface water conditions; however, water supplies are not anticipated to be affected. Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability. Developments under the general plans and future water supply, water quality improvement, and restoration projects are anticipated to potentially affect agricultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to agricultural resources.

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Stockton Deep Water Ship Channel Dissolved Oxygen Project - Grasslands Bypass Project - Central Valley Salinity Alternatives for Long-Term Sustainability (CV-SALTS) - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents) 	<p>Some of the future actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a beneficial impact to remaining agricultural resources.</p>
<p>Future Actions considered as Cumulative Effects Actions with All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - Irrigated Lands Regulatory Program - San Luis Reservoir Low Point Improvement Project - <i>Westlands Water District v. United States Settlement</i> - Future water supply projects, including water recycling, 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p> <p>Developments under the future projects are anticipated to potentially affect agricultural resources. However, development of these future programs would include preparation of environmental documentation that would identify methods to minimize adverse impacts to agricultural resources.</p> <p>Some of the reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta. These programs would result in a</p>

Scenarios	Actions	Cumulative Effects of Actions
	desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS)	beneficial impact to agricultural resources.
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p> <p>Some of the reasonably foreseeable actions would reduce the effects of agricultural drainage and/or reduce salinity in the San Joaquin River and the Delta.</p>
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1 **12.5 References**

- 2 AgAlert. 2010. “‘Rolling stumping’ could be in future for avocado trees”.
3 Written by Kate Campbell for April 14, 2010. Site Accessed June 24,
4 2014. <http://www.agalert.com/story/?id=1513>
- 5 Alameda County. 2000. *East County Area Plan (Revised by Initiative*
6 *Nov. 2000)*.
- 7 Ayers, R. S., and D. W. Westcot. Reprinted 1989, 1994. *Water Quality for*
8 *Agriculture. FAO Irrigation and Drainage Paper No. 29, Rev. 1.* Site
9 accessed August 7, 2014.
10 <http://www.fao.org/docrep/003/t0234e/T0234E00.htm>
- 11 Baldwin, K. R. 2006. *Crop Rotations on Organic Farms, North Carolina*
12 *Cooperative Extension Service.* June.
- 13 Butte County. 2010. *General Plan Draft Environmental Impact Report.* April 8.
- 14 BVWSD (Buena Vista Water Storage District). 2015. *Buena Vista Water*
15 *Storage District, James Groundwater Storage and Recovery Project.* Site
16 accessed February 15, 2015. <http://bvhd.com/James.html>
- 17 CALFED (CALFED Bay-Delta Program). 2000. *Final Programmatic*
18 *Environmental Impact Statement/Environmental Impact Report.* July.
- 19 CDOC (California Department of Conservation). 2004. *A Guide to the Farmland*
20 *Mapping and Monitoring Program, 2004 Edition.*
- 21 CDOC (California Department of Conservation). 2013. *California Department*
22 *of Conservation, Farmland Mapping and Monitoring Program.* Site
23 accessed February 7, 2013.
24 <http://www.conservation.ca.gov/dlrp/FMMP/Pages/Index.aspx>.
- 25 Colusa County. 2011. *Public Draft Environmental Impact Report for the 2030*
26 *Colusa County General Plan Update.* November.
- 27 Contra Costa County. 2005. *Contra Costa County General Plan, 2005-2020.*
28 January.
- 29 Dale et al. (Dale, L. L., and L. S. Dixon). 1998. *The Impact of Water Supply*
30 *Reductions on San Joaquin Valley Agriculture During the 1986-1992*
31 *Drought.* RAND.
- 32 DWR (California Department of Water Resources). 2009. *California Water*
33 *Plan, Update 2009, Integrated Water Management.* December.
- 34 DWR (California Department of Water Resources). 2012. *A Proposed*
35 *Methodology for Quantifying the Efficiency of Agricultural Water Use,*
36 *Report to the Legislature by the DWR Water Use and Efficiency Branch.*
37 May 8.
- 38 DWR (California Department of Water Resources). 2013a. *California Water*
39 *Plan Update 2013, Public Review Draft.* October.

- 1 DWR (California Department of Water Resources). 2013b. *North-of-the-Delta*
 2 *Offstream Storage Preliminary Administrative Draft Environmental*
 3 *Impact Report*. December.
- 4 DWR, Reclamation, USFWS and NMFS (California Department of Water
 5 Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and
 6 National Marine Fisheries Service). 2013. *Draft Environmental Impact*
 7 *Report/Environmental Impact Statement for the Bay Delta Conservation*
 8 *Plan*. November.
- 9 Edinger-Marshall, S., and J. Letey. 1997. *Irrigation Shifts toward Sprinklers,*
 10 *Drip and Microsprinklers*. University of California Agricultural and
 11 Natural Resources. *California Agriculture* 51(3):38-40.
- 12 El Dorado County. 2003. *El Dorado County General Plan Draft Environmental*
 13 *Impact Report*. May.
- 14 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
 15 *General Information – Licensing*. Site accessed April 29, 2015.
 16 <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>
- 17 Fresno Bee. 2014. *San Joaquin Valley farmers take drastic measures to deal*
 18 *with drought*. Written by Robert Rodriguez. January 18.
- 19 Fresno County. 2000. *Fresno County General Plan Background Report*.
 20 October.
- 21 Glenn County. 1993. *Glenn County General Plan*. June 15.
- 22 Grattan, Stephen. 2002. *Irrigation Water Salinity and Crop Production,*
 23 *University of California, Agricultural and Natural Resources, University*
 24 *of California, Davis, Publication 8066*.
- 25 Howitt et al. (R. Howitt, D. MacEwan, C. Garnache, J.M Azuara, P. Marchand,
 26 and D. Brown). 2012. *Yolo Bypass Flood Date and Flow Volume*
 27 *Agricultural Impact Analysis, Prepared for Yolo County*. May 15.
- 28 Kern County. 2004. *Revised Update of the Kern County General Plan and*
 29 *Amendment of the Kern County and Incorporated Cities Integrated Waste*
 30 *Management Plan Siting Element, Recirculated Draft Program*
 31 *Environmental Impact Report*. January.
- 32 Kings County. 2009. *2035 Kings County General Plan Draft Environmental*
 33 *Impact Report*. June.
- 34 KRCD (Kings River Conservation District). 2012. *Sustainable Groundwater*
 35 *Management through an Integrated Regional Water Management Plan*
 36 *(IRWMP)*.
- 37 Los Angeles County (County of Los Angeles). 2011. *Public Review Draft 4/5/11*
 38 *Text-Only Version, Los Angeles County General Plan 2035*. April.
- 39 Madera County. 1995. *Madera County General Plan Background Report*.
 40 October.

Chapter 12: Agricultural Resources

- 1 Maas and Hoffman (Maas, E. V. and Hoffman, G.J.). 1977. *Crop Salt*
2 *Tolerance: Current Assessment*. Journal of the Irrigation and Drainage
3 Division, American Society of Civil Engineers 103(2):115–134.
4 Proceeding Paper 12993.
- 5 Merced County. 2012. *2030 Merced County General Plan Draft Program*
6 *Environmental Impact Report*. November.
- 7 MORE (Mokelumne River Water & Power Authority). 2015. *Status and*
8 *Timeline*. Site accessed January 14, 2015.
9 http://www.morewater.org/about_project/status_timeline.html
- 10 MWDC (Metropolitan Water District of Southern California). 2010. *Integrated*
11 *Water Resources Plan, 2010 Update*. October.
- 12 Napa County. 2007. *Draft General Plan Environmental Impact Report*.
13 February.
- 14 NCWA (Northern California Water Association). 2011. *Final Draft, Efficient*
15 *Water Management for Regional Sustainability in the Sacramento Valley*.
16 July.
- 17 Nevada County (County of Nevada). 1995. *Nevada County General Plan, Final*
18 *Environmental Impact Report*. March.
- 19 NSJCGBA (Northeastern San Joaquin County Groundwater Banking Authority).
20 2007. *Eastern San Joaquin Integrated Regional Water Management Plan*.
21 July.
- 22 Orange County. 2005. *2005 Orange County General Plan*.
- 23 Panuska, J. 2011. Agricultural Drainage: Function and Value. Presentation to
24 and Abstract in the Proceedings of the Wisconsin Crop Management
25 Conference, Vol. 50. 2011.
- 26 Placer County. 2011. *Placer County Conservation Plan, Western Placer County,*
27 *Agency Review Draft Document*. February 1.
- 28 RCIP (Riverside County Integrated Project). 2000. *Existing Setting Report*.
29 March.
- 30 Reclamation (Bureau of Reclamation). 2005. *San Luis Drainage Feature Re-*
31 *evaluation, Draft Environmental Impact Statement*. May.
- 32 Reclamation (Bureau of Reclamation). 2013a. *Shasta Lake Water Resources*
33 *Investigation Draft Environmental Impact Statement*. June.
- 34 Reclamation (Bureau of Reclamation). 2013b. *Record of Decision, Water*
35 *Transfer Program for the San Joaquin River Exchange Contractors Water*
36 *Authority, 2014-2038*. July 30.
- 37 Reclamation (Bureau of Reclamation). 2014a. *Findings of No Significant*
38 *Impact, 2014 Tehama-Colusa Canal Authority Water Transfers*. April 22.

- 1 Reclamation (Bureau of Reclamation). 2014b. *Findings of No Significant*
 2 *Impact, 2014 San Luis & Delta-Mendota Water Authority Water*
 3 *Transfers*. April 22.
- 4 Reclamation (Bureau of Reclamation). 2014c. *Long-Term Water Transfers*
 5 *Environmental Impact Statement/Environmental Impact Report, Public*
 6 *Draft*. September.
- 7 Reclamation (Bureau of Reclamation). 2014d. *Upper San Joaquin River Basin*
 8 *Storage Investigation, Draft Environmental Impact Statement*. August.
- 9 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
 10 Game [now known as Department of Fish and Wildlife], and U.S. Fish
 11 and Wildlife Service). 2011. *Suisun Marsh Habitat Management,*
 12 *Preservation, and Restoration Plan Final Environmental Impact*
 13 *Statement/Environmental Impact Report*.
- 14 Reclamation, CCWD, and Western (Bureau of Reclamation, Contra Costa Water
 15 District, and Western Area Power Administration). 2010. *Los Vaqueros*
 16 *Expansion Project, Environmental Impact Statement/Environmental*
 17 *Impact Report*. March.
- 18 Roel et al. (Roel, A., R.G. Mutters, J.W. Eckert, and R.E. Plant). 2005. *Effect of*
 19 *Low Water Temperature on Rice Yield in California*. Published online
 20 13 May 2005, Agronomy Journal.
- 21 Sacramento County. 2010. *Final Environmental Impact Report, Sacramento*
 22 *County General Plan Update*. April.
- 23 San Benito County (County of San Benito). 2013. *2035 San Benito County*
 24 *General Plan Update Draft Program Environmental Impact Report*.
 25 November.
- 26 San Bernardino County (County of San Bernardino). 2007. *County of San*
 27 *Bernardino 2006 General Plan Program, Final Environmental Impact*
 28 *Report and Appendices*. February.
- 29 San Diego County (County of San Diego). 2011. *San Diego County General*
 30 *Plan Update, Final Environmental Impact Report*. August.
- 31 San Joaquin County. 2009. *General Plan Update Background Report*. July.
- 32 San Luis Obispo County (County of San Luis Obispo). 2013. *County of San Luis*
 33 *Obispo, Land Use and Circulation Elements*. August.
- 34 Santa Barbara County (County of Santa Barbara). 2009. *Santa Barbara County*
 35 *Comprehensive Plan*. May.
- 36 Santa Clara County (County of Santa Clara). 1994. *Santa Clara County General*
 37 *Plan Draft Environmental Impact Report*. September.
- 38 SEWD (Stockton East Water District). 2012. *Farmington Groundwater*
 39 *Recharge Program*. Site accessed November 30, 2012.
 40 <http://www.farmingtonprogram.org/index.html>

Chapter 12: Agricultural Resources

- 1 Shasta County. 2004. *Shasta County General Plan, as amended through*
2 *September 2004*. September.
- 3 SJVDP (San Joaquin Valley Drainage Program). 1990. *A Management Plan for*
4 *Agricultural Subsurface Drainage and Related Problems on the Westside*
5 *San Joaquin Valley. Final Report of the San Joaquin Valley Drainage*
6 *Program*. September.
- 7 SJVDIP (San Joaquin Valley Drainage Implementation Program). 1998.
8 *Drainage Management in the San Joaquin Valley, A Status Report*.
9 February.
- 10 Solano County. 2008. *Solano County General Plan, Draft Environmental Impact*
11 *Report*. April.
- 12 Stanislaus County (County of Stanislaus County). 2010. *Stanislaus County*
13 *General Plan Support Documentation, Revised April 2010*. April.
- 14 Sutter County. 2010. *General Plan Update Draft Environmental Impact Report*.
15 September.
- 16 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control*
17 *Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.
18 December 13.
- 19 SWRCB (State Water Resources Control Board). 2013. *Comprehensive (Phase*
20 *2) Review and Update to the Bay-Delta Plan, DRAFT Bay-Delta Plan*
21 *Workshops Summary Report*. January
- 22 SWSD (Semitropic Water Storage District). 2011. *Delta Wetlands Project Place*
23 *of Use, Final Environmental Impact Report*. August.
- 24 Tehama County. 2008. *Tehama County 2008-2028 General Plan Draft*
25 *Environmental Impact Report*. September.
- 26 Tulare County. 2010. *Tulare County General Plan 2030 Update, Recirculated*
27 *Draft Environmental Impact Report*. February.
- 28 UCCE (University of California Cooperative Extension). 2003. *Sample Costs to*
29 *Establish and Produce Pasture, Sacramento Valley, Flood Irrigation*.
- 30 UCCE (University of California Cooperative Extension). 2011. *Sample Costs to*
31 *Establish an Orchard and Produce Almonds, San Joaquin Valley North,*
32 *Flood Irrigation*.
- 33 UCCE (University of California Cooperative Extension). 2012a. *Sample Costs to*
34 *Establish a Vineyard and Produce Winegrapes, Cabernet Sauvignon, San*
35 *Joaquin Valley North-Crush District 11 of San Joaquin and Sacramento*
36 *Counties*.
- 37 UCCE (University of California Cooperative Extension). 2012b. *Sample Costs*
38 *to Produce Corn Silage, San Joaquin Valley-South, Double Cropped*
39 *Planting*.

- 1 UCCE (University of California Cooperative Extension). 2012c. *Sample Costs to*
2 *Produce Rice, Sacramento Valley, Rice Only Rotation, Medium Grain.*
- 3 UCCE (University of California Cooperative Extension). 2013a. *Sample Costs to*
4 *Establish and Produce Organic Alfalfa Hay, California-2013.*
- 5 UCCE (University of California Cooperative Extension). 2013b. *Sample Costs*
6 *to Establish a Walnut Orchard and Produce Walnuts, San Joaquin Valley-*
7 *North, Late leafing-lateral bearing.*
- 8 UCCE (University of California Cooperative Extension). 2013c. *Sample Costs to*
9 *Produce Wheat for Grain, San Joaquin Valley-South, Irrigated.*
- 10 USDA (U. S. Department of Agriculture). 2010. *Impacts of Irrigation Water*
11 *Quality on The Persistence and Transmission Of E. Coli O157:H7 from*
12 *Soil To Plants, 2010 Annual Report.* Site accessed June 24, 2014.
13 [http://seprl.ars.usda.gov/research/projects/projects.htm?ACCN_NO=4132](http://seprl.ars.usda.gov/research/projects/projects.htm?ACCN_NO=413282&fy=2010)
14 [82&fy=2010](http://seprl.ars.usda.gov/research/projects/projects.htm?ACCN_NO=413282&fy=2010)
- 15 USDA (U. S. Department of Agriculture). 2014b. *News Release: Obama*
16 *Administration Announces Additional Assistance to Californians Impacted*
17 *by Drought, February 14, 2014.* Site accessed August 10, 2014.
18 [http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/02/00](http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/02/0022.xml)
19 [22.xml.](http://www.usda.gov/wps/portal/usda/usdamediafb?contentid=2014/02/0022.xml)
- 20 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
21 Service). 2008. *California County Agricultural Commissioners' Data,*
22 *2007.* August 29.
- 23 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
24 Service). 2009. *California County Agricultural Commissioners' Data,*
25 *2008.* October 15.
- 26 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
27 Service). 2010. *California County Agricultural Commissioners' Data,*
28 *2009.* December.
- 29 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
30 Service). 2011a. *California County Agricultural Commissioners' Data,*
31 *2010.* December.
- 32 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
33 Service). 2011b. *California Agricultural Statistics, 2010 Crop Year.*
34 October 28.
- 35 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
36 Service). 2012a. *California County Agricultural Commissioners'*
37 *Reports, 2011.* December 17.
- 38 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
39 Service). 2012b. *California Agricultural Statistics, 2011 Crop Year.*
40 October 31.

Chapter 12: Agricultural Resources

- 1 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
2 Service). 2013a. *California County Agricultural Commissioners’
3 Reports, 2012.*
- 4 USDA-NASS (U. S. Department of Agriculture, National Agricultural Statistics
5 Service). 2013b. *California Agricultural Statistics, 2012 Crop Year.*
- 6 USDOC (U.S. Department of Commerce). 2014. *Bureau of Economic Analysis.
7 Gross Domestic Product Implicit Price Deflator. Annual Series.
8 Washington, D.C.* Site accessed June 24, 2014.
9 <http://research.stlouisfed.org/fred2/series/A191RD3A086NBEA>.
- 10 USGS (U.S. Geological Survey). 2008. *Technical Analysis of In-Valley
11 Drainage Management Strategies for the Western San Joaquin Valley,
12 California, Open File Report 2008-1210.*
- 13 Ventura County (County of Ventura). 2005. *Final Subsequent Environmental
14 Impact Report for Focused General Plan Update.* June.
- 15 WRCD (Westside Resource Conservation District). 2004. *A Landowner’s
16 Manual -- Managing Agricultural Irrigation Drainage Water: A guide for
17 developing Integrated On-Farm Drainage Management systems.*
- 18 WWD (Westlands Water District). 2008. *Water Management Plan, 2007.*
19 April 19.
- 20 WWD (Westlands Water District). 2013a. *Water Management Plan, 2012.*
21 April 19.
- 22 WWD (Westlands Water District). 2013b. *Water Management Handbook.*
23 June 17.
- 24 WWD (Westlands Water District). 2014a. *Annual Water Supply and Use.* Site
25 accessed March 24, 2014.
26 <http://www.westlandswater.org/resources/watersupply/supply.asp?title=Annual%20Water%20Use%20and%20Supply&cwide=1920>
27
- 28 WWD (Westlands Water District). 2014b. *Westlands Water District 2012 Crop
29 Acreage Report.* Site accessed June 28, 2014. [http://wwd.ca.gov/wp-
30 content/uploads/2014/04/croprpt2012.pdf](http://wwd.ca.gov/wp-content/uploads/2014/04/croprpt2012.pdf).
- 31 WWD (Westlands Water District). 2014c. *Westlands Water District 2013 Crop
32 Acreage Report.* Site accessed June 28, 2014. [http://wwd.ca.gov/wp-
33 content/uploads/2014/04/croprpt13.pdf](http://wwd.ca.gov/wp-content/uploads/2014/04/croprpt13.pdf).
- 34 WWD (Westlands Water District). No Date-a. *Westlands Water District Annual
35 Report 2000/2001.*
- 36 WWD (Westlands Water District). No Date-b. *Westlands Water District Annual
37 Report 2001-2002.*
- 38 WWD (Westlands Water District). No Date-c. *Westlands Water District Annual
39 Report 2004/2005.*

- 1 Yolo County. 2009. *Yolo County 2030 Countywide General Plan Environmental*
- 2 *Impact Report Public Review Draft*. April.
- 3 Yuba County. 2011. *Final Yuba County 2030 General Plan Environmental*
- 4 *Impact Report*. May.

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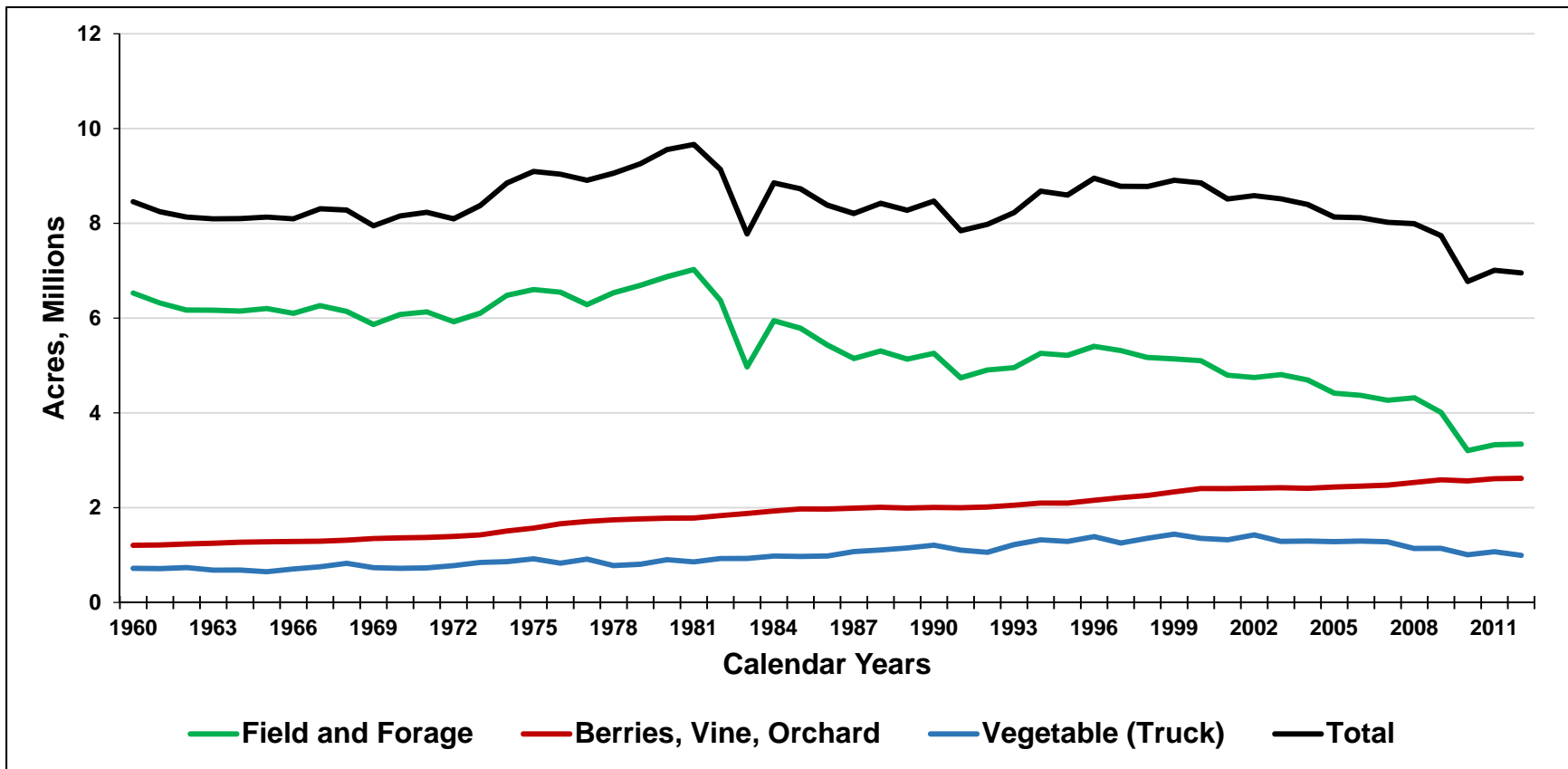


Figure 12.1 California Agricultural Production Acreage, 1960 to 2012

Source: USDA-NASS 2011, 2012a, 2012b, 2013b

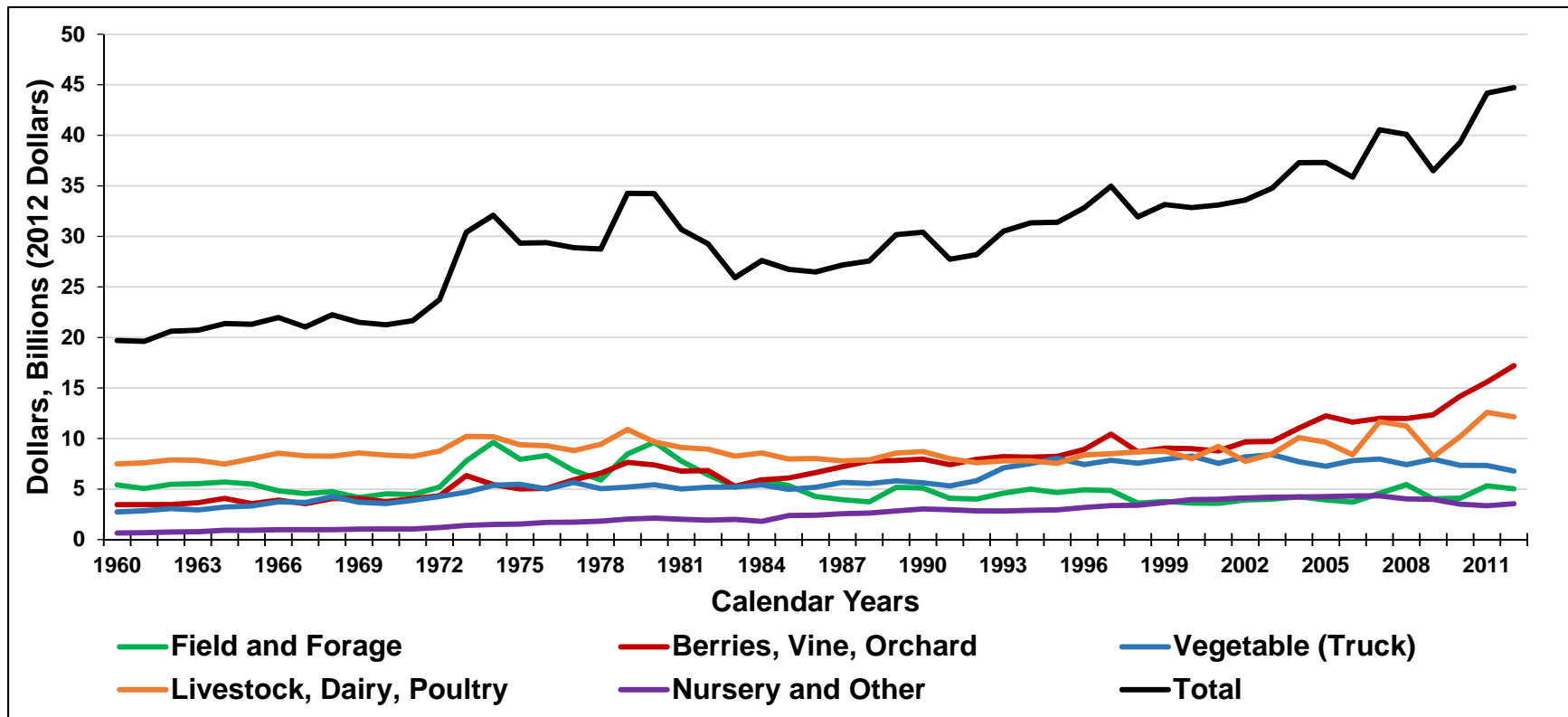


Figure 12.2 Total Value of California Agricultural Production, 1960 to 2012

Source: USDA 2014b; USDA-NASS 2008, 2009, 2010, 2011a, 2011b, 2012a, 2012b, 2013a, 2013b

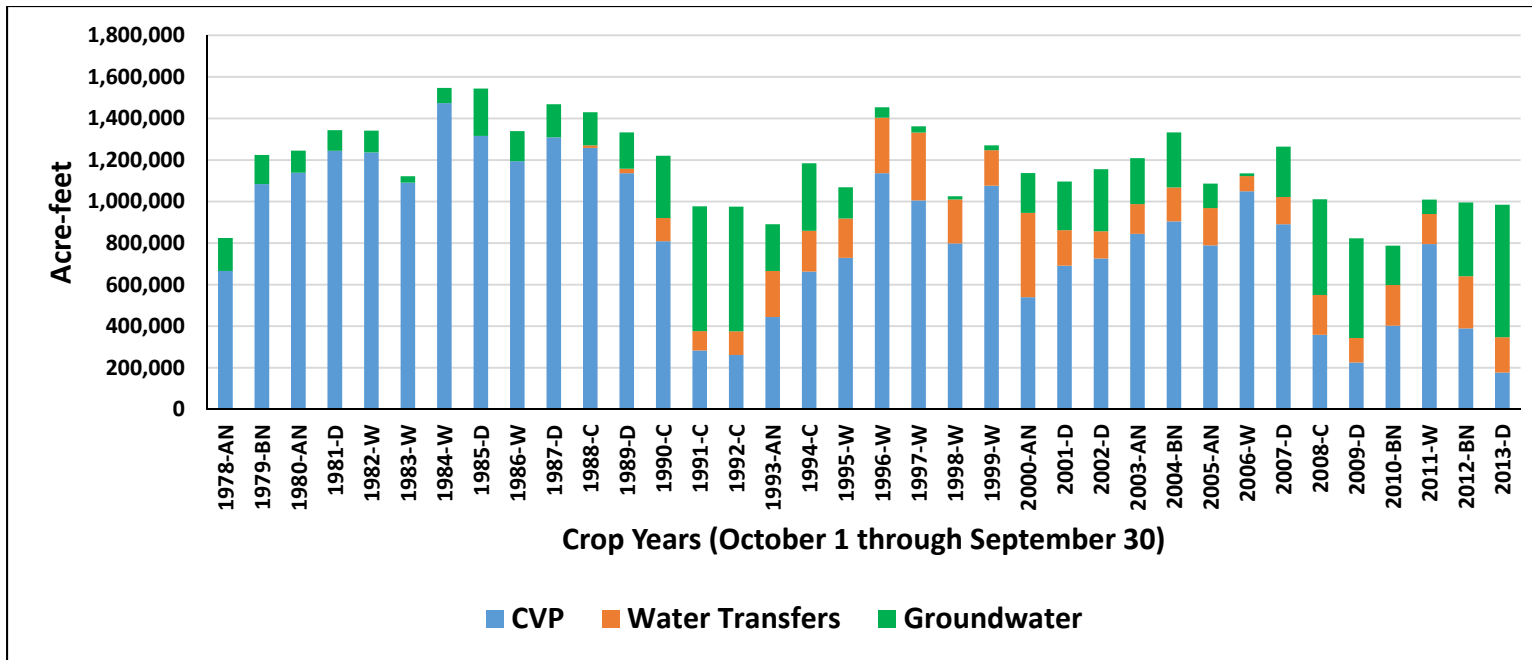


Figure 12.3 Historical Surface Water and Groundwater Supply Sources in Westlands Water District

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014a

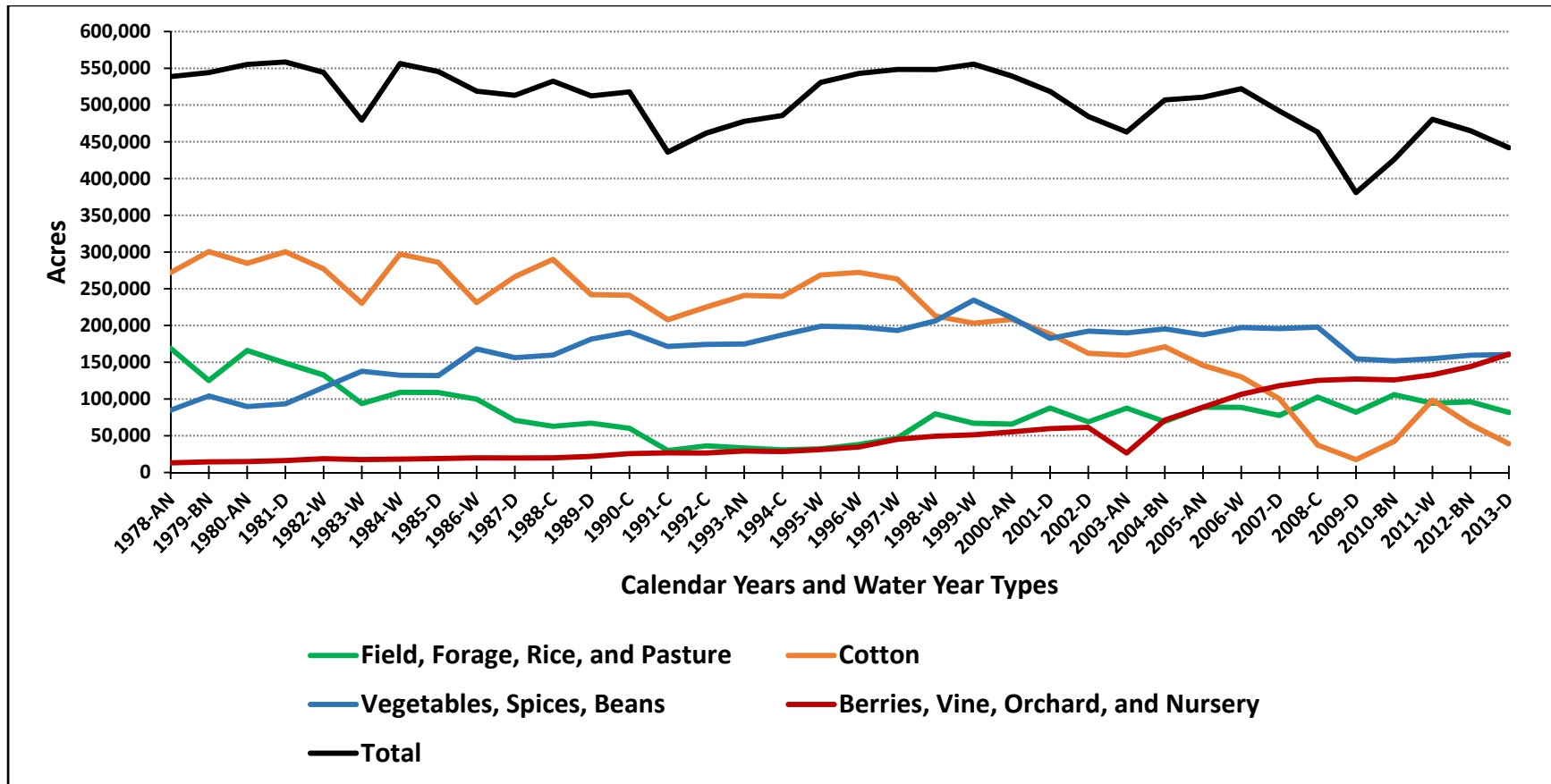


Figure 12.4 Historical Cropping Patterns in Westlands Water District

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014b, 2014c

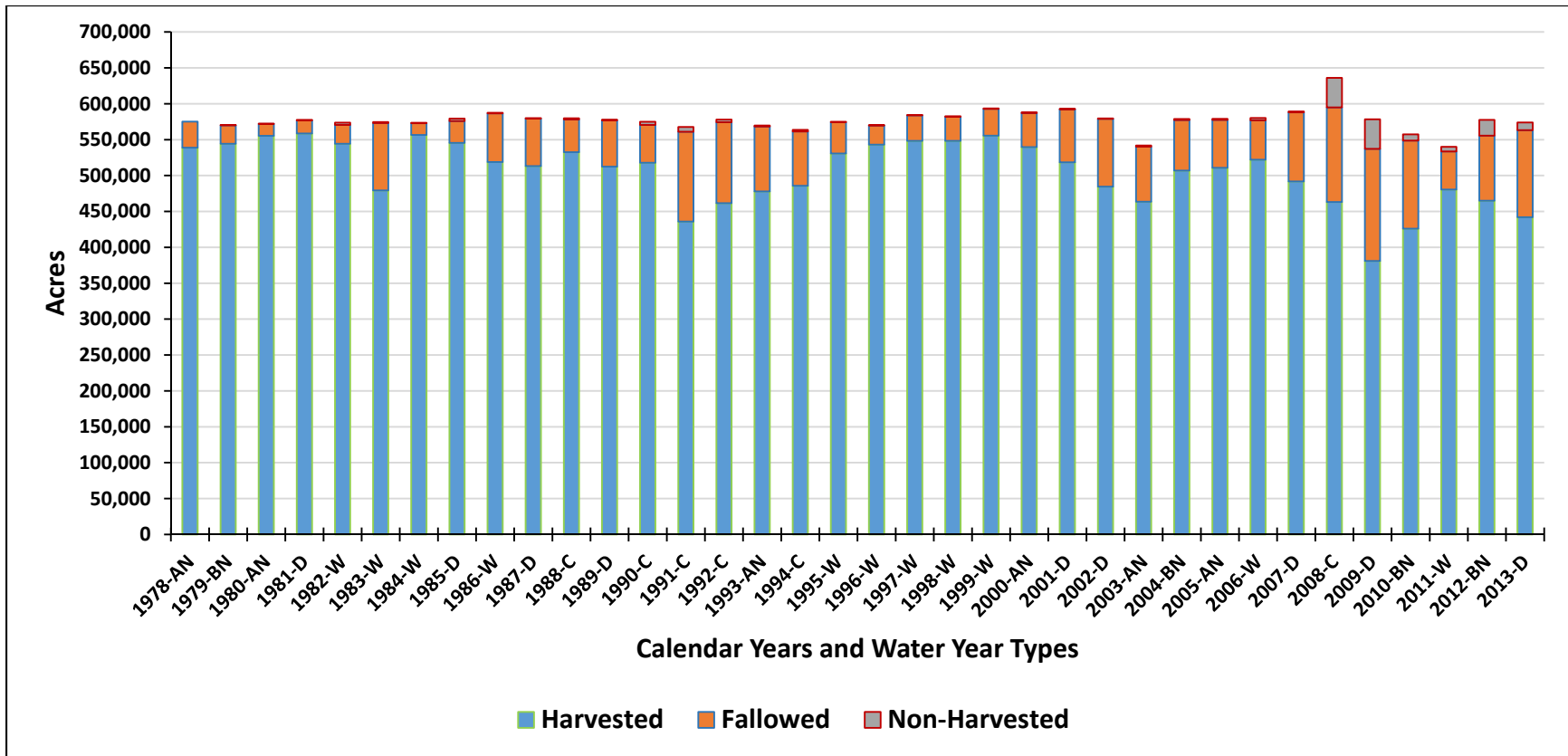


Figure 12.5 Historical Harvested, Fallowed, and Non-Harvested Acreage in Westlands Water District

W = Wet Year; AN= Above Normal Year; BN = Below Normal Year; D = Dry Year; C = Critical Dry Year

Source: WWD 2013a, 2014b, 2014c

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Chapter 13

1 Land Use

2 13.1 Introduction

3 This chapter describes non-agricultural land use in the study area, and potential
4 changes that could occur as a result of implementing the alternatives evaluated in
5 this Environmental Impact Statement (EIS). Implementation of the alternatives
6 could affect municipal and industrial land uses through potential changes in the
7 Central Valley Project (CVP) and State Water Project (SWP) operation.

8 Changes in agricultural land use and resources are described in Chapter 12,
9 Agricultural Resources. Changes to population are described in Chapter 19,
10 Socioeconomics.

11 13.2 Regulatory Environment and Compliance 12 Requirements

13 Potential actions that could be implemented under the alternatives evaluated in
14 this EIS could affect land uses served by CVP and SWP water supplies. Actions
15 done on public agency lands, or implemented, funded, or approved by Federal and
16 state agencies would need to be compliant with appropriate Federal and state
17 agency policies and regulations (summarized in Chapter 4, Approach to
18 Environmental Analysis).

19 13.3 Affected Environment

20 This section describes land use conditions potentially affected by the
21 implementation of the alternatives considered in this EIS. Changes in land uses
22 from changes in CVP and SWP operations may occur in the Trinity River, Central
23 Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

24 An extensive range of land uses are within this study area. However, direct or
25 indirect land use effects from implementing the alternatives analyzed in this EIS
26 are related to changes in agricultural, municipal, and industrial land uses from the
27 availability and reliability of CVP and SWP water supplies. The following
28 description of the affected environment is presented at the county-level for
29 agricultural and municipal and industrial land uses. More detailed agricultural
30 land use information is presented in Chapter 12, Agricultural Resources.

31 13.3.1 Trinity River Region

32 The Trinity River Region includes the area in Trinity County along the Trinity
33 River from Trinity Lake to the confluence with the Klamath River; and in
34 Humboldt and Del Norte counties along the Klamath River from the confluence

1 with the Trinity River to the Pacific Ocean. Tribal lands are also included for the
2 entire Trinity River Region.

3 **13.3.1.1 Trinity County**

4 Trinity County encompasses approximately 3,206 square miles in northwestern
5 California. It is bounded on the north by Siskiyou County, on the east by Shasta
6 and Tehama Counties, on the south by Mendocino County, and on the west by
7 Humboldt County. About 76 percent of the land area is within a national forest
8 (Shasta-Trinity, Six Rivers, and Mendocino) and in four wilderness areas (Yolla
9 Bolly-Middle Eel Reserve, Trinity Alps, Chanchellula, and North Fork). Another
10 14 percent is zoned for timber use or held in agriculture land conservation
11 contracts (Trinity County 2012).

12 The headwaters of the Trinity River are in the northeastern part of the County at
13 an elevation of 6,200 feet, in the southern Siskiyou Mountains. Trinity Lake and
14 Lewiston Reservoir are located along the middle reach of the mainstem
15 Trinity River. Downstream of Lewiston Dam, the river flows northwest to join
16 the Klamath River in Humboldt County (Trinity County 2012).

17 Development of communities is relatively limited in Trinity County because
18 much of the land is within national forests and tribal lands or is characterized by
19 steep slopes. The largest communities in Trinity County include Lewiston,
20 Weaverville, and Hayfork (Trinity County 2012).

21 Trinity County's primary industries are tourism and timber and is the sixth largest
22 timber producer in the state, with substantial acreage in National Forest and
23 private holdings. There is one operating mill in the County. Recreational
24 opportunities are also important in this area, as described in Chapter 15,
25 Recreation Resources (Trinity County 2012).

26 The portion of Trinity County in the Trinity River Region that could be affected
27 by changes in CVP and/or SWP operations and evaluated in this EIS includes
28 areas in the vicinity of CVP facilities (Trinity Lake and Lewiston Reservoir) and
29 areas along the Trinity River that use the river.

30 **13.3.1.2 Humboldt County**

31 Humboldt County encompasses approximately 3,570 square miles in
32 northwestern California. It is bounded on the north by Del Norte County, on the
33 east by Siskiyou and Trinity counties, on the south by Mendocino County, and on
34 the west by the Pacific Ocean. About 25 percent of the land area is within the Six
35 Rivers National Forest, Trinity Alps Wilderness Area, Redwood National and
36 State National Park, national wildlife refuges, or other public land. About
37 3 percent of the land area is within state park lands. The Yurok and Hoopa tribal
38 lands represent about 5.6 percent of the land within Humboldt County boundaries
39 (Humboldt County 2012).

40 Most of the population and developed areas are located in western Humboldt
41 County along U.S. Highway 101 (Humboldt County 2012). Incorporated cities
42 and residential lands in unincorporated portions of Humboldt County represent
43 less than 1 percent of the county. Development of communities is relatively

1 limited in Humboldt County because much of the land is within national forests
 2 and tribal lands, characterized by steep slopes, or within the coastal zone where
 3 new large scale developments are minimized. Timber and agricultural lands are
 4 located on over 60 percent of unincorporated areas of Humboldt County.

5 Humboldt County's primary industries are lumber manufacturing, retail, and
 6 services (Humboldt County 2012). Humboldt County provides over 25 percent of
 7 the lumber in the state.

8 The portion of Humboldt County in the Trinity River Region evaluated in this EIS
 9 is located along the Trinity and Klamath rivers. Most of this area is located
 10 within the Hoopa Valley Indian Reservation and Yurok Indian Reservation. This
 11 portion of the county includes the communities of Willow Creek and Orleans
 12 within Humboldt County; Hoopa in the Hoopa Valley Indian Reservation; and the
 13 communities of Weitchpec, Cappel, Pecwan, and Johnson's in the Yurok Tribe
 14 Indian Reservation (Humboldt County 2012).

15 **13.3.1.3 Del Norte County**

16 Del Norte County encompasses 1,070 square miles in northwestern California. It
 17 is bounded on the north by the State of Oregon, on the east by Siskiyou County,
 18 on the south by Humboldt County, and on the west by the Pacific Ocean.

19 Del Norte County includes lands within national forests (Six Rivers and Rogue
 20 River-Siskiyou), Smith River National Recreation Area, Redwood National and
 21 State Park, or other federally owned land. State lands include units of the
 22 Redwoods State Park and the Lake Earl Wildlife Area. The Yurok tribal lands are
 23 located along the lower Klamath River between the Del Norte and Humboldt
 24 county boundaries to the Pacific Ocean (Del Norte County 2003).

25 Del Norte County's primary industries are retail and services (Del Norte County
 26 2003).

27 The portion of Del Norte County in the Trinity River Region evaluated in this EIS
 28 is located along the lower Klamath River. Most of this area is within the Yurok
 29 Indian Reservation. This portion of the County includes the communities of
 30 Requa and Klamath in the Yurok Tribe Indian Reservation (Del Norte
 31 County 2003).

32 **13.3.1.4 Tribal Lands in Trinity River Region**

33 The major federally recognized tribes and tribal lands in the Trinity River Region
 34 include the tribal lands of the Hoopa Valley Tribe, Yurok Tribe of the Yurok
 35 Reservation, Resighini Rancheria, and Karuk Tribe. Aquatic and wildlife
 36 resources associated with the Trinity and Klamath rivers and the surrounding
 37 lands are very important to these tribes (NCRWQCB et al. 2009; Yurok Tribe
 38 2005; Karuk Tribe 2010).

39 The Hoopa Valley Indian Reservation includes 93,702.73 acres (Hoopa Valley
 40 Tribe 2008). The Trinity River flows through the Hoopa Valley Indian
 41 Reservation.

1 The Yurok Indian Reservation includes about 55,890 acres within Tribal trust,
2 Tribal fee, allotment, Tribal member fee, nonmember fee, Federal, state, and
3 county lands (Yurok Tribe 2012). The Tribe employs over 250 in the government
4 agency, as well as seasonal workers for fisheries, forestry, fire prevention, and
5 other programs.

6 The Resighini Rancheria includes about 435 acres of land along the south bank
7 of the lower Klamath River and extends from an inland area to the
8 U.S. Highway 101 bridge along the western boundary of the Rancheria
9 (Reclamation 2010). The Rancheria is surrounded by the Yurok Indian
10 Reservation (Reclamation 2010; Resighini Rancheria 2014). The community
11 includes tribal offices, a casino, campground, residences, agricultural lands, and
12 open space.

13 The Karuk Ancestral Territory is located to the north of the Trinity River in the
14 vicinity of Trinity County and east of the Trinity River in the vicinity of
15 Humboldt County (Karuk Tribe 2010). The western boundary of the Karuk
16 Ancestral Territory is relatively concurrent with the western boundary of the
17 Six Rivers National Forest. Therefore, changes in the Trinity River flow or water
18 quality that could be affected by changes in CVP and/or SWP operations
19 considered in the alternatives in this EIS would not occur within the Karuk
20 Ancestral Territory.

21 **13.3.2 Central Valley Region**

22 The Central Valley Region extends from above Shasta Lake to the
23 Tehachapi Mountains, and includes the Sacramento Valley, San Joaquin Valley,
24 Delta, and Suisun Marsh.

25 **13.3.2.1 Sacramento Valley**

26 The Sacramento Valley includes the counties of Shasta, Plumas, Tehama, Glenn,
27 Colusa, Butte, Sutter, Yuba, Nevada, Placer, El Dorado, and Sacramento counties.
28 Yolo and Solano counties are also located within the Sacramento Valley;
29 however, these counties are discussed as part of the Delta and Suisun Marsh
30 subsection because potential changes in land use because of changes in CVP and
31 SWP long-term operations would primarily occur within the Delta and Suisun
32 marsh geography. Other counties in this region are not anticipated to be affected
33 by changes in CVP and SWP operations, and are not discussed here, including:
34 Alpine, Sierra, Lassen, and Amador counties. Tribal lands are also described for
35 the entire Sacramento Valley.

36 **13.3.2.1.1 Shasta County**

37 Shasta County encompasses approximately 3,793 square miles in northern
38 California. It is bounded on the north by Siskiyou County, on the east by Lassen
39 County, on the south by Tehama County, and on the west by Trinity County.
40 Shasta County includes lands within national forests (Shasta-Trinity,
41 Whiskeytown-Shasta-Trinity, and Lassen), Lassen Volcanic National Park, or
42 other federally owned land. State lands include state forest and state parks
43 (Shasta County 2004).

1 The Shasta County General Plan identifies four major categories of land use:
 2 urban, rural, agricultural, and timber (Shasta County 2004). Of Shasta County's
 3 2,416,440 acres, 613,495 acres (25 percent) are designated as timber preserve
 4 zones pursuant to California's Forest Taxation Reform Act of 1976 (Shasta
 5 County 2004). Approximately 169,127 acres (7 percent), are designated as
 6 agricultural preserve lands.

7 Approximately 1.2 percent of the lands in the County are within incorporated
 8 areas (Shasta County 2004). Urban development is concentrated in the southern
 9 central portion of the county in the cities of Redding, Anderson, and Shasta Lake
 10 (Reclamation 2005a).

11 The portion of the Central Valley Region, Sacramento Valley in Shasta County
 12 that could be affected by changes in CVP and/or SWP operations and evaluated in
 13 this EIS includes CVP facilities (Shasta Lake, Keswick Reservoir, and
 14 Whiskeytown Lake), areas along the Sacramento River and Clear Creek that use
 15 the surface waters (including agricultural lands), and CVP water service areas.

16 **13.3.2.1.2 Plumas County**

17 Plumas County encompasses approximately 2,610 square miles in northern
 18 California. It is bounded on the north by Shasta County, on the east by Lassen
 19 County, on the west by Tehama and Butte counties, and on the south by Sierra
 20 County. Plumas County includes lands within national forests (Plumas, Lassen,
 21 Toiyabe, and Tahoe), Lassen Volcanic National Park, or other federally owned
 22 land. State lands include Plumas-Eureka State Park (Plumas County 2012).

23 Prominent landscape features in Plumas County are the Sierra Valley, the Lake
 24 Almanor Basin, and the Upper Feather River watershed which includes three
 25 SWP lakes (Antelope Lake, Lake Davis, and Frenchman Lake). The largest land
 26 uses in the county are agricultural and timber resource lands. Rural and
 27 semi-rural development is scattered throughout the County, with most growth
 28 concentrated in several designated planning areas. The county's only
 29 incorporated area is the City of Portola.

30 The most recent Plumas County General Plan was adopted in 1984. The county is
 31 in the process of updating its General Plan through 2030 (Plumas County 2012).
 32 Approximately 76 percent of the land in Plumas County is National Forest land
 33 owned and managed by the U.S. Forest Service. The U.S. Forest Service
 34 prepared the Plumas National Forest Land and Resource Management Plan in
 35 1988, to guide management and land use planning decisions in the forest. The
 36 National Forest Land and Resource Management Plan provides a designation for
 37 areas based on established priorities for various resources, including wilderness,
 38 recreation, wildlife, timber, and visual resources (Plumas County 2012).

39 The portion of the Central Valley Region, Sacramento Valley in Plumas County
 40 that could be affected by changes in CVP and/or SWP operations and evaluated in
 41 this EIS is located at the SWP Antelope Lake, Lake Davis, and Frenchman Lake
 42 and along the Feather River downstream of Frenchman Lake.

1 **13.3.2.1.3 Tehama County**

2 Tehama County encompasses approximately 2,951 square miles in northern
3 California. It is bounded on the north by Shasta County, on the east by Plumas
4 County, on the west by Trinity and Mendocino counties, and on the south by
5 Glenn and Butte counties. Tehama County includes lands within national forests
6 (Lassen, Mendocino, and Shasta-Trinity), Lassen Volcanic National Park, or other
7 federally owned land (Tehama County 2008).

8 Tehama County is predominantly rural, with populations primarily concentrated
9 in the incorporated cities of Corning, Red Bluff, and Tehama or along the major
10 transportation corridors. The incorporated areas include less than 1 percent of the
11 total land area in the county. The primary incorporated and unincorporated
12 developed areas in the county are adjacent to major transportation centers, with
13 most adjacent to Interstate 5 and State Route 99. Clustered commercial land uses
14 are located primarily along the major state and county roadways, most of which
15 are near Red Bluff, Corning, and the unincorporated community of Los Molinos.
16 Residential land uses in the developed portions of the county tend to be located
17 behind or beyond the commercial and service uses adjacent to the major street
18 network (Tehama County 2008).

19 Ranches, timber company holdings, and government land dominate the county.
20 Much of the land use is resource-based, such as cropland, rangeland, pasture land,
21 and timber land (Tehama County 2008). The majority of land within the CVP
22 water service area in Tehama County is designated for agricultural use (Tehama
23 County 2008; Reclamation 2005b).

24 The portion of the Central Valley Region, Sacramento Valley in Tehama County
25 that could be affected by changes in CVP and/or SWP operations and evaluated in
26 this EIS includes CVP facilities, areas along the Sacramento River that use the
27 surface waters (including agricultural lands), and CVP water service areas.

28 **13.3.2.1.4 Glenn County**

29 Glenn County encompasses 1,317 square miles in northern California. It is
30 bounded on the north by Tehama County, on the east by Butte County, on the
31 west by Lake and Mendocino counties, and on the south by Colusa County.
32 Glenn County includes lands within the Mendocino National Forest, Sacramento
33 National Wildlife Refuge, and other federally owned land (Glenn County 1993).

34 Approximately two-thirds (583,974 acres) are croplands and pasture. The two
35 incorporated towns in the county are Willows, the County seat, and Orland
36 (Reclamation 2004). Intensive agriculture provides a major segment of the
37 county's economic base (Glenn County 1993; Reclamation 2005b). The portion of
38 the Central Valley Region, Sacramento Valley in Glenn County that could be
39 affected by changes in CVP and/or SWP operations and evaluated in this EIS
40 includes wildlife refuges (described in Chapter 10, Terrestrial Biological
41 Resources), and CVP facilities, areas along the Sacramento River that use the
42 surface waters (including agricultural lands), and CVP water service areas.

1 **13.3.2.1.5 Colusa County**

2 Colusa County encompasses approximately 1,132 square miles in northern
 3 California. It is bounded on the north by Glenn County, on the east by Butte and
 4 Sutter counties, on the west by Lake County, and on the south by Yolo County.
 5 Colusa County includes lands within the Mendocino National Forest, Sacramento
 6 National Wildlife Refuge complex (Colusa, Delevan, and Sacramento national
 7 wildlife refuges); East Park Reservoir; and other federally owned land (Colusa
 8 County 2011). State lands in Colusa County include Willow Creek-Lurline,
 9 North Central Valley, Colusa Bypass, and Sacramento River wildlife
 10 management areas.

11 Existing land uses in Colusa County are predominantly agricultural.
 12 Approximately 76 percent of the county’s total land area is cropland or
 13 undeveloped rangeland. Twelve percent is national forest and national wildlife
 14 refuge land. Less than 1 percent is covered by urban and rural communities.
 15 Colusa and Williams are the only incorporated cities in the county and they
 16 encompass about 2,574 acres (Colusa County 2011). Arbuckle is the largest
 17 unincorporated town of the unincorporated communities, which includes
 18 Arbuckle, College City, Century Ranch, Grimes, Maxwell, Princeton, and
 19 Stonyford. Together, these established incorporated and unincorporated towns
 20 cover a total area in “urban” uses of about 5,451 acres (Colusa County 2011).
 21 The majority of land within the CVP water service area in Colusa County is
 22 designated for agricultural use (Colusa County 2011; Reclamation 2005b).

23 The portion of the Central Valley Region, Sacramento Valley in Colusa County
 24 that could be affected by changes in CVP and/or SWP operations and evaluated in
 25 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological
 26 Resources) and CVP facilities, areas along the Sacramento River that use the
 27 surface waters (including agricultural lands), and CVP water service areas.

28 **13.3.2.1.6 Butte County**

29 Butte County encompasses 1,680 square miles in northern California. It is
 30 bounded on the north by Tehama County, on the east by Plumas County, on the
 31 west by Glenn and Colusa counties, and on the south by Sutter and Yuba counties.
 32 Butte County includes lands within national forests (Plumas and Lassen),
 33 Sacramento National Wildlife Refuge (Butte County 2010). State lands in Butte
 34 County include Big Chico Creek and Butte Creek ecological preserves; Table
 35 Mountain Reserve; Gray Lodge, Sacramento River, and Oroville wildlife areas;
 36 SWP facilities at Lake Oroville and Thermalito Reservoir; and more than
 37 750 miles of rivers and streams.

38 The county comprises three general topographical areas: valley region, foothills
 39 east of the valley, and mountain region east of the foothills. Each of these regions
 40 contains distinct environments with unique wildlife and natural resources.

41 The U.S. Forest Service manages 135,427 acres (12 percent) within Butte County,
 42 including portions of the Plumas and Lassen National Forests. The Bureau of
 43 Land Management owns and manages 16,832 acres (1.5 percent) in the county

1 (Butte County 2010). Agriculture is the dominant land use within unincorporated
2 Butte County, accounting for approximately 599,040 acres (60 percent of the
3 county area) (Butte County 2010).

4 Butte County contains five incorporated municipalities: Biggs, Chico, Gridley,
5 Oroville, and Paradise. Each has a general plan that guides development within
6 its limits and larger planning area (Butte County 2010).

7 The portion of the Central Valley Region, Sacramento Valley, in Butte County
8 that could be affected by changes in CVP and/or SWP operations and evaluated in
9 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological
10 Resources), SWP facilities (Lake Oroville and Thermalito Afterbay), CVP
11 facilities, areas along the Feather River that use the surface waters (including
12 agricultural lands), and CVP and SWP water service areas.

13 **13.3.2.1.7 Sutter County**

14 Sutter County encompasses approximately 607 square miles in northern
15 California. It is bounded on the north by Butte County, on the east by Yuba and
16 Placer counties, on the west by Colusa and Yolo counties, and on the south by
17 Sacramento County. Sutter County includes lands within the Sutter National
18 Wildlife Refuge. State lands in Sutter County include Butte Slough, Feather
19 River, Gray Lodge, Sutter Bypass, and Butte Sink wildlife management areas; and
20 Sutter Buttes State Park (Sutter County 2010).

21 Sutter County's General Plan was updated in 2011. Approximately 98 percent of
22 the land in the County is unincorporated, and approximately 98 percent of the
23 unincorporated land is zoned for agricultural use (Reclamation 2004). The two
24 incorporated cities within the county, Yuba City and Live Oak, encompass
25 approximately 10,600 acres.

26 Existing land use in Sutter County is rural and dominated by agricultural areas.
27 The county has significant natural and recreational resources, and a relatively low
28 population density. Existing land uses in Yuba City and Live Oak contain the
29 bulk of the county's urban land uses, such as residences, commercial and
30 industrial uses, parks, and public facilities (Sutter County 2010). The county
31 includes several incorporated rural communities: Meridian, Sutter, Robbins,
32 Rio Oso, Trowbridge, Nicolaus, East Nicolaus, and Pleasant Grove (Sutter
33 County 2010).

34 The portion of the Central Valley Region, Sacramento Valley in Sutter County
35 that could be affected by changes in CVP and/or SWP operations and evaluated in
36 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological
37 Resources), CVP facilities, areas along the Sacramento River that use the surface
38 waters (including agricultural lands), and CVP and SWP water service areas.

39 **13.3.2.1.8 Yuba County**

40 Yuba County encompasses approximately 634 acres in northern California. It is
41 bounded on the north by Butte County, on the east by Sierra and Nevada counties,
42 on the west by Sutter County, and on the south by Placer County. Federally

1 owned lands in Yuba County include Tahoe and Plumas National Forests, and the
 2 22,944-acre Beale Air Force Base (Yuba County 2011). The Department of Fish
 3 and Wildlife administers the state Spenceville Wildlife Area.

4 Yuba County is predominantly rural. Over 189,500 acres (46 percent of the
 5 county), are designated for agricultural land uses. Most of the population lives in
 6 the two incorporated cities in the county (Marysville and Wheatland); and the
 7 major unincorporated communities including Brown's Valley, Brownsville,
 8 Camptonville, Dobbins, Linda/Olivehurst, Log Cabin, Loma Rica, Oregon
 9 House, Rackerby, and River Highlands (Yuba County 2011).

10 The portion of the Central Valley Region, Sacramento Valley in Yuba County
 11 that could be affected by changes evaluated in this EIS includes areas within
 12 Yuba County Water Agency facilities that provide water for environmental and
 13 water supply purposes within the Central Valley.

14 **13.3.2.1.9 Nevada County**

15 Nevada County encompasses approximately 634,880 acres in northern California.
 16 It is bounded on the north by Sierra County, on the northwest by Yuba County, on
 17 and on the south by Placer County. Federally owned lands in Nevada County
 18 include 169,686 acres in the Tahoe National Forest; 2,574 acres in the Toiyabe
 19 National Forest; and approximately 11,000 acres administered by the Bureau of
 20 Land Management (Nevada County 1995). The State Lands Commission
 21 manages approximately 4,600 acres; State Parks administers 6,300 acres at
 22 several locations, including Malakoff Diggins State Historical Park and Empire
 23 Mine State Park; and the Department of Fish and Wildlife administers
 24 approximately 11,000 acres at the Spenceville Wildlife Management and
 25 Recreation Area.

26 Nevada County is predominantly rural (Nevada County 2012). Approximately
 27 91 percent of the county is used for agriculture, timber, or open space. Most of
 28 the population lives in the three incorporated cities in the county (Grass Valley,
 29 Nevada City, and Truckee).

30 **13.3.2.1.10 Placer County**

31 Placer County encompasses approximately 1,506 square miles in northern
 32 California. It is bounded on the north by Nevada County, on the east by the
 33 California-Nevada boundary, on the west by Yuba and Sutter counties, and on the
 34 south by Sacramento and El Dorado counties. Placer County includes lands
 35 within the El Dorado and Tahoe National Forests and other federally owned land
 36 (Placer County 2011).

37 Placer County is predominantly rural. Most of the population lives in the area
 38 along Interstate 80 from the City of Auburn to the Sutter and Sacramento county
 39 boundaries. Incorporated cities and towns include Roseville, Rocklin, Lincoln,
 40 Colfax, Loomis, and Auburn (Placer County 2011; Reclamation 2005c; SACOG
 41 2007). Residential land uses range from rural residential areas to medium and
 42 high-density dwelling units in urbanized areas. Commercial land uses are
 43 primarily located in the urbanized portions of the county; although a large

1 concentration of commercial development occurs outside existing urban areas
2 along Interstate 80. Non-urban land uses include agriculture, resource extraction
3 (timber and mining), and public lands and open space uses. The largest amount of
4 public lands within Placer County is located in the eastern half of the county, and
5 is under the jurisdiction of the Bureau of Land Management, U.S. Forest Service,
6 or the Bureau of Reclamation. The CVP water service area within Placer County
7 primarily includes the communities and agricultural areas in the western portion
8 of the county. The portion of the Central Valley Region, Sacramento Valley in
9 Placer County that could be affected by changes in CVP and/or SWP operations
10 and evaluated in this EIS includes CVP water facilities (Folsom Lake), areas
11 along the American River that use the surface waters (including agricultural
12 lands), and CVP water service areas.

13 **13.3.2.1.11 El Dorado County**

14 El Dorado County encompasses approximately 1,790 square miles in northern
15 California along the American River. It is bounded on the north by
16 Placer County, on the east by California-Nevada boundaries, on the west by
17 Sacramento County, and on the south by Amador and Alpine counties. El Dorado
18 County includes about 521,210 acres (45.5 percent of the total county), under
19 Federal ownership or trust, including lands within the El Dorado and Tahoe
20 national forests. About 9,751 acres (8.5 percent of the county), is under the State
21 jurisdiction (El Dorado County 2003).

22 The county includes two specific regions: the Lake Tahoe Basin and the western
23 slopes of the Sierra Nevada (El Dorado County 2003). The CVP water service
24 area provides water to a large portion of the communities and some agricultural
25 areas along the western slope. El Dorado County includes two incorporated
26 cities, Placerville and South Lake Tahoe, which cover 621 acres of land. Other
27 major communities include El Dorado Hills, Cameron Park, Shingle Springs,
28 Rescue, Diamond Springs, Camino, Coloma and Gold Hill, Cool and Pilot Hill,
29 Georgetown and Garden Valley, Pollock Pines, Pleasant Valley, Latrobe,
30 Somerset, and Mosquito. The rural land uses in the county include over
31 259,000 acres of private production forests, 153,472 acres of agricultural lands,
32 and 35,282 acres within the waters of Folsom Lake and Lake Tahoe. The
33 county's two largest crops are wine grapes and apples.

34 The portion of the Central Valley Region, Sacramento Valley in El Dorado
35 County that could be affected by changes in CVP and/or SWP operations and
36 evaluated in this EIS includes CVP water facilities (Folsom Lake), areas along the
37 American River that use the surface waters, and CVP water service areas.

38 **13.3.2.1.12 Sacramento County**

39 Sacramento County encompasses approximately 1,769 square miles in northern
40 California. It is bounded on the north by Sutter and Placer counties, on the east
41 by El Dorado and Amador counties, on the south by Contra Costa and San
42 Joaquin counties, and on the west by Yolo and Solano counties. Sacramento
43 County includes federally owned lands within Folsom Lake and Lake Natoma.

1 Residential areas in Sacramento County primarily occur in northern and central
 2 Sacramento County. Sacramento County includes areas within the Delta,
 3 including the southwestern portion of the City of Sacramento, City of Isleton and
 4 the communities of Locke, Ryde, Courtland, Freeport, Hood, and Walnut Grove;
 5 and areas located to the east of the Delta (Sacramento County 2011). Sacramento
 6 County has seven incorporated cities located in about 56 percent of the county:
 7 Sacramento, Elk Grove, Citrus Heights, Folsom, Galt, Isleton, and Rancho
 8 Cordova. The County includes several unincorporated communities including
 9 Antelope, Arden-Arcade, Carmichael, Cordova, Elverta, Foothill Farms, Fair
 10 Oaks, Herold, Natomas, North Highlands, Orangevale, Rancho Murieta, Rio
 11 Linda, Sloughhouse, and Wilton.

12 The leading agricultural crops in Sacramento County include dairy, wine grapes,
 13 Bartlett pears, field corn, and turkeys (Sacramento County 2010). Agricultural
 14 acreage has declined as urban development has continued. Between 1989 and
 15 2004, the portion of the county designated as agriculture declined from 40 percent
 16 to 34 percent. The southeastern portion of the county remains primarily rural with
 17 smaller communities, such as Herald (Sacramento County 2011).

18 The portion of the Central Valley Region, Delta, in Sacramento County that could
 19 be affected by changes in CVP and/or SWP operations and evaluated in this EIS
 20 includes CVP facilities (Folsom Lake and Lake Natoma), areas along the
 21 American and Sacramento rivers and Delta channels that use the surface waters
 22 (including agricultural lands), and CVP water service areas.

23 **13.3.2.1.13 Tribal Lands in Sacramento Valley**

24 This section summarizes the tribal lands that could be affected by changes in CVP
 25 and/or SWP operations and that are located within the county boundaries.

26 *Tribal Lands within the Boundaries of Shasta County*

27 Major federally recognized tribes and tribal lands within the boundaries of Shasta
 28 County include the Pit River Tribe and the Redding Rancheria, which is a federal
 29 reservation of Wintun, Pit River, and Yana Indians near Redding (SDSU 2013).

30 *Tribal Lands within the Boundaries of Tehama County*

31 There are approximately 2,000 acres within the total acreage of Tehama County
 32 within tribal trust, including land near Corning owned by the Paskenta Band of
 33 Nomlaki Indians of California (Paskenta 2014).

34 *Tribal Lands within the Boundaries of Glenn County*

35 Major federally recognized tribes and tribal lands within the boundaries of Glenn
 36 County include the Grindstone Indian Reservation near Elk Creek at the
 37 Grindstone Indian Rancheria of Wintun-Wailaki Indians of California, and lands
 38 of the Paskenta Band of Nomlaki Indians of California.

39 *Tribal Lands within the Boundaries of Colusa County*

40 Major federally recognized tribes and tribal lands within the boundaries of Colusa
 41 County include the Cachil Dehe Band of Wintun Indians of the Colusa Indian

1 Community of the Colusa Rancheria, and the Cortina Indian Rancheria of Wintun
2 Indians of California (Colusa County 2011).

3 *Tribal Lands within the Boundaries of Butte County*

4 Major federally recognized tribes and tribal lands within the boundaries of Butte
5 County include the Tyme Maidu of Berry-Creek Rancheria on approximately
6 90 acres, and the Concow Maidu of Mooretown Rancheria on approximately
7 300 acres (Butte County 2010).

8 *Tribal Lands within the Boundaries of Nevada County*

9 Major federally recognized tribes and tribal lands within the boundaries of
10 Nevada County include tribal trust lands of the Shingle Springs Band of Miwok
11 Indians.

12 *Tribal Lands within the Boundaries of Placer County*

13 Major federally recognized tribes and tribal lands within the boundaries of Placer
14 County include tribal trust lands of the United Auburn Indian Community of the
15 Auburn Rancheria of California.

16 *Tribal Lands within the Boundaries of El Dorado County*

17 Major federally recognized tribes and tribal lands within the boundaries of El
18 Dorado County include the Shingle Springs Band of Miwok Indians.

19 *Tribal Lands within the Boundaries of Sacramento County*

20 Major federally recognized tribes and tribal lands within the boundaries of
21 Sacramento County include lands of the Wilton Miwok Indians of the Wilton
22 Rancheria near Elk Grove (SACOG 2007).

23 **13.3.2.2 San Joaquin Valley**

24 The San Joaquin Valley includes Stanislaus, Merced, Madera, San Joaquin,
25 Fresno, Kings, Tulare, and Kern counties. Other counties in this region are not
26 anticipated to be affected by changes in CVP and SWP operations, and are not
27 discussed here. They include Calaveras, Mariposa, and Tuolumne counties.
28 Tribal lands are also described for the entire San Joaquin Valley.

29 **13.3.2.2.1 Stanislaus County**

30 Stanislaus County encompasses approximately 1,521 square miles in central
31 California. It is bounded on the north by San Joaquin County, on the east by
32 Calaveras and Tuolumne counties, on the west by Santa Clara County, and on the
33 south by Merced County. Stanislaus County includes lands within the San
34 Joaquin River National Wildlife Refuge (Stanislaus Council of Governments
35 2007).

36 Land use in the county is primarily agricultural, with nearly 80 percent of the land
37 zoned for general agriculture or in agricultural production (Stanislaus Council of
38 Governments 2007). Over the past 40 years, some portions of the county have
39 been changing from a rural agricultural region to semi-urbanized, especially along
40 major highways and freeways. There are nine incorporated cities in the county,
41 including Ceres, Hughson, Modesto, Newman, Oakdale, Patterson, Riverbank,

1 Turlock, and Waterford. Stanislaus County has adopted community plans for
 2 most of its unincorporated towns, including Crows Landing, Del Rio, Denair,
 3 Hickman, Keyes, Knights Ferry, La Grange, Westley, and Salida (Stanislaus
 4 County 2010, 2012).

5 The portion of the Central Valley Region, San Joaquin Valley, in Stanislaus
 6 County that could be affected by changes in CVP and/or SWP operations and
 7 evaluated in this EIS includes wildlife refuges (described in Chapter 10,
 8 Terrestrial Biological Resources), CVP water facilities (New Melones Reservoir,
 9 Delta-Mendota Canal, and San Luis Canal/California Aqueduct), areas along the
 10 Stanislaus and San Joaquin rivers that use the surface waters (including
 11 agricultural lands), and CVP water service areas.

12 **13.3.2.2.2 Merced County**

13 Merced County encompasses approximately 1,977 square miles in central
 14 California. It is bounded on the north by Stanislaus County, on the east by
 15 Mariposa County, on the south by Fresno and Madera counties, and on the west
 16 by Santa Clara and San Benito counties. Merced County includes federally
 17 owned lands within the San Luis National Wildlife Refuge (Merced County
 18 2013). State lands within the county include San Luis Reservoir State Recreation
 19 Area; Great Valley Grasslands State Park; and the Los Banos, North Grasslands,
 20 and Volta wildlife areas.

21 Merced County includes the six incorporated cities of Atwater, Dos Palos,
 22 Gustine, Livingston, Los Banos, and Merced. The major unincorporated
 23 communities include Delhi, Fox Hills, Franklin, Hilmar, LeGrand, Planada, Santa
 24 Nella, Laguna San Luis, and Winton (Merced County 2013). Unincorporated
 25 land within the county includes approximately 1.2 million acres (98.1 percent of
 26 the land in the county). Agriculture is the primary land use, totaling just over
 27 1 million acres (81.2 percent). Public and quasi-public land is the next largest use
 28 with 131,582 acres or 10.6 percent of the unincorporated County. Commercial
 29 land uses represent 3,025 acres (0.2 percent), industrial uses represent 2,488 acres
 30 (0.2 percent), and mining represents 3,375 acres (0.3 percent). Incorporated cities
 31 account for 24,138 acres (1.9 percent) (Merced County 2012a, 2013). The
 32 Merced County Local Agency Formation Commission policies discourage
 33 annexation of prime agricultural land when significant areas of non-prime
 34 agricultural land are already available. The policies also encourage development
 35 of vacant areas in cities before the annexation and development of outlying areas.
 36 Local Agency Formation Commission policies encourage city annexations that
 37 reflect a planned, logical, and orderly progression of urban expansion and
 38 promote efficient delivery of urban services (Merced County 2012b).

39 The portion of the Central Valley Region, San Joaquin Valley in Merced County
 40 that could be affected by changes in CVP and/or SWP operations and evaluated in
 41 this EIS includes wildlife refuges (described in Chapter 10, Terrestrial Biological
 42 Resources), CVP and SWP water facilities (San Luis Reservoir, Delta-Mendota
 43 Canal, and San Luis Canal/California Aqueduct), areas along the San Joaquin

1 River that use the surface waters (including agricultural lands), and CVP water
2 service areas.

3 **13.3.2.2.3 Madera County**

4 Madera County encompasses approximately 2,147 square miles in central
5 California. It is bounded on the north by Merced and Mariposa counties, on the
6 east by Mono County, and on the south and west by Fresno County. Madera
7 County includes lands within the Sierra and Inyo national forests (Madera County
8 1995). State lands within the county include the Millerton Lake State
9 Recreation Area.

10 Land elevations in Madera County range from 180 feet to over 13,000 feet above
11 mean sea level. Madera County can be divided generally into three regions – the
12 San Joaquin Valley in the west, the foothills between the Madera Canal and the
13 3,500-foot elevation contour, and the mountains from the 3,500-foot contour to
14 the crest of the Sierra Nevada. The County has two incorporated cities, Madera
15 and Chowchilla (Madera County 1995). Major unincorporated communities in
16 the county include North Fork, South Fork, O’Neals, Oakhurst, Coarsegold,
17 Gunner Ranch, and Rio Mesa.

18 The portion of the Central Valley Region, San Joaquin Valley, in Madera County
19 that could be affected by changes in CVP and/or SWP operations and evaluated in
20 this EIS includes CVP water facilities (Millerton Lake and the Madera Canal),
21 areas along the San Joaquin River that use the surface waters (including
22 agricultural lands), and CVP water service areas.

23 **13.3.2.2.4 San Joaquin County**

24 San Joaquin County encompasses approximately 1,426 square miles in central
25 California. It is bounded on the north by Sacramento County, on the east by
26 Calaveras and Amador counties, on the south by Stanislaus County, and on the
27 west by Contra Costa and Alameda counties. San Joaquin County includes about
28 6,000 acres of federally owned lands (San Joaquin County 2009).

29 San Joaquin County is currently in the process of updating its General Plan. Most
30 of the county’s land is in agricultural production. Agriculture, the predominant
31 land use, covers 686,109 acres (75 percent) of the county. Residential land is the
32 second largest use in the unincorporated lands, encompassing 40,410 acres
33 (4.4 percent of the county). Residential development in the county is
34 concentrated in existing cities and in adjacent unincorporated communities. San
35 Joaquin County has seven incorporated cities: Stockton, Tracy, Manteca, Escalon,
36 Ripon, Lodi, and Lathrop. Stockton and Tracy are the largest cities in the county.
37 The major unincorporated areas in the county include French Camp, Linden,
38 Lockeford, Morada, Mountain House, New Jerusalem, Thornton, and
39 Woodbridge (San Joaquin County 2009). The incorporated cities account for
40 90,191 acres (approximately 10 percent of the county).

41 The portion of the Central Valley Region, Delta in San Joaquin County that could
42 be affected by changes in CVP and/or SWP operations and evaluated in this EIS
43 includes CVP and SWP facilities (including facilities associated with Rock

1 Slough Pumping Plant, Jones Pumping Plant, Clifton Court, and Banks Pumping
 2 Plant), areas along the Delta channels that use the surface waters (including
 3 agricultural lands), and CVP water service areas.

4 **13.3.2.2.5 Fresno County**

5 Fresno County encompasses approximately 6,000 square miles in central
 6 California. It is bounded on the north by Merced and Madera counties, on the
 7 east by Mono and Inyo counties, on the south by Kings and Tulare counties, and
 8 on the west by San Benito and Monterey counties. Fresno County includes lands
 9 within Millerton Lake, Pine Flat Lake, the Sierra and Sequoia national forests,
 10 Sequoia National Monument, and Kings Canyon National Park (Fresno County
 11 2000). State lands within the county include the Millerton Lake State Recreation
 12 Area, San Joaquin River Parkway, and Mendota Wildlife Area.

13 Fresno County is California's sixth-largest county. Agricultural land uses cover
 14 over 48 percent of the county, and resource conservation lands (e.g., forests,
 15 parks, and timber preserves) cover approximately 45 percent of the county. The
 16 15 incorporated cities and unincorporated communities cover approximately
 17 5 percent of the county (Fresno County 2000). Development constraints within
 18 the county are primarily caused by lack of funding for infrastructure
 19 improvement, availability of water supplies, air quality regulations, and physical
 20 limitations, especially in the mountains and eastern foothills. The incorporated
 21 communities include Clovis, Coalinga, Firebaugh, Fowler, Fresno, Huron,
 22 Kerman, Kingsburg, Mendota, Orange Cove, Parlier-West Parlier, Reedley,
 23 Sanger, San Joaquin, and Selma (Fresno County 2000). Major unincorporated
 24 communities include Biola, Caruthers, Del Rey, Friant, Lanare, Laton, Riverdale,
 25 Shaver Lake, and Tranquility.

26 The portion of the Central Valley Region, San Joaquin Valley in Fresno County
 27 that could be affected by changes in CVP and/or SWP operations and evaluated in
 28 this EIS includes CVP water facilities (Millerton Lake and the Friant-Kern
 29 Canal), areas along the San Joaquin River that use the surface waters, and CVP
 30 water service areas (including agricultural lands), and CVP water service areas.

31 **13.3.2.2.6 Kings County**

32 Kings County encompasses approximately 1,280 square miles in south central
 33 California. It is bounded on the north by Fresno County, on the east by Tulare
 34 County, on the south by Kern County, and on the west by Monterey County.
 35 Kings County includes lands within Naval Air Station Lemoore (Kings County
 36 2009).

37 Land use is predominantly agricultural, with more than 90 percent of the county
 38 designated for agricultural uses. Incorporated cities in Kings County include
 39 Avenal, Corcoran, Hanford, and Lemoore. Residential land uses in
 40 unincorporated areas and special districts cover less than 1 percent of the county's
 41 total acreage including for the communities of Armona, Home Garden, Kettleman
 42 City, and Stratford (Kings County 2009).

1 The portion of the Central Valley Region, San Joaquin Valley, in Kings County
2 that could be affected by changes in CVP and/or SWP operations and evaluated in
3 this EIS includes CVP and SWP water service areas.

4 **13.3.2.2.7 Tulare County**

5 Tulare County encompasses approximately 4,840 square miles in south central
6 California. It is bounded on the north by Fresno County, on the east by Inyo
7 County, on the south by Kern County, and on the west by Kings County.
8 Tulare County includes federally owned lands within the Sequoia National Forest,
9 Sequoia and Kings Canyon National Parks, Sequoia National Monument, several
10 wilderness areas, Lake Kaweah, Lake Success, and Pixley National Wildlife
11 Refuge (Tulare County 2010).

12 Agricultural land uses cover more than 2,150 square miles (approximately
13 44 percent) of the county. Lands classified as open space (i.e., national forests,
14 monuments, and parks; wilderness areas; and County parks) make up 25 percent
15 of the land use in the county. Less than 3 percent of the county lands are in the
16 incorporated cities of Dinuba, Exeter, Farmersville, Lindsay, Porterville, Tulare,
17 Visalia, and Woodlake (Tulare County 2010). Less than 2 percent of the county
18 is designated for unincorporated residential areas, including the major
19 communities of Alpaugh, Cutler, Ducor, Earlimart, East Oros, Goshen, Ivanhoe,
20 Lemoncove, London, Oros, Pixley, Plainview, Poplar-Cotton Center, Richgrove,
21 Springville, Strathmore, Terra Bella, Three Rivers, Tipton, Traver, and
22 Woodville.

23 The portion of the Central Valley Region, San Joaquin Valley, in Tulare County
24 that could be affected by changes in CVP and/or SWP operations and evaluated in
25 this EIS includes CVP water service areas.

26 **13.3.2.2.8 Kern County**

27 Kern County encompasses approximately 8,202 square miles in south central
28 California. It is bounded on the north by Kings, Tulare, and Inyo counties; on the
29 east by San Bernardino County, on the south by Ventura and Los Angeles
30 counties; and on the west by San Luis Obispo County. Kern County includes
31 lands within the Sequoia National Forest, Kern and Bitter Creek national wildlife
32 refuges, Lake Isabella, China Lake Naval Air Weapons Station, and Edwards Air
33 Force Base (Kern County 2004). State lands within the county include the Tule
34 Elk State Reserve.

35 The county's geography includes mountainous regions, agricultural lands, and
36 deserts. There are 11 incorporated cities in the county, including Arvin,
37 Bakersfield, California City, Delano, Maricopa, McFarland, Ridgecrest, Shafter,
38 Taft, Tehachapi, and Wasco (Kern County 2009). The major unincorporated
39 communities include Kernville, Lake Isabella, Inyokern, Mojave, Boron,
40 Rosamond, Golden Hills, Stallion Springs, and Buttonwillow. Agricultural land
41 uses are designated for approximately 85 percent of the unincorporated lands that
42 are under the jurisdiction of the county (not including lands under the jurisdiction

1 of the Federal, state, tribes, or incorporated cities). Less than 6 percent of the
 2 unincorporated lands under county jurisdiction are designated for residential uses.
 3 The portion of the Central Valley Region, San Joaquin Valley, in Kern County
 4 that could be affected by changes in CVP and/or SWP operations and evaluated in
 5 this EIS includes CVP and SWP water service areas.

6 **13.3.2.2.9 Tribal Lands in San Joaquin Valley**

7 This section summarizes the tribal lands that could be affected by changes in CVP
 8 and/or SWP operations and that are located within the county boundaries
 9 described above.

10 *Tribal Lands within the Boundaries of Madera County*

11 Major federally recognized tribes and tribal lands within the boundaries of
 12 Madera County include the Picayune Rancheria of the Chuckchansi Indians of
 13 California near the community of Coarsegold and the Northfork Rancheria of the
 14 Mono Indians of California near Northfork (SDSU 2013).

15 *Tribal Lands within the Boundaries of Fresno County*

16 Major federally recognized tribes and tribal lands within the boundaries of Fresno
 17 County include the lands of the Big Sandy Rancheria of the Western Mono
 18 Indians of California and Table Mountain Rancheria of California.

19 *Tribal Lands within the Boundaries of Kings County*

20 Major federally recognized tribes and tribal lands within the boundaries of Kings
 21 County includes the lands of the Santa Rosa Indian Community of Santa Rosa
 22 Rancheria near the town of Lemoore (SDSU 2013).

23 *Tribal Lands within the Boundaries of Tulare County*

24 Major federally recognized tribes and tribal lands within the boundaries of Tulare
 25 County includes the Tule River Indian Tribe of the Tule River Reservation of the
 26 Yokut Indians about 20 miles east of Porterville and covers 55,356 acres
 27 (SDSU 2013).

28 **13.3.2.3 Delta and Suisun Marsh**

29 The Delta and Suisun Marsh includes Sacramento, Yolo, Solano, San Joaquin,
 30 and Contra Costa counties. Sacramento County is discussed in the Sacramento
 31 Valley subsection because more of the land that could be affected by changes in
 32 CVP and SWP long-term operations is located within the Sacramento Valley than
 33 in the Delta and Suisun Marsh geographical areas. San Joaquin County is
 34 discussed in the San Joaquin Valley subsection because more of the land that
 35 could be affected by changes in CVP and SWP long-term operations is located
 36 within the San Joaquin Valley than in the Delta and Suisun Marsh geographical
 37 areas. Contra Costa County is discussed as part of the San Francisco Bay Region
 38 because more of the land that could be affected by changes in CVP and SWP
 39 long-term operations is located within the San Francisco Bay Region than in the
 40 Delta and Suisun Marsh geographical areas.

1 **13.3.2.3.1 Yolo County**

2 Yolo County encompasses approximately 1,021 square miles in northern
3 California. It is bounded on the north by Colusa County, on the east by Sutter and
4 Sacramento counties, on the south by Solano County, and on the west by Lake
5 and Napa counties. Yolo County includes federally owned lands in the Yolo
6 Bypass and Cache Creek areas and state lands within the Yolo Bypass.

7 Residential areas in Yolo County primarily occur in the county's four
8 incorporated cities (Davis, West Sacramento, Winters, and Woodland) that
9 comprise approximately 32,325 acres (5 percent) of county lands (Yolo County
10 2009). Yolo County includes areas within the Delta, including the City of West
11 Sacramento and the community of Clarksburg. The unincorporated portion of the
12 county encompasses 35 community areas, including Capay, Clarksburg,
13 Dunnigan, Esparto, Guinda, Knights Landing, Madison, Monument Hills,
14 Rumsey, Yolo, and Zamora.

15 Yolo County adopted its 2030 General Plan in 2011. The general plan designates
16 more than 92 percent of the County area for agricultural and open space uses.
17 The major crops are tomatoes, alfalfa, wine grapes, rice, seed crops, almonds,
18 organic production, walnuts, cattle, and wheat (Yolo County 2009).

19 The 59,000-acre Yolo Bypass is primarily located within Yolo County and
20 includes a portion of the Sacramento River Flood Control Project, as described in
21 Chapter 5, Surface Water Resources and Water Supplies (CALFED et al. 2001).
22 The upper section of the Yolo Bypass is defined as the area between Fremont
23 Weir and Interstate 80 and is located within Yolo County. The lower section is
24 defined as the area between Interstate 80 and the southern boundary of Egbert
25 Tract at the Sacramento River. The portion of the southern area located to the
26 north of the upper Holland Tract and upper Liberty Island is within Yolo County.
27 In the northern area, agricultural crops include rice, corn, and safflower with
28 melons and tomatoes planted in years when the bypass is not inundated with flood
29 waters. The southern bypass crops include corn, milo, safflower, beans, and
30 sudan grass. Approximately 16,770 acres in the southern Yolo Bypass is within
31 the Yolo Bypass Wildlife Area (Yolo County 2009).

32 The portion of the Central Valley Region, Delta in Yolo County that could be
33 affected by changes in CVP and/or SWP operations and evaluated in this EIS
34 includes areas in the Yolo Bypass and along the Delta channels that use the
35 surface waters (including agricultural lands), and CVP water service areas.

36 **13.3.2.3.2 Solano County**

37 Solano County encompasses approximately 910 square miles in northern
38 California. It is bounded on the north by Yolo County, on the east by Sutter and
39 Sacramento counties, on the south by Contra Costa County, and on the west by
40 Napa County. Solano County includes federally owned lands within Travis Air
41 Force Base (Solano County 2008). State lands include areas within Suisun Marsh
42 and the Cache Slough area of Yolo Bypass.

1 Solano County's General Plan was adopted in 2008. Approximately 81,678 acres
 2 of the county (14 percent of the total land area), lies within seven incorporated
 3 cities: Benicia, Dixon, Fairfield, Rio Vista, Suisun City, Vacaville, and Vallejo.
 4 Urban development is generally concentrated within the incorporated cities or
 5 surrounding suburban communities. Travis Air Force Base is located on
 6 approximately 7,100 acres (1 percent of the land within the county). In 2006,
 7 agriculture accounted for 56.5 percent of the total land use in Solano County
 8 (Solano County 2008). The southern section of the Yolo Bypass, as described
 9 under the Yolo County subsection, is located within Solano County.

10 The portion of the Central Valley Region, Delta in Solano County that could be
 11 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 12 includes SWP facilities (North Bay Aqueduct intakes at Barker Slough), areas in
 13 the Yolo Bypass and along the Delta channels that use the surface waters
 14 (including agricultural lands), and CVP and SWP water service areas.

15 **13.3.2.3.3 Tribal Lands in Delta and Suisun Marsh**

16 This section summarizes the tribal lands that could be affected by changes in CVP
 17 and/or SWP operations and that are located within the county boundaries
 18 described above.

19 *Tribal Lands within the Boundaries of Yolo County*

20 Major federally recognized tribes and tribal lands within the boundaries of Yolo
 21 County include lands of the Yocha Dehe Wintun Nation (previously called the
 22 Rumsey Indian Rancheria of Wintun Indians of California) (Yolo County 2009).

23 **13.3.3 San Francisco Bay Area Region**

24 The San Francisco Bay Area Region includes portions of Napa, Contra Costa,
 25 Alameda, Santa Clara, and San Benito counties that are within the CVP and SWP
 26 service areas.

27 **13.3.3.1.1 Napa County**

28 Napa County encompasses approximately 793 square miles in northern
 29 California. It is bounded on the north by Lake County, on the east by Yolo
 30 County, on the south by Solano County, and on the west by Sonoma County.
 31 Napa County includes 62,865 acres of federally owned and 40,307 acres of state-
 32 owned lands throughout the county, including approximately 28,000 acres related
 33 to Lake Berryessa and the State Cedar Rough Wilderness and Wildlife Area
 34 (Napa County 2007).

35 Approximately 479,000 acres (95 percent) of the county, are unincorporated. The
 36 five incorporated cities include American Canyon, Calistoga, Napa, and
 37 St. Helena, and the town of Yountville. Land use in the county is predominantly
 38 agricultural (Napa County 2007, 2008).

39 The portion of the San Francisco Bay Area Region in Napa County that could be
 40 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 41 includes SWP water service areas.

1 **13.3.3.1.2 Contra Costa County**

2 Contra Costa County encompasses approximately 805 square miles in northern
3 California. It is bounded on the north by Solano and Sacramento counties, on the
4 east by San Joaquin County, on the south by Alameda County, and on the west by
5 San Francisco Bay. Contra Costa County includes federally owned and state-
6 owned lands throughout the county, including approximately 20,000 acres within
7 Mount Diablo State Park (Contra Costa County 2005).

8 Over 40 percent of the county's land is in agricultural production, or about
9 200,370 acres. Residential land is the second largest use in the county,
10 encompassing approximately 122,100 acres (25.4 percent of the county).
11 Approximately 46,700 acres (9 percent of the land within the county), are within
12 surface waters (Contra Costa County 2005).

13 Residential development is concentrated in existing cities and adjacent
14 unincorporated communities. The Contra Costa County incorporated cities
15 include Antioch, Brentwood, Clayton, Danville, El Cerrito, Hercules, Lafayette,
16 Martinez, Moraga, Oakley, Orinda, Pinole, Pleasant Hill, Pittsburg, Richmond,
17 San Pablo, San Ramon, and Walnut Creek. The major unincorporated areas in the
18 county include Alamo, Bethel Island, Byron, Crockett, Discovery Bay,
19 Kensington, Knightsen, North Richmond, Pacheco, Port Costa, and Rodeo
20 (Contra Costa County 2005). Portions of the cities of Pittsburg, Antioch, Oakley,
21 and Brentwood and eastern Contra Costa County are located within the Delta.

22 The portion of the San Francisco Bay Area Region in Contra Costa County that
23 could be affected by changes in CVP and/or SWP operations and evaluated in this
24 EIS includes CVP facilities (including facilities associated with Rock Slough),
25 areas along the Delta channels that use the surface waters (including agricultural
26 lands), and CVP water service areas.

27 **13.3.3.1.3 Alameda County**

28 Alameda County encompasses approximately 738 square miles in northern
29 California. It is bounded on the north by Contra Costa County, on the east by San
30 Joaquin County, on the south by Santa Clara County, and on the west by San
31 Francisco Bay. Alameda County includes federally owned and state-owned lands
32 throughout the county (Alameda County 2009).

33 Western Alameda County and the portions of the Livermore-Amador Valley are
34 heavily urbanized. The incorporated cities include Oakland, which is the County
35 seat; Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward,
36 Livermore, Newark, Piedmont, Pleasant, San Leandro, and Union City. The
37 unincorporated area of the County covers approximately 277,760 acres
38 (59 percent) of the total land area, includes the unincorporated areas of Castro
39 Valley, Eden Area, and (Alameda County Community Development Agency
40 2010; Alameda County 2000, 2009). Large portions of the unincorporated areas
41 located to the east of Castro Valley and within the Livermore-Amador Valley hills
42 include agricultural and open space lands which are not served by the CVP or
43 SWP water supplies.

1 The portion of the San Francisco Bay Area Region in Alameda County that could
2 be affected by changes in CVP and/or SWP operations and evaluated in this EIS
3 includes CVP and SWP facilities (including the SWP South Bay Aqueduct),
4 reservoirs that store CVP or SWP water, and CVP and SWP water service areas.

5 **13.3.3.1.4 Santa Clara County**

6 Santa Clara County encompasses approximately 1,306 square miles in northern
7 California. It is bounded on the north by Alameda County, on the east by
8 Stanislaus and Merced counties, on the south by San Benito County, and on the
9 west by San Mateo and Santa Cruz counties. Santa Clara County includes
10 federally owned and state-owned lands throughout the county, including
11 approximately 87,000 acres within Henry W. Coe State Park (Santa Clara County
12 1994, 2012).

13 Approximately 83 percent of the county's population resides in the
14 15 incorporated cities. The incorporated cities include Campbell, Cupertino,
15 Gilroy, Los Altos, Los Altos Hills, Los Gatos, Milpitas, Monte Sereno, Morgan
16 Hill, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale.
17 The southern portion of the county near Gilroy and Morgan Hill is predominantly
18 rural, with low-density residential developments scattered though the valley and
19 foothill areas (Santa Clara County 1994, 2012).

20 The portion of the San Francisco Bay Area Region in Santa Clara County that
21 could be affected by changes in CVP and/or SWP operations and evaluated in this
22 EIS includes CVP and SWP facilities (including the SWP South Bay Aqueduct
23 and CVP facilities that convey water from San Luis Reservoir) and CVP and
24 SWP water service areas.

25 **13.3.3.1.5 San Benito County**

26 San Benito County encompasses approximately 1,386 square miles in central
27 California. It is bounded on the north by Santa Clara County, on the east by
28 Merced and Fresno counties, and on the south and west by Monterey County.
29 San Benito County includes federally owned and state-owned lands throughout
30 the county, including approximately 26,000 acres within Pinnacles National
31 Monument, over 105,403 acres owned by Bureau of Land Management, and over
32 8,800 acres associated with the Hollister Hills State Vehicular Recreation Area
33 and San Juan Bautista State Historic Park (San Benito County 2010, 2013).

34 San Benito County has approximately 882,675 acres of unincorporated lands
35 (nearly 99.5 percent of the total land area). The incorporated cities of Hollister
36 and San Juan Bautista account for approximately 4,044 acres (0.5 percent of the
37 county land area). Agriculture is the predominant land use, totaling 747,409 acres
38 (84 percent of the county) (San Benito County 2010, 2013).

39 The portion of the San Francisco Bay Area Region in San Benito County that
40 could be affected by changes in CVP and/or SWP operations and evaluated in this
41 EIS includes CVP and SWP facilities (including San Justo Reservoir and other
42 facilities to convey water from San Luis Reservoir) and CVP water service areas.

1 **13.3.4 Central Coast Region**

2 The Central Coast Region includes portions of San Luis Obispo and Santa
3 Barbara counties served by the SWP. Tribal lands are also described for the
4 Central Coast Region.

5 **13.3.4.1 San Luis Obispo County**

6 San Luis Obispo County encompasses approximately 3,594 square miles in
7 central California, including over 200,000 acres of surface waters (San Luis
8 Obispo County 2013). It is bounded on the north by Monterey County, on the
9 east by Kern County, on the south by Santa Barbara County, and on the west by
10 the Pacific Ocean. Federally owned land in San Luis Obispo County includes
11 Los Padres National Forest, Carizzo Plain National Monument, several wilderness
12 areas, and Guadalupe-Nipomo Dunes National Wildlife Refuge. State-owned
13 lands include Hearst-San Simeon State Historical Monument, Montano de Oro
14 State Park, and state beaches and marine conservation areas.

15 Land uses in the County are predominantly rural and agricultural with over
16 1,672,000 acres in agricultural and rural land uses (83 percent of the total county
17 lands). Incorporated cities include Arroyo Grande, Atascadero, Grover Beach,
18 Morro Bay, Paso Robles, Pismo Beach, and San Luis Obispo. Major
19 unincorporated communities include Avila, California Valley, Creston Village,
20 Edna Village, Heritage Ranch, Los Ranchos, Nipoma, Oak Shores, Oceano, San
21 Miguel, Santa Margarita, and Templeton (San Luis Obispo County 2013).

22 The portion of the Central Coastal Region in San Luis Obispo County that could
23 be affected by changes in CVP and/or SWP operations and evaluated in this EIS
24 includes SWP facilities (including facilities associated with the Central Coast
25 Water Authority) and SWP water service areas.

26 **13.3.4.2 Santa Barbara County**

27 Santa Barbara County encompasses approximately 2,744 square miles in central
28 California. It is bounded on the north by San Luis Obispo, on the east by Ventura
29 County, and on the south and west by the Pacific Ocean. Federally owned land in
30 Santa Barbara County includes 629,120 acres in the Los Padres National Forest,
31 98,560 acres in the Vandenberg Air Force Base, Channel Islands National Park,
32 and Guadalupe-Nipomo Dunes National Wildlife Refuge. The state-owned lands
33 include the University of California at Santa Barbara, Sedgwick Reserve, La
34 Purissima Mission State Park and other state parks, and Burton Mesa Ecological
35 Reserve (Santa Barbara County 2009; SBCAG 2013).

36 Agricultural is the predominant land use in the county with over 1,440,000 acres
37 (82 percent of the land) (Santa Barbara County 2009; SBCAG 2013). Santa
38 Barbara County includes eight incorporated cities, Buellton, Carpinteria, Goleta,
39 Guadalupe, Lompoc, Santa Barbara, Santa Maria, and Solvang. Less than
40 3 percent of the County is within incorporated cities. The major unincorporated
41 communities include Cuyuama, Los Alamos, Los Olivos, Mission Hills,
42 Montecito, New Cayamu, Orcutt, Summerland, and Vandenberg Village. The
43 portion of the Central Coastal Region, in Santa Barbara County, that could be

1 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 2 includes SWP facilities (including facilities associated with the Central Coast
 3 Water Authority), recreation facilities at Cachuma Lake that stores SWP water,
 4 and SWP water service areas.

5 **13.3.4.3 Tribal Lands in Central Coast Region**

6 This section summarizes the tribal lands that could be affected by changes in CVP
 7 and/or SWP operations and that are located within the county boundaries
 8 described above.

9 *Tribal Lands within the Boundaries of Santa Barbara County*

10 Major federally recognized tribes and tribal lands within the boundaries of Santa
 11 Barbara County include the Santa Ynez Reservation, which is home to the Santa
 12 Ynez Band of Chumash Mission Indians of the Santa Ynez Reservation near
 13 Santa Barbara (SDSU 2013).

14 **13.3.5 Southern California Region**

15 The Southern California Region includes portions of Ventura, Los Angeles,
 16 Orange, San Diego, Riverside, and San Bernardino counties served by the SWP.
 17 Tribal lands are also described for the Southern California Region.

18 **13.3.5.1 Ventura County**

19 Ventura County encompasses approximately 1,873 square miles in southern
 20 California. It is bounded on the north by Kern County, on the east and south by
 21 Los Angeles County, and on the west by Santa Barbara County and the Pacific
 22 Ocean. Ventura County includes federally owned and state-owned lands
 23 throughout the county, including 550,211 acres in Los Padres National Forest,
 24 Chumash and Sespe wilderness area, 4,331 acres at the Point Mugu Naval Air
 25 Station, 670 acres at the California State University Channel Islands, and over
 26 410 acres in state beach parks (Ventura County 2013).

27 Ventura County has 10 incorporated cities, including Camarillo, Fillmore,
 28 Moorpark, Ojai, Oxnard, Port Hueneme, Santa Paula, San Buenaventura, Simi
 29 Valley, and Thousand Oaks (Ventura County 2013). Major unincorporated
 30 communities within the county include Bell Canyon, Box Canyon, Camarillo
 31 Heights, Del Norte, El Rio, Hidden Valley, Lake Sherwood, Matilija Canyon,
 32 Montalvo, Oak Park, Ojai Valley, Piru, Saticoy, and Somis (Ventura County
 33 2005).

34 The portion of the Southern California Region in Ventura County that could be
 35 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 36 includes recreation at Lake Piru that stores SWP water, and SWP water service
 37 areas.

38 **13.3.5.2 Los Angeles County**

39 Los Angeles County encompasses approximately 4,083 square miles in northern
 40 California. It is bounded on the north by Kern County, on the east by San
 41 Bernardino County, on the south by Orange County, and on the west by Ventura

1 County and the Pacific Ocean. Los Angeles County includes federally owned and
2 state-owned lands throughout the county, including nearly 650,000 acres in Los
3 Padres and Angeles national forests, portions of Edwards Air Force Base, over
4 29,000 acres of other federally owned open space (including wilderness areas),
5 and approximately 50,893 acres of state-owned land, including Hungry Valley
6 State Vehicular Recreation Area (Los Angeles County 2011).

7 More than half of Los Angeles County's 1,698,240 acres of unincorporated land
8 area is designated a natural resources land use category. The next highest land
9 use is rural, which accounts for 39 percent of the unincorporated areas, followed
10 by residential, which accounts for 3 percent of the unincorporated areas. The
11 remaining land area is in the county's 88 incorporated cities, the most populous of
12 which is the City of Los Angeles (Los Angeles County 2012). The County has
13 approximately 140 unincorporated areas (Los Angeles County 2014).

14 The portion of the Southern California Region in Los Angeles County that could
15 be affected by changes in CVP and/or SWP operations and evaluated in this EIS
16 includes SWP facilities and SWP water service areas.

17 **13.3.5.3 Orange County**

18 Orange County encompasses 948 square miles in southern California. It is
19 bounded on the north by Los Angeles County, on the east by San Bernardino and
20 Riverside counties, on the south by San Diego County, and on the west by the
21 Pacific Ocean. Orange County includes federally owned lands, including lands in
22 the Cleveland National Forests.

23 Orange County has 34 incorporated cities in Orange County. The unincorporated
24 lands cover approximately 192,758 acres (Orange County 2005). Land zoned as
25 open space forms the largest land use type (143,313 acres).

26 The portion of the Southern California Region in Orange County that could be
27 affected by changes in CVP and/or SWP operations and evaluated in this EIS
28 includes SWP facilities and SWP water service areas.

29 **13.3.5.4 San Diego County**

30 San Diego County encompasses approximately 4,525 square miles in southern
31 California. It is bounded on the north by Orange and Riverside counties, on the
32 east by Imperial County, on the south by Mexico, and on the west by the Pacific
33 Ocean. San Diego County includes federally owned land, including Camp
34 Pendleton Marine Corps Base, Cleveland National Forest, and San Diego and
35 San Diego national wildlife refuges. State-owned lands throughout the county,
36 includes Cuyamaca Rancho State Park, Anza-Borrego Desert State Park, Felipe
37 Wildlife Area, and Ocotillo Wells State Vehicular Recreation Area (San Diego
38 County 2011).

39 The incorporated cities include Carlsbad, Chula Vista, Coronado, Del Mar,
40 El Cajon, Encinitas, Escondido, Imperial Beach, La Mesa, Lemon Grove,
41 National City, Oceanside, Poway, San Marcos, Santee, Solano Beach, and Vista
42 San Diego (San Diego County 2011). The unincorporated communities include
43 Lakeside, Ramona, San Dieguito, Spring Valley, and Valle de Oro.

1 The portion of the Southern California Region in San Diego County that could be
 2 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 3 includes SWP facilities, non-SWP reservoirs that store SWP water (including
 4 Dixon Lake; and San Vicente, Lower Otay, and Sweetwater Reservoir), and CVP
 5 water service areas.

6 **13.3.5.5 Riverside County**

7 Riverside County encompasses approximately 7,295 square miles in southern
 8 California. It is bounded on the north by San Bernardino County, on the east by
 9 the state of Nevada, on the south by San Diego and Imperial counties, and on the
 10 west by Orange County. Riverside County includes federally owned lands
 11 throughout the county, including March Air Reserve Base, Chocolate Mountains
 12 Naval Gunnery Range, Joshua Tree National Park, San Bernardino and Cleveland
 13 national forests, numerous wilderness areas, and Coachella Valley National
 14 Wildlife Refuge; and state-owned lands including San Jacinto and Santa Rose
 15 wildlife areas and Mount San Jacinto State Park (RCIP 2000).

16 Residential land use accounts for approximately 184,000 acres, nearly 57 percent
 17 of which are within incorporated cities. Approximately 1,313,000 acres
 18 (28 percent) is in open space, recreation, agriculture, and wildland preservation
 19 (RCIP 2000).

20 Most of the population is concentrated in the 24 incorporated cities of Banning,
 21 Beaumont, Calimesa, Canyon Lake, Cathedral City, Coachella, Corona, Desert
 22 Hot Springs, Hemet, Indian Wells, Indio, Lake Elsinore, La Quinta, Moreno
 23 Valley, Murrieta, Norco, Palm Desert, Palm Springs, Perris, Rancho Mirage,
 24 Riverside, San Jacinto, and Temecula. The major unincorporated communities in
 25 the county include Banning Bench, Bermuda Dunes, Cabazon, Cherry Valley,
 26 Cleveland Ridge, Desert Center, Eagle Mountain, El Cerrito, Lakeview/Nuevo,
 27 Meadowbrook, Mecca, Menifee Valley, North Palm Springs, Ripley, Sun City,
 28 Temescal Canyon, Tenaja, Thermal, Thousand Palms, Warm Springs, and
 29 Wildomar.

30 The portion of the Southern California Region in Riverside County that could be
 31 affected by changes in CVP and/or SWP operations and evaluated in this EIS
 32 includes SWP facilities, reservoirs that store SWP water (including Diamond
 33 Valley Lake and Lake Skinner), and SWP water service areas.

34 **13.3.5.6 San Bernardino County**

35 San Bernardino County encompasses approximately 20,106 square miles in
 36 southern California. It is bounded on the north by Inyo County, on the east by the
 37 state of Nevada, on the south by Riverside County, and on the west by Kern, Los
 38 Angeles, and Orange counties. Most of the land in San Bernardino County is
 39 federally owned and state-owned lands, including approximately 10,500,000 acres
 40 (81 percent of the county) (San Bernardino County 2007, 2012). The federally
 41 owned lands include 28 Bureau of Land Management wilderness areas
 42 (approximately 47 percent of the total county), San Bernardino and Angeles
 43 National Forests (676,666 and 655,387 acres, respectively), Mojave National

1 Preserve, Joshua Tree and Death Valley National Parks, and four military bases
2 (Edwards Air Force Base, Twentynine Palms Marine Corps Air Ground Combat
3 Training Center, Fort Irwin, and China Lake Naval Weapons Center). State-
4 owned lands include Silverwood Lake State Recreation Area at the SWP
5 reservoir, Wildwood Canyon State Park, and Providence Mountain and Chino
6 Hills state recreation areas.

7 San Bernardino County includes 24 incorporated cities, including Adelanto,
8 Apple Valley, Barstow, Big Bear Lake, Chino, Chino Hills, Colton, Fontana,
9 Grand Terrace, Hesperia, Highland, Loma Linda, Montclair, Needles, Ontario,
10 Rancho Cucamonga, Redlands, Rialto, San Bernardino, Twentynine Palms,
11 Upland, Victorville, Yucaipa, and Yucca Valley. Major unincorporated
12 communities in the county include Amboy, Baker, Bear Valley, Bloomington,
13 Crest Forest, Earp, Essex, Fontana suburbs, Goffs, Harvard, Havasu Lake,
14 Helendale, Hilltop, Hinckley, Homestead Valley, Joshua Tree, Kelso, Kramer
15 Junction, Lake Arrowhead, Landers, Lucerne Valley, Ludlow, Lytle Creek,
16 Mentone, Moronga Valley, Muscoy, Newberry Springs, Nipton, Oak Glen, Oak
17 Hills, Parker, Phelan/Pinon Hills, Pioneertown, Red Mountain, Rimrock, Silver
18 Lake, Trona, Vidal, and Yerno.

19 The portion of the Southern California Region in San Bernardino County that
20 could be affected by changes in CVP and/or SWP operations and evaluated in this
21 EIS includes SWP water service areas.

22 **13.3.5.7 Tribal Lands in Southern California Region**

23 This section summarizes the tribal lands that could be affected by changes in CVP
24 and/or SWP operations and that are located within the county boundaries
25 described above.

26 *Tribal Lands within the Boundaries of San Diego County*

27 Major federally recognized tribes and tribal lands within the boundaries of
28 San Diego County includes lands of the Capitan Grande Band of Diegueno
29 Mission Indians of California (Barona Reservation and Viejas Reservation),
30 Cahuilla Band of Mission Indians of the Cahuilla Reservation, Campo Band of
31 Diegueno Mission Indians of the Campo Indian Reservation, Ewiiapaayp Band
32 of Kumeyaay Indians, Inaja Band of Diegueno Mission Indians of the Inaja and
33 Cosmit Reservation, Jamul Indian Village of California, La Jolla Band of Luiseno
34 Indians, La Posta Band of Diegueno Mission Indians of the La Posta Indian
35 Reservation, Los Coyotes Band of Cahuilla and Cupeno Indians, Manzanita Band
36 of Diegueno Mission Indians of the Manzanita Reservation, Mesa Grade Band of
37 Diegueno Mission Indians of the Mesa Grande Reservation, Pala Band of Luiseno
38 Mission Indians of the Pala Reservation, Pauma Band of Luiseno Mission Indians
39 of the Pauma & Yuima Reservation, Rincon Band of Luiseno Indians of the
40 Rincon Reservation, San Pasqual Band of Diegueno Mission Indians of
41 California, Iipay Nation of Santa Ysabel, and Sycuan Band of Kumeyaay Nation.

1 *Tribal Lands within the Boundaries of Riverside County*
 2 Major federally recognized tribes and tribal lands within the boundaries of
 3 Riverside County include lands of the Agua Caliente Band of Cahuilla Indians of
 4 the Agua Caliente Reservation, Augustine Band of Cahuilla Indians, Cabazon
 5 Band of Mission Indians, Cahuilla Band of Mission Indians of the Cahuilla
 6 Reservation, Morongo Band of Mission Indians, Pechanga Band of Luiseno
 7 Mission Indians of the Pechanga Reservation, Ramona Band of Cahuilla, Santa
 8 Rosa Band of Cahuilla Indians, Soboba Band of Luiseno Indians, Torres-Martinez
 9 Desert Cahuilla Indians, Twenty-Nine Palms Band of Mission Indians of
 10 California, and Colorado River Indian Tribes of the Colorado River Indian
 11 Reservation (RCIP 2000).

12 *Tribal Lands within the Boundaries of San Bernardino County*
 13 Major federally recognized tribes and tribal lands within the boundaries of San
 14 Bernardino County include the lands of the San Manual Band of Mission Indians
 15 and the Twenty-Nine Palms Band of Mission Indians of California (SDSU 2013).
 16 The Chemehuevi Indian Tribe of the Chemehuevi Reservation is also located in
 17 San Bernardino County near the Colorado River.

18 **13.4 Impact Analysis**

19 This section describes the potential mechanisms for change in non-agricultural
 20 land uses and analytical methods; results of the impact analysis; potential
 21 mitigation measures; and potential cumulative effects.

22 **13.4.1 Potential Mechanisms for Change and Analytical Tools**

23 As described in Chapter 4, Approach to Environmental Analysis, the
 24 environmental consequences assessment considers changes in non-agricultural
 25 land uses related to changes in CVP and SWP operations under the alternatives as
 26 compared to the No Action Alternative and Second Basis of Comparison.

27 **13.4.1.1 Changes in Land Uses**

28 Land uses in 2030 are assumed to be consistent with the future projections
 29 included in existing general plans. The general plans were developed assuming
 30 adequate water supplies to support the projected lands uses. Changes in CVP and
 31 SWP operations under the No Action Alternative and Alternatives 1 through 5
 32 could change the availability of CVP and SWP water supplies. If the CVP and
 33 SWP water supplies were reduced as compared to the No Action Alternative and
 34 Second Basis of Comparison to a level that would not support planned municipal
 35 and industrial water demands, development of future land uses may not occur.
 36 Potential changes to agricultural land uses are described in Chapter 12,
 37 Agricultural Resources.

38 Availability of CVP and SWP water supplies were analyzed using CalSim II
 39 model output (see Chapter 5, Surface Water Resources and Water Supplies).
 40 Most of the CVP and SWP municipal and industrial water users prepared Urban

1 Water Management Plans (UWMPs) that project availability of water supplies to
2 support land uses in 2030. That information was used with projected CVP and
3 SWP water supply availability under each of the alternatives to determine if
4 projected municipal and industrial water demands could be met in 2030 using the
5 CWEST model, as described in Chapter 19, Socioeconomics. The results of the
6 CWEST model indicated that municipal and industrial water demands of CVP
7 and SWP water users in the Central Valley, San Francisco Bay Area, Central
8 Coast, and Southern California regions would be met through a combination of
9 water conservation, available CVP and SWP water supplies, local and regional
10 surface water supplies, groundwater, recycled water, and, in some cases,
11 desalination.

12 Alternative 4 includes provisions for floodway development regulations. It is
13 assumed that under the No Action Alternative and Alternatives 1 through 5,
14 existing programs to protect floodways would continue to be implemented,
15 including Federal and state requirements as implemented by the U.S. Army Corps
16 of Engineers (USACE), Central Valley Flood Protection Board, and Department
17 of Water Resources (DWR). Within the Delta, the floodways are further
18 regulated by the Delta Protection Commission and Delta Stewardship Council to
19 preserve and protect the natural resources of the Delta; and prevent encroachment
20 into Delta floodways, including the Delta Stewardship Council's recently adopted
21 Delta Plan. These regulations would continue to be implemented in the No
22 Action Alternative, Alternatives 1 through 5, and the Second Basis of
23 Comparison. Therefore, future development would be prevented from occurring
24 within the Delta floodplains and floodways; and in the Sacramento, Feather,
25 American, and San Joaquin river corridors upstream of the Delta. Provisions in
26 Alternative 4 would require additional setbacks along the floodways as compared
27 to other alternatives and the Second Basis of Comparison. The potential change
28 in land use is analyzed qualitatively in this chapter.

29 The No Action Alternative, Alternatives 1 through 5, and Second Basis of
30 Comparison include restoration of more than 10,000 acres of intertidal and
31 associated subtidal wetlands in Suisun Marsh and Cache Slough; 17,000 to
32 20,000 acres of seasonal floodplain restoration in the Yolo Bypass; and continued
33 delivery of refuge water supplies under the Central Valley Project Improvement
34 Act, as described in Chapter 3, Description of Alternatives. Land uses in 2030
35 due to implementation of these programs would be consistent between all
36 alternatives and the Second Basis of Comparison. Therefore, this EIS does not
37 analyze changes due to these programs.

38 **13.4.1.2 Effects Related to Cross Delta Water Transfers**

39 Cross Delta water transfers involving the CVP and SWP facilities or water
40 supplies would be required to be implemented in accordance with all existing
41 regulations and requirements, including not causing adverse impacts to other
42 water users in accordance with the requirements of Reclamation, DWR, and the
43 State Water Resources Control Board. It is anticipated that water transfers would
44 continue under all alternatives to provide water supplies to agricultural, municipal
45 and industrial, and wildlife refuges under all alternatives and the Second Basis of

1 Comparison in a similar manner. Transfers for municipal and industrial water
 2 users would be one of several water supply sources to meet the future water
 3 demands in Year 2030. If the availability of transferred water is reduced, it is
 4 anticipated that other water supplies (e.g., recycled water and desalination) would
 5 be increased, as described in the UWMPs for 2030 water demands.

6 Reclamation recently prepared a long-term regional water transfer environmental
 7 document which evaluated potential changes in surface water conditions related to
 8 water transfer actions (Reclamation 2014c). Results from this analysis were used
 9 to inform the impact assessment of potential effects of water transfers under the
 10 alternatives as compared to the No Action Alternative and the Second Basis of
 11 Comparison. The analysis indicated that water transfers would not result in
 12 changes to non-agricultural land uses.

13 Under all of the alternatives and Second Basis of Comparison, it is assumed that
 14 these transfers would continue to occur each year to meet the water demands in
 15 the existing general plans. It is not anticipated that water transfers would change
 16 municipal and industrial land uses as defined in the existing general plans. If a
 17 water transfer program was implemented for the purposes of changing existing
 18 general plan land uses, separate environmental documentation would be required
 19 for the changes to the general plan and the water transfer. Potential effects due to
 20 Cross Delta water transfers on agricultural land uses are described in
 21 Chapter 12, Agricultural Resources. Therefore, this chapter does not include
 22 separate analyses of changes in municipal and industrial land uses due to cross
 23 Delta water transfers.

24 **13.4.2 Conditions in Year 2030 without Implementation of** 25 **Alternatives 1 through 5**

26 This EIS includes two bases of comparison (described in Chapter 3, Description
 27 of Alternatives): the No Action Alternative and the Second Basis of Comparison.
 28 Both of these bases are evaluated at 2030 conditions.

29 **13.4.2.1 No Action Alternative**

30 The impact analysis in this EIS is based upon the comparison of the alternatives to
 31 the No Action Alternative and the Second Basis of Comparison in the Year 2030.
 32 Many of the changed conditions would occur in the same manner under both the
 33 No Action Alternative and the Second Basis of Comparison (e.g., climate change,
 34 sea level rise, projected development under existing general plans, and
 35 implementation of reasonable and foreseeable projects). Due to these changes,
 36 especially climate change and sea level rise, it is anticipated that CVP and SWP
 37 water supply availability would be less than under recent conditions (described in
 38 Chapter 5, Surface Water Resources and Water Supplies). However, it is
 39 anticipated that projected land uses would occur by 2030 with implementation of
 40 water conservation programs and the development of other water supplies,
 41 including ongoing recycled water programs, desalination, and groundwater use.

1 By 2030 under the No Action Alternative and the Second Basis of Comparison, it
2 is assumed that ongoing programs would result in restoration of more than
3 10,000 acres of intertidal and associated subtidal wetlands in Suisun Marsh and
4 Cache Slough; and 17,000 to 20,000 acres of seasonal floodplain restoration in the
5 Yolo Bypass.

6 Under the No Action Alternative and the Second Basis of Comparison, land uses
7 in 2030 would occur in accordance with the general plans for counties and cities
8 within the Central Valley Region; tribal lands; and regulations of state and
9 regional agencies, including Central Valley Flood Protection Board, Delta
10 Protection Commission, and Delta Stewardship Council.

11 Development along the river corridors in the Central Valley would continue to be
12 limited by the state regulations to protect floodways. The Central Valley Flood
13 Protection Board adopts floodway boundaries and approves uses within those
14 floodways (DWR 2010). Various uses are permitted in the floodways, such as
15 agriculture, canals, low dikes and berms, parks and parkways, golf courses, sand
16 and gravel mining, structures that will not be used for human habitation, and other
17 facilities and activities that will not be substantially damaged by the base flood
18 event and will not cause adverse hydraulic impacts that will raise the water
19 surface in the floodway.

20 Within the Delta, future development also is subject to the requirements of the
21 Delta Protection Commission and Delta Stewardship Council. The general plans
22 within the Delta are required by state laws to be consistent with the Delta
23 Protection Commission's *Land Use and Resource Management Plan for the*
24 *Primary Zone of the Delta* (DPC 2010; OAL 2010), which does not allow
25 development within the Primary Zone of the Delta unless proponents can
26 demonstrate that implementing their projects would preserve and protect natural
27 resources of the Delta, promote protection of remnants of riparian and aquatic
28 habitat, not result in loss of wetlands or riparian habitat, would not degrade water
29 quality, would not interfere with migratory birds or public access, would not harm
30 agricultural operations, and would not degrade levees or expose the public to
31 increased flood hazards. Farmers are encouraged to implement management
32 practices to maximize habitat values for migratory birds and wildlife.

33 The Delta Plan adopted by the Delta Stewardship Council in May 2013 included a
34 policy that protects floodways within the entire Delta that are not regulated by
35 other Federal or state agencies (23 California Code of Regulations Section 5014).
36 This policy prevents encroachment into floodways that would impede the free
37 flow of water in the floodway or jeopardize public safety.

38 **13.4.3 Evaluation of Alternatives**

39 As described in Chapter 4, Approach to Environmental Analysis, Alternatives 1
40 through 5 have been compared to the No Action Alternative; and the No Action
41 Alternative and Alternatives 1 through 5 have been compared to the Second Basis
42 of Comparison.

1 During review of the numerical modeling analyses used in this EIS, an error was
 2 determined in the CalSim II model assumptions related to the Stanislaus River
 3 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
 4 model runs. Appendix 5C includes a comparison of the CalSim II model run
 5 results presented in this chapter and CalSim II model run results with the error
 6 corrected. Appendix 5C also includes a discussion of changes in the comparison
 7 of the following alternative analysis:

- 8 • No Action Alternative compared to the Second Basis of Comparison
- 9 • Alternative 1 compared to the No Action Alternative
- 10 • Alternative 3 compared to the Second Basis of Comparison
- 11 • Alternative 5 compared to the Second Basis of Comparison.

12 **13.4.3.1 No Action Alternative**

13 As described in Chapter 4, Approach to Environmental Analysis, the No Action
 14 Alternative is compared to the Second Basis of Comparison.

15 **13.4.3.1.1 Changes in Land Use**

16 No municipal and industrial land uses in the Trinity River Region are served by
 17 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
 18 would be the same under the No Action Alternative and the Second Basis of
 19 Comparison in the Trinity River Region.

20 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
 21 and SWP water deliveries to municipal and industrial Sacramento River Water
 22 Rights Settlement Contractors and water rights holders would be similar under the
 23 No Action Alternative and the Second Basis of Comparison. CVP water
 24 deliveries to water service contractors over the long-term conditions would be
 25 6 percent less for the North of Delta water users and 10 percent less for the South
 26 of Delta users under the No Action Alternative, compared to the Second Basis of
 27 Comparison. SWP water deliveries to water contractors over the long-term
 28 conditions (without Article 21 water) would be reduced by 18 percent throughout
 29 the SWP service area under the No Action Alternative, compared to the Second
 30 Basis of Comparison. However, as described in Chapter 19, Socioeconomics,
 31 2030 municipal and industrial water demands would be met through a
 32 combination of available CVP and SWP water supplies and other water supplies,
 33 including water conservation, water transfers, local and regional surface water and
 34 groundwater, recycled water, and desalination. Adequate water supplies would be
 35 available to support future municipal and industrial land uses projected in existing
 36 general plans under the No Action Alternative and the Second Basis of
 37 Comparison. Therefore, land use in 2030 would be the same under the No Action
 38 Alternative and the Second Basis of Comparison in the Trinity River, Central
 39 Valley, San Francisco Bay Area, Central Coast, and Southern California regions.

40 **13.4.3.2 Alternative 1**

41 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is
 42 compared to the No Action Alternative and the Second Basis of Comparison.
 43 However, because land use conditions under Alternative 1 are identical to land

1 use conditions under the Second Basis of Comparison, Alternative 1 is only
2 compared to the No Action Alternative.

3 **13.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

4 *Change in Land Use*

5 No municipal and industrial land uses in the Trinity River Region are served by
6 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
7 would be the same under Alternative 1 and the No Action Alternative in the
8 Trinity River Region.

9 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
10 and SWP water deliveries to municipal and industrial Sacramento River Water
11 Rights Settlement Contractors and water rights holders would be similar under
12 Alternative 1 and the No Action Alternative. CVP water deliveries to water
13 service contractors over the long-term conditions would be 7 percent greater for
14 the North of Delta water users and 11 percent greater for the South of Delta users
15 under Alternative 1 as compared to the No Action Alternative. SWP water
16 deliveries to water contractors over the long-term conditions (without Article 21
17 water) would be increased by 22 percent under Alternative 1 as compared to the
18 No Action Alternative. The increased CVP and SWP water supply availability
19 would allow water users to reduce other water supplies, including groundwater. It
20 is anticipated that the additional water supplies would not result in changes in the
21 general plan development plans without subsequent environmental
22 documentation. Adequate water supplies would be available to support future
23 municipal and industrial land uses projected in existing general plans under
24 Alternative 1 and the No Action Alternative. Therefore, land use in 2030 would
25 be the same under Alternative 1 and the No Action Alternative in the Trinity
26 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern
27 California regions.

28 **13.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

29 Alternative 1 is identical to the Second Basis of Comparison.

30 **13.4.3.3 Alternative 2**

31 The land use conditions under Alternative 2 would be identical to the conditions
32 under the No Action Alternative; therefore, Alternative 2 is only compared to the
33 Second Basis of Comparison.

34 **13.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

35 Changes to land use under Alternatives 2 as compared to the Second Basis of
36 Comparison would be the same as the impacts described in Section 13.4.3.1,
37 No Action Alternative.

38 **13.4.3.4 Alternative 3**

39 The CVP and SWP operations under Alternative 3 are similar to the Second Basis
40 of Comparison with modified Old and Middle River flow criteria and New
41 Melones Reservoir operations.

1 Alternative 3 would include changed water demands for American River water
 2 supplies as compared to the No Action Alternative or Second Basis of
 3 Comparison. Alternative 3 would provide water supplies of up to 17 thousand
 4 acre feet (TAF)/year under a Warren Act Contract for El Dorado Irrigation
 5 District and 15 TAF/year under a CVP water service contract for El Dorado
 6 County Water Agency. These demands are not included in the analysis presented
 7 in this section of the EIS. A sensitivity analysis comparing the results of the
 8 analysis with and without these demands is presented in Appendix 5B of this EIS.

9 **13.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

10 *Changes in Land Use*

11 No municipal and industrial land uses in the Trinity River Region are served by
 12 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
 13 would be the same under Alternative 3 and the No Action Alternative in the
 14 Trinity River Region.

15 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
 16 and SWP water deliveries to municipal and industrial Sacramento River Water
 17 Rights Settlement Contractors and water rights holders would be similar under
 18 Alternative 3 and the No Action Alternative. CVP water deliveries to water
 19 service contractors over the long-term conditions would be similar for the North
 20 of Delta water users and 9 percent greater for the South of Delta users under
 21 Alternative 3, compared to the No Action Alternative. SWP water deliveries to
 22 water contractors over the long-term conditions (without Article 21 water) would
 23 be increased by 17 percent under Alternative 3, compared to the No Action
 24 Alternative. The increased CVP and SWP water supply availability would allow
 25 water users to reduce other water supplies, including groundwater. It is
 26 anticipated that the additional water supplies would not result in changes in the
 27 general plan development plans without subsequent environmental
 28 documentation. Adequate water supplies would be available to support future
 29 municipal and industrial land uses projected in existing general plans under
 30 Alternative 3 and the No Action Alternative. Therefore, land use in 2030 would
 31 be the same under Alternative 3 and the No Action Alternative in the Trinity
 32 River, Central Valley, San Francisco Bay Area, Central Coast, and Southern
 33 California regions.

34 **13.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

35 *Changes in Land Use*

36 No municipal and industrial land uses in the Trinity River Region are served by
 37 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
 38 would be the same under Alternative 3 and the Second Basis of Comparison in the
 39 Trinity River Region.

40 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
 41 and SWP water deliveries to municipal and industrial Sacramento River Water
 42 Rights Settlement Contractors and water rights holders would be similar under
 43 Alternative 3 and the Second Basis of Comparison. CVP water deliveries to

1 water service contractors over the long-term conditions would be similar for the
2 North of Delta water users and South of Delta users under Alternative 3 and the
3 Second Basis of Comparison. SWP water deliveries to water contractors over the
4 long-term conditions (without Article 21 water) would be similar under
5 Alternative 3 and the Second Basis of Comparison. Adequate water supplies
6 would be available to support future municipal and industrial land uses projected
7 in existing general plans under Alternative 3 and the Second Basis of
8 Comparison. Therefore, land use in 2030 would be the same under Alternative 3
9 and the Second Basis of Comparison in the Trinity River, Central Valley, San
10 Francisco Bay Area, Central Coast, and Southern California regions.

11 **13.4.3.5 Alternative 4**

12 The CVP and SWP operations under Alternative 4 are identical to the CVP and
13 SWP operations under the Second Basis of Comparison and Alternative 1. Under
14 Alternative 4, new development and substantial improvements would be
15 prohibited within floodways or within 170 feet of the ordinary high water line of
16 any floodway.

17 **13.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

18 *Changes in Land Use*

19 The CVP and SWP operations under Alternative 4 are identical to the CVP and
20 SWP operations under Alternative 1. Therefore, the land use conditions
21 influenced by availability of CVP and SWP water supplies under Alternative 4
22 would be the same as conditions under Alternative 1.

23 Under Alternative 4, new development and substantial improvements would be
24 prohibited within floodways or within 170 feet of the ordinary high water line of
25 any floodway. Development within floodways is currently prohibited in
26 accordance with existing general plans and state and regional plans (e.g.,
27 requirements of the Delta Protection Commission and Delta Stewardship
28 Council). Structures that either cannot be moved before flood events or that
29 would reduce the flood management function of the floodway are not allowed. It
30 is anticipated that these requirements would continue to be implemented in 2030,
31 to protect the floodways. However, Alternative 4 would include additional
32 restrictions on new development within 170 feet of the ordinary high water line of
33 any floodway. It is anticipated that the provisions under Alternative 4 could result
34 in site-specific parcel changes as compared to the No Action Alternative.
35 However, the development that would have occurred on these parcels could be
36 incorporated within the general plan development plans and guidelines.
37 Therefore, land use conditions under Alternative 4 would be similar to conditions
38 under the No Action Alternative; and would be the same as the impacts described
39 in Section 13.4.3.2.1, Alternative 1 Compared to the No Action Alternative.

1 **13.4.3.5.2 Alternative 4 Compared to the Second Basis of Comparison**

2 *Changes in Land Use*

3 The CVP and SWP operations under Alternative 4 are identical to the CVP and
4 SWP operations under Second Basis of Comparison. Therefore, the land use
5 conditions influenced by availability of CVP and SWP water supplies under
6 Alternative 4 would be the same as conditions under the Second Basis of
7 Comparison.

8 Under Alternative 4, new development and substantial improvements would be
9 prohibited within floodways or within 170 feet of the ordinary high water line of
10 any floodway. Development within floodways is currently prohibited in
11 accordance with existing general plans and state and regional plans (e.g.,
12 requirements of the Delta Protection Commission and Delta Stewardship
13 Council). Structures that either cannot be moved prior to flood events or that
14 would reduce the flood management function of the floodway are not allowed. It
15 is anticipated that these requirements would continue to be implemented in 2030
16 to protect the floodways. However, Alternative 4 would include additional
17 restrictions on new development within 170 feet of the ordinary high water line of
18 any floodway. It is anticipated that the provisions under Alternative 4 could result
19 in site-specific parcel changes as compared to the Second Basis of Comparison.
20 However, the development that would have occurred on these parcels could be
21 incorporated within the general plan development plans and guidelines.
22 Therefore, land use conditions under Alternative 4 would be identical to
23 conditions under the Second Basis of Comparison.

24 **13.4.3.6 Alternative 5**

25 The CVP and SWP operations under Alternative 5 are similar to the No Action
26 Alternative with modified Old and Middle River flow criteria and New Melones
27 Reservoir operations.

28 Alternative 5 would include changed water demands for American River water
29 supplies as compared to the No Action Alternative or Second Basis of
30 Comparison. Alternative 5 would provide water supplies of up to 17 TAF/year
31 under a Warren Act Contract for El Dorado Irrigation District and 15 TAF/year
32 under a CVP water service contract for El Dorado County Water Agency. These
33 demands are not included in the analysis presented in this section of the EIS. A
34 sensitivity analysis comparing the results of the analysis with and without these
35 demands is presented in Appendix 5B of this EIS.

36 **13.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

37 *Changes in Land Use*

38 No municipal and industrial land uses in the Trinity River Region are served by
39 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
40 would be the same under Alternative 5 and the No Action Alternative in the
41 Trinity River Region.

1 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
2 and SWP water deliveries to municipal and industrial Sacramento River Water
3 Rights Settlement Contractors and water rights holders would be similar under
4 Alternative 5 and the No Action Alternative. CVP water deliveries to water
5 service contractors over the long-term conditions would be similar for the North
6 of Delta and South of Delta water users under Alternative 5, compared to the No
7 Action Alternative. SWP water deliveries to water contractors over the long-term
8 conditions (without Article 21 water) would be similar under Alternative 5,
9 compared to the No Action Alternative. Adequate water supplies would be
10 available to support future municipal and industrial land uses projected in existing
11 general plans under Alternative 5 and the No Action Alternative. Therefore, land
12 use in 2030 would be the same under Alternative 5 and the No Action Alternative
13 in the Trinity River, Central Valley, San Francisco Bay Area, Central Coast, and
14 Southern California regions.

15 **13.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

16 *Changes in Land Use*

17 No municipal and industrial land uses in the Trinity River Region are served by
18 CVP and SWP water supplies. Therefore, the municipal and industrial land uses
19 would be the same under Alternative 5 and the Second Basis of Comparison in the
20 Trinity River Region.

21 As described in Chapter 5, Surface Water Resources and Water Supplies, CVP
22 and SWP water deliveries to municipal and industrial Sacramento River Water
23 Rights Settlement Contractors and water rights holders would be similar under the
24 No Action Alternative and the Second Basis of Comparison. CVP water
25 deliveries to water service contractors over the long-term conditions would be
26 similar for the North of Delta water users and 10 percent less for the South of
27 Delta water users under Alternative 5 as compared to the Second Basis of
28 Comparison. SWP water deliveries to water contractors over the long-term
29 conditions (without Article 21 water) would be reduced by 19 percent throughout
30 the SWP service area under the Alternative 5, compared to the Second Basis of
31 Comparison. However, as described in Chapter 19, Socioeconomics, 2030
32 municipal and industrial water demands would be met through a combination of
33 available CVP and SWP water supplies and other water supplies, including water
34 conservation, water transfers, local and regional surface water and groundwater,
35 recycled water, and desalination. Adequate water supplies would be available to
36 support future municipal and industrial land uses projected in existing general
37 plans under Alternative 5 and the Second Basis of Comparison. Therefore, land
38 use in 2030 would be the same under Alternative 5 and the Second Basis of
39 Comparison in the Trinity River, Central Valley, San Francisco Bay Area, Central
40 Coast, and Southern California regions.

41 **13.4.3.7 Summary of Impact Analysis**

42 The results of the environmental consequences of implementation of
43 Alternatives 1 through 5, compared to the No Action Alternative and the Second
44 Basis of Comparison are presented in Tables 13.1 and 13.2.

1 **Table 13.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	No effects to municipal and industrial and regional land uses	None needed
Alternative 2	No effects to municipal and industrial and regional land uses	None needed
Alternative 3	No effects to municipal and industrial and regional land uses	None needed
Alternative 4	No effects to municipal and industrial and regional land uses	None needed
Alternative 5	No effects to municipal and industrial and regional land uses	None needed

2 **Table 13.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 3 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	No effects to municipal and industrial and regional land uses	None needed
Alternative 1	No effects to municipal and industrial and regional land uses	None needed
Alternative 2	No effects to municipal and industrial and regional land uses	None needed
Alternative 3	No effects to municipal and industrial and regional land uses	None needed
Alternative 4	No effects to municipal and industrial and regional land uses	None needed
Alternative 5	No effects to municipal and industrial and regional land uses	None needed

4 **13.4.3.8 Potential Mitigation Measures**

5 Mitigation measures are presented in this section to avoid, minimize, rectify,
 6 reduce, eliminate, or compensate for adverse environmental effects of
 7 Alternatives 1 through 5, as compared to the No Action Alternative. Mitigation
 8 measures were not included to address adverse impacts under the alternatives as
 9 compared to the Second Basis of Comparison because this analysis was included
 10 in this EIS for information purposes only.

11 Changes in CVP and SWP operations under Alternatives 1 through 5, compared
 12 to the No Action Alternative, would not result in changes in municipal and
 13 industrial land uses or regional lands use plans. Therefore, there would be no
 14 adverse impacts to land use and no mitigation measures are required.

1 **13.4.3.9 Cumulative Effects Analysis**

2 As described in Chapter 3, Description of Alternatives, the cumulative effects
 3 analysis considers projects, programs, and policies that are not speculative; and
 4 are based upon known or reasonably foreseeable long-range plans, regulations,
 5 operating agreements, or other information that establishes them as reasonably
 6 foreseeable.

7 The cumulative effects analysis for Alternatives 1 through 5 for Land Use are
 8 summarized in Table 13.3.

9 **Table 13.3 Summary of Cumulative Effects on Land Use with Implementation of**
 10 **Alternatives 1 through 5 as Compared to the No Action Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative and all Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): <ul style="list-style-type: none"> - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Iron Mountain Mine Superfund Site - Nimbus Fish Hatchery Fish Passage Project - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish 	<u>These effects would be the same under all alternatives.</u> Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council. Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley would continue to be limited by the state regulations to protect floodways. Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions. Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans. Most of these programs were initiated prior to implementation of the 2008 USFWS BO and 2009 NMFS BO which reduced CVP and SWP water supply reliability.

Scenarios	Actions	Cumulative Effects of Actions
	<p>Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project</p> <ul style="list-style-type: none"> - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents) 	
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan(including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - San Luis Reservoir Low Point Improvement Project - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS) 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries.</p>

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Community development would occur in accordance with general plan projections for 2030. Development within the Delta would be subject to the requirements of the Delta Protection Commission and Delta Stewardship Council.</p> <p>Restoration plans for the ongoing programs would be completed. Development along river corridors in the Central Valley would continue to be limited by the state regulations to protect floodways.</p> <p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce availability of CVP and SWP water supplies as compared to past conditions.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p>
Alternative 1 reasonably foreseeable actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 reasonably foreseeable actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 reasonably foreseeable actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

Scenarios	Actions	Cumulative Effects of Actions
Alternative 4 reasonably foreseeable actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant) Increased restrictions for development within floodways.	Implementation of Alternative 4 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 reasonably foreseeable actions in Year 20530	Full implementation of the 2008 USFWS BO and 2009 NMFS BO Positive Old and Middle River flows and increased Delta outflow in spring months	Implementation of Alternative 5 with reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.

1

2 13.5 References

- 3 Alameda County. 2000. *East County Area Plan (Revised by Initiative Nov.*
4 *2000).*
- 5 _____. 2009. *Initial Study and Negative Declaration, Alameda County Housing*
6 *Element Update (2009-2014).* December 2.
- 7 Alameda County Community Development Agency. 2010. *Demographic Map.*
8 March.
- 9 Antelope Valley. 2013. *Antelope Valley Integrated Regional Water Management*
10 *Plan, Final, 2013 Update.*
- 11 BARDP (Bay Area Regional Desalination Project). 2015. *About the Project,*
12 *Schedule.* Site accessed January 12, 2015.
13 <http://www.regionaldesal.com/schedule.html>
- 14 Butte County. 2010. *General Plan Draft Environmental Impact Report.* April 8.
- 15 BVWSD (Buena Vista Water Storage District). 2015. *Buena Vista Water*
16 *Storage District, James Groundwater Storage and Recovery Project.* Site
17 accessed February 15, 2015. <http://bvhd2o.com/James.html>
- 18 CALFED et al. (CALFED Bay-Delta Program, Yolo Bypass Working Group, and
19 Yolo Basin Foundation). 2001. *A Framework for the Future: Yolo*
20 *Bypass Management Strategy.* August.
- 21 CCWD (Contra Costa Water District). 2014. *Bay Area Regional Water Supply*
22 *Reliability Presentation.* November 18.
- 23 City of Carlsbad. 2006. *California Environmental Quality Act (CEQA)*
24 *Addendum City of Carlsbad, California Precise Development Plan and*
25 *Desalination Plant Project, Final Environmental Impact Report.* June 13.
- 26 City of Fresno. 2011. *City of Fresno Recycled Water Master Plan, Final*
27 *Environmental Impact Report.* June.

- 1 City of Huntington Beach. 2010. *Draft Subsequent Environmental Impact*
2 *Report, Seawater Desalination Project at Huntington Beach*. May.
- 3 City of Long Beach. 2015. *Capital Projects, Seawater Desalination*. Site
4 accessed January 12, 2015. [http://www.lbwater.org/overview-long-beach-](http://www.lbwater.org/overview-long-beach-seawater-desalination-project)
5 [seawater-desalination-project](http://www.lbwater.org/overview-long-beach-seawater-desalination-project)
- 6 City of Los Angeles (Los Angeles Department of Water and Power). 2005.
7 *Integrated Resources Plan, Draft Environmental Impact Report*.
8 November.
- 9 _____. 2010. *Water System Ten-Year Capital Improvement Program for the*
10 *Fiscal Years 2010-2019*.
- 11 _____. 2013. *Initial Study, Los Angeles Groundwater Replenishment Project*.
12 September.
- 13 City of Oceanside. 2012. *Oceanside Harbor Desalination Testing Project*.
- 14 City of Roseville. 2012. *Aquifer Storage and Recovery Program Final*
15 *Environmental Impact Report*. March.
- 16 City of San Diego. 2009a. *Mission Valley Basin*. September 11.
17 _____. 2009b. *San Pasqual Basin*. September 11.
- 18 City of Santa Barbara. 2015. *Desalination*. Site accessed February 19, 2015.
19 [http://www.santabarbaraca.gov/gov/depts/pw/resources/system/sources/de](http://www.santabarbaraca.gov/gov/depts/pw/resources/system/sources/desalination.asp)
20 [salination.asp](http://www.santabarbaraca.gov/gov/depts/pw/resources/system/sources/desalination.asp)
- 21 Colusa County. 2011. *Public Draft Environmental Impact Report for the 2030*
22 *Colusa County General Plan Update*. November.
- 23 Contra Costa County. 2005. *Contra Costa County General Plan, 2005-2020*.
24 January.
- 25 CVRWQCB (Central Valley Regional Water Quality Control Board). 2015a.
26 *Status of the Central Valley Salt & Nitrate Management Plan, Central*
27 *Valley Water Board Meeting, Agenda Item #14*. April 16.
- 28 _____. 2015b.CV-SALTS. No Date (n.d.). CV-SALTS, Central Valley Salinity
29 Alternatives for Long-Term Sustainability. Site accessed April 29, 2015.
30 http://www.waterboards.ca.gov/centralvalley/water_issues/salinity/
- 31 CWD (Camarosa Water District). 2015. *Local Water Desalination*. Site
32 accessed January 25, 2015.
33 http://www.camrosa.com/self_reliance_lwd.html
- 34 Del Norte County. 2003. *Del Norte County General Plan*. January 28.
- 35 DPC (Delta Protection Commission). 2010. *Draft Land Use and Resource*
36 *Management Plan for the Primary Zone of the Delta, Adopted February*
37 *25, 2010, February 25*.

- 1 DSC (Delta Stewardship Council). 2013. *The Delta Plan, Ensuring a reliable*
 2 *water supply for California, a healthy Delta ecosystem, and a place of*
 3 *enduring value*. May.
- 4 DWR (California Department of Water Resources). 2010. *Central Valley Flood*
 5 *Management Planning Program, State Plan of Flood Control Descriptive*
 6 *Document*. November.
- 7 _____. 2011. *Scoping Report, North Bay Aqueduct Alternative Intake Project*.
 8 February.
- 9 _____. 2013. *North-of-the-Delta Offstream Storage Preliminary Administrative*
 10 *Draft Environmental Impact Report*. December.
- 11 DWR and Reclamation (California Department of Water Resources and Bureau of
 12 Reclamation). 2014. *Draft Technical Information for Preparing Water*
 13 *Transfer Proposals (Water Transfer White Paper) Information for Parties*
 14 *Preparing Proposals for Water Transfers Requiring Department of Water*
 15 *Resources or Bureau of Reclamation Approval*. November.
- 16 DWR, Reclamation, USFWS and NMFS (California Department of Water
 17 Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and
 18 National Marine Fisheries Service). 2013. *Draft Environmental Impact*
 19 *Report/Environmental Impact Statement for the Bay Delta Conservation*
 20 *Plan*. November.
- 21 EBMUD (East Bay Municipal Utility District). 2014. *Memo to the Board of*
 22 *Directors, Bay Area Regional Reliability Principles*. May 8.
- 23 El Dorado County. 2003. *El Dorado County General Plan Draft Environmental*
 24 *Impact Report*. May.
- 25 EMWD (Eastern Municipal Water District). 2014a. *Hemet/San Jacinto*
 26 *Groundwater Management Area, 2013 Annual Report, Prepared for*
 27 *Hemet-San Jacinto Watermaster*. April.
- 28 _____. 2014b. *Indirect Potable Reuse Program*. January 8.
- 29 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
 30 *General Information – Licensing*. Site accessed April 29, 2015.
 31 <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>
- 32 Fresno County. 2000. *Fresno County General Plan Background Report*.
 33 October.
- 34 Glenn County. 1993. *Glenn County General Plan*. June 15.
- 35 Hoopa Valley Tribe. 2008. *Water Quality Control Plan, Hoopa Valley Indian*
 36 *Reservation*. February.
- 37 Humboldt County. 2012. *Humboldt 21st Century General Plan Update, Draft*
 38 *Environmental Impact Report*. April 2.
- 39 JCSD et al. (Jurupa Community Services District, City of Ontario, Western
 40 Municipal Water District). 2010. *Chino Desalter Phase 3*. December.

- 1 Karuk Tribe. 2010. *Karuk Tribe Department of Natural Resources Eco-Cultural*
2 *Resources Management Plan*. June.
- 3 Kern County. 2004. *Revised Update of the Kern County General Plan and*
4 *Amendment of the Kern County and Incorporated Cities Integrated Waste*
5 *Management Plan Siting Element, Recirculated Draft Program*
6 *Environmental Impact Report*. January.
- 7 _____. 2010. *Greater Tehachapi Area Specific Plan Draft Environmental*
8 *Impact Report*. August.
- 9 Kings County. 2009. *2035 Kings County General Plan Draft Environmental*
10 *Impact Report*. June.
- 11 KRCD (Kings River Conservation District). 2012. *Sustainable Groundwater*
12 *Management through an Integrated Regional Water Management Plan*
13 *(IRWMP)*.
- 14 Los Angeles County (County of Los Angeles). 2010. *The County of Los Angeles*
15 *Annual Report 2009-2010*.
- 16 _____. 2011. *Public Review Draft 4/5/11 Text-Only Version, Los Angeles*
17 *County General Plan 2035*. April.
- 18 _____. 2012a. *Cities within the County of Los Angeles*. February.
- 19 _____. 2013. *Press Release, LA County Flood Control District Tapped to*
20 *Receive \$28 Million State Flood Protection, Water Supply Grant*. October
21 3.
- 22 Madera County. 1995. *Madera County General Plan Background Report*.
23 October.
- 24 Merced County. 2012a. *Merced County General Plan Revised Background*
25 *Report*. November.
- 26 _____. 2012b. *2030 Merced County General Plan Draft Program*
27 *Environmental Impact Report*. November.
- 28 _____. 2013. *2030 Merced County General Plan Update Recirculated Draft*
29 *Program Environmental Impact Report*. July.
- 30 MORE (Mokelumne River Water & Power Authority). 2015. *Status and*
31 *Timeline*. Site accessed January 14, 2015.
32 http://www.morewater.org/about_project/status_timeline.html
- 33 MWDOC (Metropolitan Water District of Orange County). *Doheny Desalination*
34 *Project*. Site accessed January 12, 2015.
35 <http://www.mwdoc.com/services/dohenydesalhome>
- 36 MWDOC (Metropolitan Water District of Southern California). 2010. *Integrated*
37 *Water Resources Plan, 2010 Update*. October.
- 38 Napa County. 2007. *Draft General Plan Environmental Impact Report*.
39 February.

- 1 Napa County. 2008. *Napa County General Plan*. June.
- 2 NCRWQCB et al. (California North Coast Regional Water Quality Control Board
3 and Bureau of Reclamation). 2009. *Channel Rehabilitation and Sediment
4 Management for Remaining Phase 1 and Phase 2 Sites, Draft Master
5 Environmental Impact Report and Environmental Assessment*. June.
- 6 Nevada County (County of Nevada). 1995. *Nevada County General Plan, Final
7 Environmental Impact Report*. March.
- 8 _____. 2012. *Nevada County Demographic and Statistical Profile*.
- 9 NSJCGBA (Northeastern San Joaquin County Groundwater Banking Authority).
10 2007. *Eastern San Joaquin Integrated Regional Water Management Plan*.
11 July.
- 12 OAL (California Office of Administrative Law). 2010. *Notice of Approval of
13 Regulatory Action, Delta Protection Commission*. October 7.
- 14 OMWD (Olivenhain Municipal Water District). 2015. North County Recycled
15 Water Project on Track to Receive Millions More in State Grant Funds.
16 Site accessed February 16, 2015.
17 [http://www.olivenhain.com/component/content/article/3-news/236-north-
18 county-recycled-water-project-on-track-to-receive-millions-more-state-
19 grant-funds](http://www.olivenhain.com/component/content/article/3-news/236-north-county-recycled-water-project-on-track-to-receive-millions-more-state-grant-funds).
- 20 Orange County. 2005. *2005 Orange County General Plan*.
- 21 Paskenta. 2014. *Winththunun Lewquit/About the Tribe, About our People*. Site
22 accessed March 30, 2014. <http://www.paskentaweb.com/about/>
- 23 Placer County. 2011. *Placer County Conservation Plan, Western Placer County,
24 Agency Review Draft Document*. February 1.
- 25 Plumas County. 2012. *2035 Plumas County General Plan Update Draft
26 Environmental Impact Report*. November.
- 27 PWD (Palmdale Water District). 2010. *Strategic Water Resources Plan, Final
28 Report*. March.
- 29 RCIP (Riverside County Integrated Project). 2000. *Existing Setting Report*.
30 March.
- 31 RCWD (Rancho California Water District). 2011. *2010 Urban Water
32 Management Plan Update*. June 30.
- 33 _____. 2012. *Agricultural Water Management Plan*. December 13.
- 34 Reclamation (Bureau of Reclamation). 2004. *Sacramento River Settlement
35 Contractors Environmental Impact Statement*. September.
- 36 _____. 2005a. *Final Environmental Assessment for the Long-term Contract
37 Renewal, Shasta and Trinity Divisions*. March.
- 38 _____. 2005b. *Final Environmental Assessment for Renewal of Long-term
39 Contracts for the Sacramento River Division Contractors*. February.

- 1 _____. 2005c. *Central Valley Project Long-Term Water Service Contract*
2 *Renewal American River Division Environmental Impact Statement*. June.
- 3 _____. 2006. *San Luis Drainage Feature Re-evaluation. Final Environmental*
4 *Impact Statement*. May.
- 5 _____. 2009. *Record of Decision, Grassland Bypass Project, 2010-2019*.
6 December.
- 7 _____. 2010. *Resighini Rancheria Water Resources Development Project*. July.
- 8 _____. 2011. *Record of Decision Madera Irrigation District Water Supply*
9 *Enhancement Project*. July.
- 10 _____. 2012. *Record of Decision San Joaquin River Restoration Program*.
11 September 28.
- 12 _____. 2013a. *Shasta Lake Water Resources Investigation Draft Environmental*
13 *Impact Statement*. June.
- 14 _____. 2013b. *Record of Decision, Water Transfer Program for the San Joaquin*
15 *River Exchange Contractors Water Authority, 2014-2038*. July 30.
- 16 _____. 2014a. *Findings of No Significant Impact, 2014 Tehama-Colusa Canal*
17 *Authority Water Transfers*. April 22.
- 18 _____. 2014b. *Findings of No Significant Impact, 2014 San Luis & Delta-*
19 *Mendota Water Authority Water Transfers*. April 22.
- 20 _____. 2014c. *Long-Term Water Transfers Environmental Impact*
21 *Statement/Environmental Impact Report, Public Draft*. September.
- 22 _____. 2014d. *Upper San Joaquin River Basin Storage Investigation, Draft*
23 *Environmental Impact Statement*. August.
- 24 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
25 Game [now known as Department of Fish and Wildlife], and U.S. Fish
26 and Wildlife Service). 2011. *Suisun Marsh Habitat Management,*
27 *Preservation, and Restoration Plan Final Environmental Impact*
28 *Statement/Environmental Impact Report*.
- 29 Reclamation, CCWD, and Western (Bureau of Reclamation, Contra Costa Water
30 District, and Western Area Power Administration). 2010. *Los Vaqueros*
31 *Expansion Project, Environmental Impact Statement/Environmental*
32 *Impact Report*. March.
- 33 Resighini Rancheria. 2014. *Resighini Rancheria, About Us*. Site accessed
34 April 25, 2014. http://resighin.ipower.com/about_us.html.
- 35 SACOG (Sacramento Area Council of Governments). 2007. *Draft*
36 *Environmental Impact Report for the Metropolitan Transportation Plan*
37 *for 2035*. October.
- 38 Sacramento County. 2010. *Final Environmental Impact Report, Sacramento*
39 *County General Plan Update*. April.

- 1 _____. 2011. *General Plan of 2005-2030*. November 9.
- 2 San Benito County. 2010. *San Benito County General Plan Public Review Draft*
3 *Background Report*. November.
- 4 _____. 2013. *2035 San Benito County General Plan Update Draft Program*
5 *Environmental Impact Report*. November.
- 6 San Bernardino County (County of San Bernardino). 2007. *County of San*
7 *Bernardino 2006 General Plan Program, Final Environmental Impact*
8 *Report and Appendices*. February.
- 9 _____. 2012. *County of San Bernardino 2007 General Plan*. May.
- 10 San Diego County (County of San Diego). 2011. *San Diego County General*
11 *Plan Update, Final Environmental Impact Report*. August.
- 12 San Joaquin County. 2009. *General Plan Update Background Report*. July.
- 13 San Luis Obispo County (County of San Luis Obispo). 2013. *County of San Luis*
14 *Obispo, Land Use and Circulation Elements*. August.
- 15 Santa Barbara County (County of Santa Barbara). 2009. *Santa Barbara County*
16 *Comprehensive Plan*. May.
- 17 Santa Clara County (County of Santa Clara). 1994. *Santa Clara County General*
18 *Plan Draft Environmental Impact Report*. September.
- 19 _____. 2012. *Santa Clara Valley Habitat Plan, Final Environmental Impact*
20 *Report/Environmental Impact Statement*. 2012.
- 21 SBCAG (Santa Barbara County Association of Governments). 2013. *2040 Santa*
22 *Barbara County Regional Transportation Plan and Sustainable*
23 *Communities Strategy, Draft Environmental Impact Report*. May.
- 24 SDCWA (San Diego County Water Authority). 2009. *Camp Pendleton Seawater*
25 *Desalination Project Feasibility Study*. December.
- 26 _____. 2015. *Seawater Desalination*. Site accessed January 12, 2015.
27 <http://www.sdcwa.org/seawater-desalination>
- 28 SDSU (San Diego State University). 2013. Site accessed March 25, 2013.
29 <http://library.sdsu.edu/guides/sub2.php?id=195&pg=193>.
- 30 SEWD (Stockton East Water District). 2012. *Farmington Groundwater*
31 *Recharge Program*. Site accessed November 30, 2012.
32 <http://www.farmingtonprogram.org/index.html>
- 33 Shasta County. 2004. *Shasta County General Plan, as amended through*
34 *September 2004*. September.
- 35 SJRECWA (San Joaquin River Exchange Contractors Water Authority). 2012.
36 *Los Banos Creek Water Restoration Management Plan, Attachment 4 –*
37 *Project Description*.
- 38 SJRRP (San Joaquin River Restoration Program). 2011. *Friant-Kern Canal*
39 *Capacity Restoration, Draft*. June.

- 1 _____. 2015. *Madera Canal Capacity Restoration Project*. Site accessed
2 February 21, 2015. [http://restoresjr.net/activities/site_specific/madera-
4 canal/index.html](http://restoresjr.net/activities/site_specific/madera-
3 canal/index.html)
- 4 Solano County. 2008. *Solano County General Plan, Draft Environmental Impact
5 Report*. April.
- 6 Stanislaus Council of Governments. 2007. *Final Supplemental Program
7 Environmental Impact Report for the 2007-2030 Regional Transportation
8 Plan of Stanislaus County*. May.
- 9 Stanislaus County (County of Stanislaus County). 2010. *Stanislaus County
10 General Plan Support Documentation, Revised April 2010*. April.
- 11 _____. 2012. *Text Revisions to the Stanislaus County General Plan*.
- 12 Sutter County. 2010. *General Plan Update Draft Environmental Impact Report*.
13 September.
- 14 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control
15 Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary*.
16 December 13.
- 17 _____. 2013. *Comprehensive (Phase 2) Review and Update to the Bay-Delta
18 Plan, DRAFT Bay-Delta Plan Workshops Summary Report*. January
- 19 _____. 2015. *CV-SALTS Annual Report, State Water Board Meeting, Agenda
20 Item #5*. January 20.
- 21 SWSD (Semitropic Water Storage District). 2011. *Delta Wetlands Project Place
22 of Use, Final Environmental Impact Report*. August.
- 23 Tehama County. 2008. *Tehama County 2008-2028 General Plan Draft
24 Environmental Impact Report*. September.
- 25 Trinity County. 2012. *2009 Housing Element of the Trinity County General
26 Plan*. December 4.
- 27 Tulare County. 2010. *Tulare County General Plan 2030 Update, Recirculated
28 Draft Environmental Impact Report*. February.
- 29 USGVMWD (Upper San Gabriel Valley Municipal Water District). 2013.
30 *Integrated Resources Plan*. January.
- 31 Ventura County (County of Ventura). 2005. *Final Subsequent Environmental
32 Impact Report for Focused General Plan Update*. June.
- 33 _____. 2013. Ventura County Statistics. Assessor's Office. Site accessed
34 February 5, 2013.
35 [http://assessor.countyofventura.org/generallyspeaking/CountyStatistics.ht
ml](http://assessor.countyofventura.org/generallyspeaking/CountyStatistics.ht
36 ml)
- 37 WBMWD (West Basin Municipal Water District). 2011. *Edward C. Little Water
38 Recycling Facility Phase V Expansion, Initial Study/Mitigated Negative
39 Declaration*. March.

- 1 _____. 2015. *Ocean Water Desalination*. Site accessed January 12, 2015.
- 2 [http://www.westbasin.org/water-reliability-2020/ocean-water-
desalination/overview](http://www.westbasin.org/water-reliability-2020/ocean-water-
desalination/overview)
- 3
- 4 Yolo County. 2009. *Yolo County 2030 Countywide General Plan Environmental
5 Impact Report Public Review Draft*. April.
- 6 Yuba County. 2011. *Final Yuba County 2030 General Plan Environmental
7 Impact Report*. May.
- 8 Yurok Tribe. 2005. *Tribal Park Concept Plan*. August.
- 9 _____. 2012. *NPS Assessment and Management Program Plan*. December.

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Chapter 14

1 Visual Resources

2 14.1 Introduction

3 This chapter describes the visual resources in the study area related to natural and
4 artificial landscape features and potential changes that could occur as a result of
5 implementing the alternatives evaluated in this Environmental Impact Statement
6 (EIS). Implementation of the alternatives considered in this EIS could affect
7 visual resources through changes in surface water elevations at Central Valley
8 Project (CVP) and State Water Project (SWP) reservoirs and changes in land use
9 related to potential changes in operation of the CVP and SWP and ecosystem
10 restoration.

11 Changes in reservoir surface water elevations, agricultural resources, and land use
12 are described in more detail in Chapter 5, Surface Water Resources and Water
13 Supplies; Chapter 12, Agricultural Resources; and Chapter 13, Land Use,
14 respectively.

15 14.1.1 Visual Effects

16 Natural and artificial landscape features contribute to perceived visual images and
17 aesthetic values of views. The values of views frequently are determined by
18 contrasts of forms and textures related to geology, hydrology, vegetation and
19 wildlife, agricultural crops, and other land uses. For example, a small water
20 feature in a plain may be a significant visual feature; however, a small water
21 feature within an area with vast rivers or larger ponds may be of less significance.

22 Visual effects are dependent upon the viewpoint of individuals because each
23 person can respond differently to changes in the physical environment depending
24 upon expectations, historical perspective, duration and frequency of the views,
25 and extent of a viewshed. A viewshed is defined by the Federal Highway
26 Administration (DOT 1981) as a surface area visible from a particular location.
27 The character of a viewshed can also vary daily, seasonally, and with changing
28 weather.

29 Visual effects also are affected by the general activities of the viewers.

30 Passengers in automobiles and trains with relatively short exposure to views may
31 have a different experience than recreationists or residents who view the area for
32 longer periods of time. Residents and recreationists frequently select a location
33 for their activities due to the views. Changes in views could affect the quality of
34 their activities, including housing, camping, hiking, or boating locations.

35 Therefore, changes in visual effects are dependent upon the visual quality of the
36 landscape within the context of the setting (DOT 1981).

37 Visual quality, or scenic value, has been classified with respect to the lines, forms,
38 colors, textures, and composition of landforms, vegetation, rocks, cultural
39 features, and water features by the U.S. Department of Agriculture (USDA),

1 Forest Service (USDA 1995). The classification system includes Class A,
2 Distinctive; Class B, Typical (or ordinary or common features); and Class C,
3 Indistinctive. This classification system also considers the scenic integrity, or the
4 completeness of the landscape character.

5 **14.2 Regulatory Environment and Compliance** 6 **Requirements**

7 Potential actions that could be implemented under the alternatives evaluated in
8 this EIS could affect visual resources at reservoirs and lands served by CVP and
9 SWP water supplies. Actions located on public agency lands or implemented,
10 funded, or approved by Federal and state agencies, would need to be compliant
11 with appropriate Federal and state agency policies and regulations, as summarized
12 in Chapter 4, Approach to Environmental Analysis.

13 **14.3 Affected Environment**

14 This section describes visual resources that could be potentially affected by the
15 implementation of the alternatives considered in this EIS. Changes in visual
16 resources due to changes in CVP and SWP operations may occur in the Trinity
17 River, Central Valley, San Francisco Bay Area, and Central Coast and Southern
18 California regions.

19 Physical form and visual character are the result of the interaction of natural and
20 engineered elements. Natural elements, including topography, hydrology,
21 vegetation, and climate create the physical context. Engineered elements, such as
22 buildings, roads, infrastructure, and settlement patterns, are secondary elements
23 that act on the natural physical context to establish a visual environment.

24 Both the natural and engineered landscape features contribute to perceived views
25 and the aesthetic value of those views. In areas considered to have high resource
26 value and scenic character, it is important to evaluate and protect the visual
27 character and aesthetic value of landscapes that may undergo alteration.

28 **14.3.1 Trinity River Region**

29 The Trinity River Region includes the area along the Trinity River from Trinity
30 Lake to the confluence with the Klamath River, and along the Klamath River
31 from the confluence with the Trinity River to the Pacific Ocean.

32 **14.3.1.1 Trinity River Watershed**

33 The Trinity River drains an area of the Coast Range, northwest of the Sacramento
34 Valley. Dams on the river form Trinity Lake and Lewiston Lake, both of which
35 are in the Whiskeytown-Shasta-Trinity National Recreation Area, as described in
36 Chapter 15, Recreation Resources. The Trinity River flows through sparsely
37 populated and heavily forested, mountainous terrain, jagged cliffs that can be
38 viewed during numerous recreational opportunities, including fishing, rafting,

1 kayaking, and canoeing. The forests offer visual resources which include snow-
 2 covered peaks, volcanoes, rock outcroppings, mountain creeks, lakes, meadows,
 3 and a wide variety of trees and vegetation. Downstream of Lewiston Dam, the
 4 Trinity River corridor is characterized by gravel bars, riparian vegetation, and
 5 human-built features (NCRWQCB et al. 2009). Artificial lights occur related to
 6 passing vehicles and local residential and commercial buildings. Glare related to
 7 the water surfaces may occur from some view locations.

8 **14.3.1.1.1 Wild and Scenic Rivers and Scenic Highways in the Trinity River** 9 **Watershed**

10 On January 19, 1981, the Secretary of the Interior designated portions of the
 11 Trinity River watershed as part of the National Wild and Scenic Rivers System,
 12 including the Trinity River downstream of Lewiston Dam, and portions of the
 13 South Fork, North Fork, and New River (BLM et al. 2012). The State of
 14 California adopted similar reaches as wild and scenic under Public Resources
 15 Code sections 5093.54 and 5093.545.

16 The Trinity River Region includes two highways in Trinity County and one
 17 highway in Humboldt County that are eligible for State Scenic Highway
 18 designations. The two highways in Trinity County are eligible for State Scenic
 19 Highway designation and include the Siskiyou-Trinity Scenic Byway (State Route
 20 3, which extends from south of Hayfork to north of Trinity Lake to Interstate 5)
 21 and Trinity Scenic Byway (State Route 299, which extends from the Pacific
 22 Ocean to Redding) (CalTrans 2014a). In Humboldt County, State Route 96 along
 23 the Trinity River from Willow Creek to the confluence with the Klamath River is
 24 eligible for State Scenic Highways designation (CalTrans 2014b).

25 **14.3.1.2 Lower Klamath River Watershed**

26 The Klamath River from the confluence with the Trinity River to the Pacific
 27 Ocean is characterized by a forested river canyon with riparian vegetation along
 28 the river. Reduced flows in the summer have frequently resulted in algal blooms
 29 which has reduced water clarity and visual quality of the river corridor (DOI and
 30 DFG 2012).

31 **14.3.1.2.1 Wild and Scenic Rivers and Scenic Highways in the Klamath** 32 **River Watershed**

33 The portion of the Klamath River watershed within the Trinity River Region
 34 considered in this EIS (from the confluence with the Trinity River to the Pacific
 35 Ocean) was designated as part of the entire reach of the Klamath River from Iron
 36 Gate to the Pacific Ocean by the Secretary of the Interior to be part of the
 37 National Wild and Scenic Rivers System on January 19, 1981. The State of
 38 California also adopted this reach of Klamath River as wild and scenic under
 39 Public Resources Code sections 5093.54 and 5093.545.

40 Caltrans has not designated highways within the Klamath River watershed in the
 41 Trinity River Region as Scenic Highways or identified roadways to be eligible for
 42 Scenic Highways status (CalTrans 2014b, 2014c).

1 **14.3.2 Central Valley Region**

2 The Central Valley Region extends from above Shasta Lake to the Tehachapi
3 Mountains, and includes the Sacramento Valley, San Joaquin Valley, Delta, and
4 Suisun Marsh.

5 The Central Valley Region is predominantly made up of lowlands and plains
6 surrounded by foothills and tall mountains of the Coast Range to the west, the
7 Cascade Range to the north, the Sierra Nevada to the east, and the Tehachapi
8 Mountains to the south. Communities and roadways of various sizes are located
9 throughout the valley. Land use outside of the communities is primarily
10 agricultural, with riparian, wetland and oak woodlands along the major
11 waterways.

12 **14.3.2.1 Sacramento Valley**

13 The Sacramento Valley extends from the northern mountainous areas to the less
14 dramatic landscapes of the Central Valley at the lower elevations. The
15 mountainous areas are characterized by rugged and deep river canyons and
16 valleys that extend from jagged peaks to forested areas with pine and deciduous
17 trees. Large rivers flow from the mountain areas through the foothills into the
18 agricultural areas and communities along the valley floor. Oak woodlands are
19 located at middle and lower elevations of the foothills and along riparian corridors
20 on the valley floor.

21 The Sacramento Valley extends from Shasta Lake and Whiskeytown Lake to the
22 Delta. The Sacramento Valley portion of the Central Valley Region considered in
23 this EIS includes the middle and lower portions of the Feather River and
24 American River watersheds that are influenced by CVP and SWP water supply
25 facilities, respectively.

26 **14.3.2.1.1 Shasta Lake, Keswick Reservoir, and Whiskeytown Lake**

27 Shasta Lake, Keswick Reservoir, and Whiskeytown Lake are in the
28 Whiskeytown-Shasta-Trinity National Recreation Area, as described in
29 Chapter 15, Recreation Resources. These watersheds provide opportunities for
30 high quality visual attractions, such as mountains, forests, waterfalls, streams,
31 open water, and vistas of the sky that can be experienced during numerous
32 recreational activities such as boating, water skiing, swimming, fishing, camping,
33 picnicking, hiking, hunting, and mountain biking. Panoramic views for travelers
34 through the area can be seen from many locations, including State Route 151 vista
35 point, Shasta Dam Visitor Center, and Interstate 5. The contrast between the open
36 water bodies and surrounding mountains provides a wide diversity of views. The
37 quality and diversity of visual resources at the lakes and the surrounding areas is
38 influenced by human-built features such as highways, railroads, resorts, bridges,
39 communities, and electrical transmission facilities. The visual quality of open
40 waters also is influenced by fluctuating water levels. Typically, the water levels
41 decline from an annual maximum in May to a minimum in October. In extremely
42 dry years, exposed bare mineral soils in a “bathtub ring” are in substantial contrast
43 to the open water and the upslope vegetation (Reclamation 2013a).

1 Between the lakes, pine and oak forests predominate, with intermittent chaparral
 2 and rock outcrops. The landscape includes mountain ranges, volcanoes, and
 3 waterways, opening below the reservoir to the agricultural vistas and communities
 4 of the Central Valley.

5 **14.3.2.1.2 Sacramento River Watershed: Keswick Reservoir to**
 6 **Feather River**

7 The scenic qualities of the upper reaches of the Sacramento River watershed south
 8 of Keswick Reservoir are generally considered to be of high quality, especially in
 9 areas where little to no development has occurred. Varied topography, geologic
 10 formations, and natural and manmade water bodies provide striking vistas.

11 Similar conditions are found in the Sierra Nevada Mountains and foothills near
 12 the upper and middle Feather, Yuba, American, Mokelumne, Calaveras, and
 13 Stanislaus rivers watersheds.

14 The foothills provide views of rolling hills, open grasslands, and scattered oak and
 15 pine woodlands. In the lower elevations of the Central Valley, the human-built
 16 environment becomes more dominant, and detracts from views of the natural
 17 landscape. Outside of the urban and suburban areas, land use is rural in character,
 18 with agricultural areas that include irrigated row crops, orchards, and grazing
 19 lands. Sporadically, flooded agricultural fields, especially rice fields managed for
 20 wetlands, are used heavily by migrating birds.

21 Between the Keswick Reservoir and Feather River confluence with the
 22 Sacramento River, the landscape also includes human-built reservoirs and canals.
 23 Black Butte Reservoir is operationally integrated with the CVP, and the canal
 24 system includes the CVP Corning Canal, Tehama-Colusa Canal, and Glenn-
 25 Colusa Irrigation District's canal. The canals provide visual interest in localized
 26 areas with limited viewing opportunities (Reclamation 1997).

27 Visual resources that could be affected in the Feather River and American River
 28 watersheds are described below. The remaining portions of the Sacramento
 29 Valley between the Feather River and the San Francisco Bay Area Region
 30 includes the Delta (described in following subsections of this chapter) and areas
 31 located to the east and west of the Delta. Land uses located to the south of the
 32 Feather River and outside of the Delta include agricultural, open space, and major
 33 urban centers that all use SWP water supplies. The urban areas include the cities
 34 of Vacaville, Fairfield, and Vallejo in Solano County and unincorporated areas of
 35 Napa County.

36 *Scenic Highways in the Sacramento River Area*

37 In the Sacramento Valley portion of the Central Valley Region, there are several
 38 designated State Scenic Highways and several roads that are eligible for this
 39 designation, including the following roadways:

- 40 • Shasta County: State Route 151 from Shasta Dam to Lake Boulevard is
 41 designated as a State Scenic Highway due to views of the Sacramento River,
 42 Shasta Lake, and distant hills. State Routes 299, 44, and 89 are eligible for
 43 State Scenic Highway designation (CalTrans 2014a, 2014d).

- 1 • Tehama County: State Routes 89 and 36 are eligible for State Scenic Highway
2 designation (CalTrans 2014e).
- 3 • Yolo County: A portion of State Route 16 is eligible for State Scenic
4 Highways designation (CalTrans 2014f).
- 5 • Solano County: A portion of State Route 37 is eligible for State Scenic
6 Highways designation (CalTrans 2014g).
- 7 • Napa County: Portions of State Routes 29 and 121 are eligible for State
8 Scenic Highways designation (CalTrans 2014h).

9 **14.3.2.1.3 Feather River Watershed**

10 Antelope Lake, Lake Davis, Frenchman Lake, Lake Oroville, and Thermalito
11 Afterbay on the Feather River are human-built reservoirs providing visual contrast
12 with surrounding terrain.

13 *Upper Feather River*

14 Antelope Lake, Lake Davis, and Frenchman Lake are located in the upper Feather
15 River watershed (DWR 2013a; USFS 2006a, 2006b, 2011). Antelope Lake,
16 located on Indian Creek, has the longest dam of the three reservoirs. This remote
17 lake, surrounded by pine and fir trees, can be viewed from Fruit Growers
18 Boulevard and Indian Creek Road. Lake Davis is formed by Grizzly Dam on Big
19 Grizzly Creek, and is the largest of the three dams. It is located in the upper
20 watershed surrounded by many trees, and can be viewed from Beckwourth-
21 Taylorsville Road and Lake Davis Road. Frenchman Lake, located on Last
22 Chance Creek, is formed by the tallest dam of the three dams. This lake also is
23 surrounded by trees to the waterline and can be viewed from Little Last Chance
24 Creek Road and Frenchman Lake Road.

25 *Lake Oroville and Thermalito Reservoir*

26 The terrain adjacent to Lake Oroville is generally quite steep with limited
27 vehicular access. Most views of the water are from the bridges on State Route
28 162, State Route 70, and several county roads. Some residents live in the lands
29 around Lake Oroville and Thermalito Afterbay. The residents can easily view the
30 water and visitors can view the structures. As described above for Shasta Lake
31 and other reservoirs in the upper Sacramento River watershed, Lake Oroville
32 water levels decline as summer progresses, leaving a ring of bare soil along the
33 water's edge. In extremely dry years at Lake Oroville, more than 200 vertical feet
34 of bare mineral soils in a "bathtub ring" may be exposed when the surface water
35 elevation approaches 710 feet above mean sea level (DWR 2007).

36 The Diversion Pool between Oroville Dam and Thermalito Diversion Dam
37 extends about 4.5 miles along the Feather River and meanders through hillsides
38 with substantial vegetation within widths ranging from 50 to 200 feet (DWR
39 2007). Vistas of the Diversion Pool are primarily viewed by recreationists on the
40 water or along the adjacent trails. A 1.9-mile-long concrete Thermalito Power
41 Canal appears as a contrast from State Route 70 and county roads to the
42 undeveloped landscape between the Diversion Dam and the Thermalito Forebay.

1 The Thermalito Forebay is a 630-acre reservoir, approximately 3 miles in length
 2 that can be viewed by recreationists along or within the open water and travelers
 3 along State Route 70 as the roadway extends from the foothills to the valley floor.
 4 Water levels in these human-built features generally vary by 2 to 4 feet during a
 5 week. When the water levels are low, exposed bare soils create a “bathtub ring”
 6 effect.

7 Thermalito Afterbay is located in a more flat terrain than Lake Oroville and can
 8 be viewed from many locations and residences. The Thermalito Afterbay Dam is
 9 located parallel to State Route 99 and rises over 30 feet above the roadway (DWR
 10 2007). The Thermalito Afterbay is approximately 4,300 acres and is visible from
 11 State Route 162, several county roads, recreation areas, and neighboring
 12 residences. Because the afterbay is located on flat lands with minimal foothills,
 13 vistas from the water or lands surrounding the afterbay extend from the Sierra
 14 Nevada foothills to the Feather River on the valley floor. Water levels in the
 15 afterbay generally vary by 2 to 6 feet during a week, but can decline by as much
 16 as 11 feet. When the water levels are low, exposed bare soils create a “bathtub
 17 ring” effect.

18 The low flow channel of the Feather River extends from the Diversion Dam
 19 through the community of Oroville (DWR 2007). Urban land uses and other
 20 buildings, including the Feather River Fish Hatchery, are located along the
 21 channel upstream of the State Route 70 bridge. The Oroville Wildlife Area
 22 extends from State Route 70 on the east, downstream of the bridge, and includes
 23 the Thermalito Afterbay area. Dredge tailings from hydraulic mining that
 24 occurred over 100 years ago occur along the low flow channel with some of the
 25 tailings reaching heights of more than 40 feet above the roadway.

26 *Wild and Scenic Rivers and Scenic Highways in the Feather River Watershed*

27 Within the Central Valley Region considered in this EIS, the Middle Fork Feather
 28 River (from Beckworth to Lake Oroville) was designated as part of Public Law
 29 90-542 (Wild and Scenic Rivers Act) to be part of the National Wild and Scenic
 30 Rivers System on October 2, 1968.

31 In the Feather River watershed and adjacent Bear River watershed of the Central
 32 Valley Region, there is one designated State Scenic Highway and several roads
 33 that are eligible for this designation, including the following roadways.

- 34 • Butte County: State Route 70 is eligible for State Scenic Highways designation
 35 (CalTrans 2014i).
- 36 • Plumas County: State Routes 70 and 89 are eligible for State Scenic Highways
 37 designation (CalTrans 2014j).
- 38 • Nevada County: State Route 20 from Skillman Flat Campground to half-mile
 39 east of Lowell Hill Road is designated as a State Scenic Highway and a U.S.
 40 Forest Service (USFS) Scenic Byway due to views of pine forests and results
 41 of hydraulic mining. Interstate 80 and State Routes 20, 49, and 174 are
 42 eligible for State Scenic Highways designation (CalTrans 2014k).

1 **14.3.2.1.4 Yuba River Watershed**

2 The middle and lower Yuba River watershed extends through Nevada and Yuba
3 counties. Upstream of New Bullards Bar Reservoir, the watershed is
4 characterized by coniferous, mixed conifer/hardwood, and ponderosa pine forests
5 along steep canyons. Most of the upper watershed is undeveloped with rural
6 communities located along State Route 49 (DWR et al. 2007).

7 New Bullards Bar Reservoir, on the Yuba River and in Yuba County, is a human
8 built reservoir providing visual contrast of the lake surface with mountainous
9 landscape with conifers and mixed hardwood forests (DWR et al. 2007). There
10 are many locations in the watershed to view the lake and the adjacent forests.
11 Recreational developments are located near the marina and campgrounds near the
12 shoreline.

13 Downstream of New Bullards Bar Reservoir along the Middle Yuba River and to
14 Englebright Reservoir (located in Nevada and Yuba counties), the landscape is
15 characterized by rolling hills with hardwood and coniferous trees and grasslands
16 (DWR et al. 2007, USACE 2012). This portion of the watershed is rural with
17 communities located along State Route 20.

18 Downstream of Englebright Reservoir, the landscape includes grasslands and
19 agricultural fields with several small communities (USACE 2012). Along the
20 river, the landscape is dominated by remnants of historic gold and gravel mining
21 and ongoing gravel mining activities with minimal riparian vegetation. This
22 portion of the watershed can be viewed from State Route 20.

23 **14.3.2.1.5 Middle and Lower American River Watershed**

24 The middle and lower American River watershed extends through Placer, El
25 Dorado, and Sacramento counties. Upstream of Folsom Dam, much of Placer and
26 El Dorado counties are characterized by undeveloped rolling grasslands and oak
27 woodlands with sporadic agricultural activities related to orchards, vineyards,
28 ornamental flowers, and Christmas tree farms in the wooded foothills.
29 Communities have been developed throughout the counties especially near
30 Interstate 80, U.S. Highway 50, and State Routes 49 and 89.

31 Folsom Lake, on the American River, is a human built reservoir providing visual
32 contrast with the foothill landscape. Views from the water surface provide
33 panoramic vistas of the foothills with open grasslands, oak woodlands, and pine
34 woodlands. Folsom Lake is generally considered to provide a pleasing visual
35 setting for recreationists, residences, and from roadways along the foothills above
36 the reservoir, especially from the Lake Overlook and the Folsom Dam
37 Observation Point vista points. Increased population in the communities around
38 the lake have provided more scenic view points, including increased vistas of
39 human-built structures such as electric transmission facilities, roadways, dams,
40 and residential subdivisions. Reservoir levels fluctuate and decline as summer
41 progresses, leaving a “bathtub ring” of bare soil along the water’s edge. The
42 visual quality also degrades because visitors drive vehicles onto the exposed soils
43 which cause tire tracks and erosion (Reclamation et al. 2006).

1 Lake Natoma extends from Folsom Dam along the American River to Nimbus
 2 Dam. The land along the river is mostly undeveloped and includes wooded
 3 canyon areas, sheer bluffs, and dredge tailings from the gold mining era.
 4 Residential and community developments have been constructed along the
 5 foothills that overlook the canyon, and these structures can be seen by
 6 recreationists from the water or adjacent trails. Lake Natoma can be viewed from
 7 U.S. Highway 50 and local roads.

8 Downstream of Nimbus Dam to Gristmill Recreation Area (downstream of
 9 William B. Pond Recreation Area and approximately 2 miles upstream from the
 10 Watt Avenue Bridge), the American River flows through a landscape
 11 characterized by steep bluffs, terraces, mid-river sand and gravel bars, backwater
 12 areas along the edges, and riparian vegetation. This viewshed is seen from the
 13 recreational areas on the water and adjoining trails, from the bridge crossings, and
 14 from residences along the terraces and foothills. Downstream of the Gristmill
 15 Dam Recreation Area, the visual characteristics are less complex with an
 16 increased number of bridges, water treatment plant intake, and artificial bank
 17 protection. The communities along the American River corridor include the cities
 18 of Folsom, Roseville, Rancho Cordova, and Sacramento and unincorporated
 19 areas. The communities, transportation infrastructure, and water-river corridor
 20 are visible from multiple vantage points.

21 *Wild and Scenic Rivers and Scenic Highways in the American River Watershed*
 22 Within the American River watershed, the Lower American River from Nimbus
 23 Dam to the confluence with the Sacramento River were designated by the
 24 Secretary of the Interior to be part of the National Wild and Scenic Rivers System
 25 on January 19, 1981. The State of California also designated the Lower American
 26 River as wild and scenic under Public Resources Code sections 5093.54 and
 27 5093.545. In addition, the state designated the North Fork American River from
 28 the source to Iowa Hill Bridge as wild and scenic.

29 In the portion of the American River watershed in the study area of this EIS, there
 30 is one roadway designated as a State Scenic Highway and one road that is eligible
 31 for this designation. In El Dorado County, U.S. Highway 50 from Government
 32 Center Interchange in Placerville to South Lake Tahoe is designated as a State
 33 Scenic Highway due to vistas of the American River canyon, suburban foothills,
 34 granite peaks, and Lake Tahoe. Also in El Dorado County, State Route 49 is
 35 eligible for State Scenic Highways designation (CalTrans 2014).

36 **14.3.2.2 San Joaquin Valley**

37 The San Joaquin Valley land cover ranges from high alpine vegetation near the
 38 crest of the Sierra Nevada Mountains, through coniferous forest, mixed forest, oak
 39 woodlands and oak savanna, to grasslands and agricultural areas at the lower
 40 elevations (Reclamation 1997, 2005a, 2005b). Water bodies include reservoirs,
 41 natural lakes and ponds, rivers, and tributary streams. The human-built
 42 environment is more dominant at lower elevations, and includes roadways,
 43 communities, roadside businesses, and transmission lines, detracting from views
 44 of the natural environment. On the valley floor, the San Joaquin Valley is

1 characterized by agricultural lands, including many that are irrigated with CVP
2 and/or SWP water supplies. The valley is arid to semi-arid, and there are few
3 natural lakes or streams on the valley floor.

4 Several wetlands have been established as wildlife refuges in the San Joaquin
5 Valley (as described in Chapter 10, Terrestrial Biological Resources), providing
6 views of water and vegetation, enhanced seasonally by waterfowl and seasonal
7 wildflowers.

8 The predominant land use is agricultural, with sparse to moderate populations.
9 Interstate 5 and major railroads pass along the western San Joaquin Valley at the
10 base of the Coast Ranges foothills. State Route 99 and other railroads are located
11 along the eastern San Joaquin Valley at the base of the Sierra Nevada foothills.
12 Interstate 580 and State Routes 152, 198, and 46 cross the San Joaquin Valley
13 from east to west between Interstate 5 and State Route 99. Larger cities have
14 been established in the northern San Joaquin Valley, including Lodi, Stockton,
15 Lathrop, Manteca, and Tracy; and along State Route 99, including Merced,
16 Fresno, Visalia, and Bakersfield. Both Interstate 5 and State Route 99 are
17 extensively traveled and provide numerous viewing opportunities.

18 **14.3.2.2.1 Northern San Joaquin Valley**

19 In the northern San Joaquin Valley, the foothills range from rolling hills to
20 mountainous terrain with riparian corridors that range from narrow canyons to
21 alluvial plains. The San Joaquin, Stanislaus, Merced, and Tuolumne rivers are the
22 principal water features that flow from the Sierra Nevada foothills. One or more
23 reservoirs are located along each of these rivers, including the CVP New Melones
24 Reservoir on the Stanislaus River and Millerton Lake on the San Joaquin River.
25 Other reservoirs are owned and operated by local and regional water suppliers, as
26 described in Chapter 5, Surface Water Resources and Water Supplies. Dredge
27 tailings have been deposited along some of the rivers as the streams flow from the
28 mountains into the foothills.

29 The CVP New Melones Reservoir is located in the western foothills of the Sierra
30 Nevada along the Stanislaus River. The area is characterized by foothills, ridges,
31 and small valleys with vegetated slopes and the open water surface (Reclamation
32 2010). The vegetation is primarily grasslands and oak woodlands with varying
33 densities, with gray pine and low shrubs along some slopes. Views of the water
34 are primarily from the water surface, adjacent recreation areas, and State
35 Route 49. The surrounding lands are rural and undeveloped except for the
36 infrastructure associated with the dam, canals, and power generation facilities and
37 some minor structures associated with the recreation areas and utility lines. When
38 the reservoir is drawn down, broad bands of bare soil are exposed.

39 Millerton Lake also is located in the western foothills of the Sierra Nevada along
40 the San Joaquin River in an area that ranges from grasslands and rolling hills near
41 Friant Dam to steep, craggy slopes in the upper reaches of the lake (Reclamation
42 et al. 2011a). The lake, dam infrastructure, and surrounding hills can be viewed
43 from the lake surface and adjacent county roads. Development has occurred
44 along the hillsides that can be viewed from the lake surface and adjacent

1 recreation areas; however; future development will be regulated by Madera and
 2 Fresno counties to protect visual and scenic resources. When the reservoir is
 3 drawn down, broad bands of bare soil are exposed. The Madera Canal and Friant-
 4 Kern Canal extend from Millerton Lake to the north and south, respectively. The
 5 canals are located along the Sierra Nevada foothills through mostly agricultural
 6 landscapes and limited residences (Reclamation et al. 2011, Reclamation 1997).
 7 The canals are only intermittently visible from county roads.

8 **14.3.2.2.2 Western San Joaquin Valley**

9 The Coast Range foothills on the western side of the northern San Joaquin Valley
 10 are sparsely populated and characterized by mountainous to hilly terrain with
 11 grasslands and scattered oak woodlands along narrow streams. The CVP and
 12 SWP San Luis Reservoir complex is located within the western foothills; and the
 13 CVP and SWP water supply canals are located at the base of the foothills to the
 14 north and south of the San Luis Reservoir.

15 The CVP and SWP water supply facilities are prominent features in the viewshed
 16 of the San Joaquin Valley, including facilities at or near San Luis Reservoir,
 17 Delta-Mendota Canal, San Luis Canal-California Aqueduct, Cross Valley Canal,
 18 New Melones Reservoir, and Millerton Lake. The San Luis Reservoir, O'Neill
 19 Forebay, and Los Banos Creek Reservoir are located in northwestern San Joaquin
 20 Valley. State Route 152 is located along the northern and eastern rims of San
 21 Luis Reservoir and the western rim of O'Neill Forebay (Reclamation and State
 22 Parks 2013). O'Neill Forebay and Los Banos Creek Reservoir can be seen to the
 23 west from Interstate 5. The reservoirs are also part of the visual resources for the
 24 San Luis Reservoir State Recreation Area, Pacheco State Park, and Upper and
 25 Lower Cottonwood Wildlife Areas (which are described in Chapter 10, Terrestrial
 26 Biological Resources, and Chapter 15, Recreation Resources). The shorelines of
 27 the reservoirs are undeveloped, except for recreational facilities. Views included
 28 annual grassland, coastal sage, and riparian woodland. When the reservoirs are
 29 drawn down, broad bands of bare soil are exposed. Open water viewing
 30 opportunities also occur to the south of the San Luis complex at the Little
 31 Panoche Reservoir located to the west of Interstate 5.

32 The open water and canal infrastructure of the Delta-Mendota Canal, San Luis
 33 Canal-California Aqueduct, Cross Valley Canal, and irrigation district canals can
 34 be viewed from Interstate 5 and the railroad lines along the western San Joaquin
 35 Valley. The open water of Mendota Pool is located at the terminus of the Delta
 36 Mendota Canal and can be viewed from county roads.

37 **14.3.2.2.3 Southern San Joaquin Valley**

38 In the southern portion of the San Joaquin Valley, the Kings, Kaweah, Tule, and
 39 Kern rivers are the principal water features along the eastern Sierra Nevada
 40 foothills. One or more reservoirs are located along each of these rivers. Riparian
 41 vegetation and oak woodlands occur along these river corridors. The western
 42 Coast Ranges foothills are characterized by distinct, folded foothills with

1 grasslands and infrequent oak woodlands along small drainages. The Tehachapi
2 Mountains rise abruptly along the southern boundary of the valley.

3 **14.3.2.2.4 Wild and Scenic Rivers and Scenic Highways in the San Joaquin**
4 **Valley**

5 In the San Joaquin Valley within or near the Central Valley Region considered in
6 this EIS, four rivers were designated to be part of the National Wild and Scenic
7 Rivers System. Portions of the Tuolumne River from the source waters to Don
8 Pedro Reservoir were designated through Public Law 98-425 as wild and scenic.
9 Portions of the Merced River were designated through Public Laws 100-149 and
10 102-432 as wild and scenic, including the entire South Fork and the mainstem
11 from the source waters to Lake McClure. Portions of the Kings River were
12 designated as wild and scenic through Public Law 100-150, including the Middle
13 Fork and South Fork from their respective sources to the confluences with the
14 mainstem; and the mainstem from these confluences to an elevation of 1595 feet
15 above mean sea level (upstream of the confluence with the North Fork and Pine
16 Flat Lake). Portions of the Kern River were designated as wild and scenic
17 through Public Law 100-174, including the North Fork from the source to the
18 Tulare County/Kern County boundary; and the South Fork from the source to the
19 Domeland Wilderness. Most of these reaches are located outside of the Central
20 Valley Region; however, the flows from these reaches could influence the visual
21 resources of downstream reaches in the Central Valley Region.

22 In the San Joaquin Valley of the Central Valley Region, there are five roadway
23 sections designated as a State Scenic Highway and seven roadway sections that
24 are eligible for this designation.

- 25 • San Joaquin County and Alameda County: Interstate 580 from Interstate 5 to
26 State Route 205 is designated as a State Scenic Highway due to vistas of the
27 Coast Ranges and Central Valley. Interstate 5 from the Stanislaus County
28 boundary to Interstate 580 is designated as a State Scenic Highway due to
29 vistas of agricultural lands and the Delta Mendota Canal and California
30 Aqueduct (CalTrans 2014m, 2014n).
- 31 • Stanislaus County: Interstate 5 from the San Joaquin County boundary to the
32 Merced County boundary is designated as a State Scenic Highway due to
33 vistas of agricultural lands and the Delta Mendota Canal and California
34 Aqueduct (CalTrans 2014o).
- 35 • Merced County: Interstate 5 from State Route 152 to the Stanislaus County
36 boundary is designated as a State Scenic Highway due to vistas of agricultural
37 lands and the Delta Mendota Canal and California Aqueduct (CalTrans
38 2014p). State Route 152 from Interstate 5 to the Santa Clara County boundary
39 is designated as a State Scenic Highway due to vistas of agricultural lands and
40 the San Luis Reservoir State Recreational Area.
- 41 • Fresno County: State Routes 168, 180, and 198 are eligible for State Scenic
42 Highways designation (CalTrans 2014q).

- 1 • Tulare County: State Routes 190 and 198 are eligible for State Scenic
2 Highways designation (CalTrans 2014s).
- 3 • Kern County: State Routes 14 and 58 are eligible for State Scenic Highways
4 designation (CalTrans 2014t).

5 **14.3.2.3 Delta and Suisun Marsh**

6 Most of the Delta is used for agricultural purposes with major waterways and
7 sloughs that connect the Sacramento, San Joaquin, Mokelumne, Cosumnes, and
8 Calaveras rivers (CALFED 2000). Flood management and irrigation facilities
9 include levees, impoundments, pumping plants, and control gate structures.
10 Bodies of open water occur where historic levee failures were not repaired,
11 including Franks Tract and Liberty Island. The Sacramento Deep Water Ship
12 Channel is a larger water feature between levees that extends from the
13 Sacramento River near Rio Vista to West Sacramento. Cities within the Delta
14 include the southern portion of Sacramento, Isleton, West Sacramento, Rio Vista,
15 Lathrop, western portions of Stockton and Manteca, Tracy, Brentwood, Oakley,
16 Antioch, and Pittsburg. Small communities to serve the agriculture and recreation
17 users include Freeport, Clarksburg, Hood, Courtland, Locke, Walnut Grove,
18 Ryde, Thornton, Knightsen, and Collinsville. Vistas of the Delta can be seen
19 from residences and agricultural areas in the Delta, open water areas used by
20 recreationists, and from vehicles on roadways and railroads that cross the Delta.
21 Waterfront industries are located along the rivers, especially along the San
22 Joaquin River.

23 The Suisun Marsh is characterized by tidal and freshwater wetlands and riparian
24 woodlands (Reclamation et al. 2010). The area is bounded by Interstate 80 and
25 State Route 12 on the north; the Montezuma Hills and Sulphur Springs Mountains
26 on the east and west, respectively; and on the south by the open waters of Suisun
27 Bay, Grizzly Bay, and Honker Bay with adjoining wetlands, marshes, and riparian
28 forests. The marsh is relatively flat and comprised primarily of tidal marsh and
29 submerged lands. Upland areas serve as a backdrop with grasslands and nearby
30 rolling foothills. Vistas of Suisun Marsh can be viewed from adjacent roadways
31 railroads; roads and trails within the marsh; a few residences within the marsh;
32 and open water that can be accessed by boats, kayaks, and canoes. Much of
33 Suisun Marsh is managed wetlands and provides habitat for resident and
34 migrating birds and waterfowl.

35 **14.3.2.3.1 Scenic Highways in the Delta**

36 In the Delta and Suisun Marsh portion of the Central Valley Region, there two
37 roadway sections designated as a State Scenic Highway and two roadway sections
38 that are eligible for this designation.

- 39 • Sacramento County: State Route 160 between the southern limits of the City
40 of Sacramento to the Contra Costa County boundary is designated as a State
41 Scenic Highway due to the views of historic Delta agriculture and small towns
42 along the Sacramento River (CalTrans 2014u).

- 1 • Contra Costa County: State Route 160 from the Antioch Bridge to State
2 Route 4 and State Route 4 continuing on towards Brentwood are eligible for
3 State Scenic Highways designation (CalTrans 2014v).

4 **14.3.3 San Francisco Bay Area Region**

5 The San Francisco Bay Area Region includes portions of Contra Costa, Alameda,
6 Santa Clara, and San Benito counties that are within the CVP and SWP service
7 areas. The San Francisco Bay Area Region ranges in topography from sea level
8 to the East Bay and South Bay foothills that reach elevations of 3,500 feet and
9 higher (CALFED 2000; WTA 2003; Reclamation 2005c). It offers a diverse
10 physical and natural environment, and a wide range of visual resources. Typical
11 views and landscapes include urban development, natural and altered open-space
12 areas, major ridgelines, and scenic waterways. The terrain ranges from alluvial
13 plains to gently sloping hills and wooded ravines. Striking views of iconic scenes
14 are available throughout the area, of San Francisco Bay, the San Francisco
15 skyline, Angel Island, Mount Tamalpais, Peninsula foothills, and the East Bay
16 hills. Views to the east are dominated by Mount Diablo and adjacent Diablo
17 Ridge and valleys. Views in the South Bay extend through the baylands that
18 extend along the Contra Costa, San Mateo, Santa Clara, and Alameda counties
19 shorelines; the river floodplains of the Guadalupe River and Coyote Creek in
20 Santa Clara County; and towards the Santa Cruz Mountains (Santa Clara County
21 1994).

22 Urban and industrial areas are located throughout the San Francisco Bay Area
23 Region, including along the San Francisco Bay shoreline. Smaller, localized
24 scenic resources include wetlands, isolated hilltops, rock outcroppings, mature
25 stands of trees, lakes, reservoirs, and other natural features. City parks and
26 recreation areas, open-space areas adjacent to ravines, golf courses, and resource
27 preserves provide visual opportunities in urban areas. The reservoirs that store
28 CVP or SWP water or water from other surface water sources are human built
29 reservoirs located in the foothills or at the edge of the foothills. The water can be
30 viewed from roadways located at elevations higher than the reservoirs and by
31 recreationists on the reservoirs. Agricultural areas that use CVP and SWP water
32 are located within coastal valleys especially within the Livermore-Amador valleys
33 of Alameda County, southern Santa Clara County, and northern San Benito
34 County.

35 **14.3.3.1 Scenic Highways in the San Francisco Bay Area Region**

36 In the San Francisco Bay Area Region, there are four roadway sections designated
37 as a State Scenic Highway and five roadway sections that are eligible for this
38 designation.

- 39 • Contra Costa County: State Route 24 from the Alameda County boundary to
40 Interstate 680, and Interstate 680 from State Route 24 to Interstate 580 at the
41 Alameda County boundary are designated as State Scenic Highways due to
42 the views of Mount Diablo and attractive residential and commercial areas
43 (CalTrans 2014v).

- 1 • Alameda County: Interstate 580 between Interstate 80 and State Route 92 are
2 designated as a State Scenic Highways (CalTrans 2014n). Portions of
3 Interstate 680 from the Contra Costa County boundary to Mission Boulevard
4 in Fremont and portions of State Route 84 are designated as State Scenic
5 Highways due to vistas of wooded hillsides and valleys. Other portions of
6 Interstate 580 are eligible for State Scenic Highways designation.
- 7 • Santa Clara County: Portions of State Routes 152 and 280 within the San
8 Francisco Bay Area Region are eligible for State Scenic Highways
9 designation (CalTrans 2014w).
- 10 • San Benito County: Portions of State Routes 156 and 25 within the San
11 Francisco Bay Area Region are eligible for State Scenic Highways
12 designation (CalTrans 2014x).

13 **14.3.4 Central Coast and Southern California Regions**

14 The Central Coast and Southern California Regions include portions of San Luis
15 Obispo, Santa Barbara, Ventura, Los Angeles, Orange, San Diego, Riverside, and
16 San Bernardino counties served by the SWP.

17 Areas along the Pacific Coast in San Luis Obispo, Santa Barbara, Ventura,
18 portions of Los Angeles, portions of Orange, and San Diego counties are
19 characterized by steep, craggy coastal mountains and coastal plains that can be
20 viewed from the roadways, residences, and the Pacific Ocean. The visual
21 resources include beaches, sand dunes, coastal bluffs, headlands, wetlands,
22 estuaries, islands, hillsides, and canyons (Santa Barbara County 2009, SBCAG
23 2013). The foothills extend from the Pacific Ocean to more than 800 feet above
24 mean sea level; and the mountains extend to more than 3,000 feet above mean sea
25 level. The foothills are generally covered with mature trees and shrubs, including
26 native oaks, deciduous trees, and eucalyptus. The coastal plains gradually slope
27 towards the foothills with streams through the plains. Small to medium size
28 communities occur along the coast and the coastal plains in San Luis Obispo,
29 Santa Barbara, and Ventura counties and within portions of the coastline in Los
30 Angeles, Orange and San Diego counties. Larger communities also are located
31 along the coastline separated by large areas of undeveloped lands.

32 Inland from the Pacific Ocean, urban areas extend throughout large portions of
33 the foothills and valleys of Los Angeles, Orange, San Diego, Riverside, and San
34 Bernardino counties. Reduced abundance of natural features, vistas, and non-
35 urban land uses may diminish the visual resources for many viewers (SCAG
36 2010). However, in many inland areas urban areas are separated by areas of
37 undeveloped or agricultural lands, especially in Riverside and San Bernardino
38 counties. Minimal development has occurred within the higher elevations of the
39 Central Coast and Southern California regions, as described in Chapter 13, Land
40 Use. Therefore, the mountainous areas (such as the San Gabriel, Santa Monica,
41 Santa Ana, Santa Rosa, and San Jacinto mountains) provide dramatic viewsheds
42 from the valleys (Los Angeles 2011, RCIP 2000, San Bernardino County 2007).
43 The mountains also are characterized by deep canyons, rock outcroppings, and
44 sparse vegetation. In the Coachella Valley portion of Riverside County, the visual

1 resources are dominated by dramatic vistas of the Santa Rosa, San Jacinto, San
2 Bernardino, Cottonwood, and Chocolate mountains with high desert craggy rock
3 outcroppings and sparse vegetation. The Salton Sea in the southern Coachella
4 Valley provides dramatic vistas from the shoreline and highways that extend
5 around the open water.

6 The inland areas also include major surface water resources that provide open
7 water vistas, including Twitchell Reservoir, Silverwood Lake, Diamond Valley
8 Lake, Lake Perris, Lake Skinner, Vail Lake, and Lake Mathews; and smaller
9 water supply reservoirs. Many of these reservoirs store CVP and SWP water and
10 are human built reservoirs located in the foothills or at the edge of the foothills.
11 The water can be viewed from highways located at elevations higher than the
12 reservoirs and by recreationists on the reservoirs.

13 **14.3.4.1 Wild and Scenic Rivers and Scenic Highways in the Central**
14 **Coast and Southern California Regions**

15 The wild and scenic rivers in the Central Coast and Southern California areas are
16 not located within the study area of this EIS.

17 In the Central Coast and Southern California regions, there are seven roadway
18 sections designated as State Scenic Highways and several roadway sections that
19 are eligible for this designation.

- 20 • San Luis Obispo County: U.S. Highway 1 from the Monterey County
21 boundary to the City of San Luis Obispo is designated as a State Scenic
22 Highway and an All American Road due to dramatic vista along the
23 mountains and rocky headlands of the Pacific Ocean coastline (CalTrans
24 2014y). Portions of State Route 41 and Interstate 101 are eligible for State
25 Scenic Highways designation.
- 26 • Santa Barbara County: U.S. Highway 1 from Interstate 101 near Las Cruces to
27 near Lompoc is designated as a State Scenic Highway due to dramatic vista
28 along the mountains and rocky headlands of the Pacific Ocean coastline
29 (CalTrans 2014z). Portions of Interstate 101 are eligible for State Scenic
30 Highways designation.
- 31 • Ventura County: State Route 33 from the Santa Barbara County boundary to
32 the north of the junction with State Route 150 is designated as a State Scenic
33 Highway and a USFS Scenic Byway due to dramatic vista along the
34 mountains between the Coast Ranges and the Central Valley with landscapes
35 that range from pine forests to semi-desert vegetation (CalTrans 2014aa).
36 Portions of Interstate 101 and State Routes 33 and 1 are eligible for State
37 Scenic Highways designation.
- 38 • Los Angeles County: State Route 2 from near La Cañada-Flintridge to the San
39 Bernardino County boundary is designated as a State Scenic Highway and a
40 U.S. Forest Service Scenic Byway due to dramatic vista along the San Gabriel
41 Mountains with vistas of the Mojave Desert and the Los Angeles Basin
42 (CalTrans 2014ab). Portions of Interstate 101, 210, and 110 and State

- 1 Routes 1, 23, 27, 39, 118, and 126 are eligible for State Scenic Highways
 2 designation.
- 3 • Orange County: State Route 91 from State Route 55 to the City of Anaheim is
 4 designated as a State Scenic Highway due vistas of the Santa Ana River and
 5 urban development with intermittent riparian and chaparral vegetation
 6 (CalTrans 2014ac). State Routes 1, 57, and 74 and portions of State Route 91
 7 are eligible for State Scenic Highways designation.
 - 8 • San Diego County: State Route 75 from the City of Imperial Beach to
 9 Coronado is designated as a State Scenic Highway due to vistas of the Pacific
 10 Ocean, San Diego Harbor, and the Coronado Bridge (CalTrans 2014ad). State
 11 Route 125 between State Routes 94 and 8 is designated as a State Scenic
 12 Highway due to vistas of Mt. Helix and attractive residential and commercial
 13 areas. Interstate 5 and 8 and portions of State Routes 52, 76, and 93 within
 14 the Southern California Region are eligible for State Scenic Highways
 15 designation.
 - 16 • Riverside County: State Route 243 from the City of Banning to State Route 74
 17 is designated as a State Scenic Highway and a U.S. Forest Service Scenic
 18 Byway due to the vistas of the San Bernardino Mountains and valley
 19 (CalTrans 2014ae). Interstate 15 and State Routes 71, 74, 91, and 111 are
 20 eligible for State Scenic Highways designation.
 - 21 • San Bernardino County: State Routes 2, 18, 38, 138, 173, 189, and 247 are
 22 eligible for State Scenic Highways designation (CalTrans 2014af).

23 **14.4 Impact Analysis**

24 This section describes the potential mechanisms and analytical methods for
 25 change in visual resources; results of the impact analysis; potential mitigation
 26 measures; and cumulative effects.

27 **14.4.1 Potential Mechanisms for Change and Analytical Methods**

28 As described in Chapter 4, Approach to Environmental Analysis, the impact
 29 analysis considers changes in visual resources conditions related to changes in
 30 CVP and SWP operations under the alternatives as compared to the No Action
 31 Alternative and Second Basis of Comparison.

32 Changes in CVP and SWP operations under the alternatives as compared to the
 33 No Action Alternative and Second Basis of Comparison could change the vistas at
 34 reservoirs that store CVP and SWP water during dry and critical dry water years
 35 and at irrigated agricultural lands during dry and critical dry water years when the
 36 crops are idled.

1 **14.4.1.1 Changes in Visual Resources at Reservoirs that Store CVP and**
2 **SWP Water**

3 Vistas at reservoirs that store CVP and SWP water provide a wide diversity of
4 visual experiences related to the contrasts between the open water surface and
5 surrounding foothills or mountains. By the end of September, the surface water
6 elevations decline, and a bare “bathtub ring” appears in contrast to the open water
7 and the upslope vegetation. Changes in CVP and SWP operations under the
8 alternatives could change the extent of the “bathtub” ring over the long-term
9 average condition and in dry and critical dry years as compared to the No Action
10 Alternative and Second Basis of Comparison.

11 The CalSim II model output includes monthly reservoir elevations for CVP and
12 SWP reservoirs in the Central Valley and Trinity Lake. The end-of-September
13 reservoir elevations in dry and critical dry water years generally indicate low
14 reservoir elevations. To assess changes in visual resources, changes in reservoir
15 storage elevations for the end of September in dry and critical dry years were
16 compared between alternatives and the No Action Alternative and Second Basis
17 of Comparison.

18 Reservoirs in the San Francisco Bay Area, Central Coast, and Southern California
19 regions store water from multiple water supplies including CVP and SWP water;
20 however, these reservoirs are not included in the CalSim II model simulation. For
21 the purposes of this EIS analysis, changes in surface water elevations in these
22 reservoirs were assumed to be related to changes in CVP and SWP water
23 deliveries to the areas located to the south of the Delta.

24 **14.4.1.2 Changes in Vista at Irrigated Agricultural Lands**

25 Agrarian vistas of irrigated row crops, orchards, and grazing lands intermixed
26 within a landscape of grasslands, large water canals, isolated riparian corridors,
27 and several small communities occur throughout the Central Valley, San
28 Francisco Bay Area, Central Coast, and Southern California regions. Changes in
29 CVP and SWP operations under the alternatives could change the extent of
30 irrigated acreage and the associated vistas over the long-term average condition
31 and in dry and critical dry years as compared to the No Action Alternative and
32 Second Basis of Comparison. However, as described in Chapter 12, Agricultural
33 Resources, the extents of irrigated acreage between Alternatives 1 through 5 are
34 similar to irrigated acreage under the No Action Alternative and the Second Basis
35 of Comparison. Therefore, changes in CVP and SWP operations would not
36 change irrigated acreage and as a result they are not analyzed in this EIS.

37 **14.4.1.3 Effects Related to Water Transfers**

38 Historically water transfer programs have been developed on an annual basis.
39 The demand for water transfers is dependent upon the availability of water
40 supplies to meet water demands. Water transfer transactions have increased over
41 time as CVP and SWP water supply availability has decreased, especially during
42 drier water years.

1 Parties seeking water transfers generally acquire water from sellers who have
 2 available surface water who can make the water available through releasing
 3 previously stored water; pumping groundwater instead of using surface water
 4 (groundwater substitution); idle crops; or substitute crops that use less water in
 5 order to reduce normal consumptive use of surface water.

6 Water transfers using CVP and SWP Delta pumping plants and south of Delta
 7 canals generally occur when there is unused capacity in these facilities. These
 8 conditions generally occur during drier water year types when the flows from
 9 upstream reservoirs plus unregulated flows are adequate to meet the Sacramento
 10 Valley water demands and the CVP and SWP export allocations. In non-wet
 11 years, the CVP and SWP water allocations would be less than full contract
 12 amounts; therefore, capacity may be available in the CVP and SWP conveyance
 13 facilities to move water from other sources.

14 Projecting future visual conditions related to water transfer activities is difficult
 15 because specific water transfer actions required to make the water available,
 16 convey the water, and/or use the water would change each year due to changing
 17 hydrological conditions, CVP and SWP water availability, specific local agency
 18 operations, and local cropping patterns. Reclamation recently prepared a long-
 19 term regional water transfer environmental document which evaluated potential
 20 changes in conditions related to water transfer actions (Reclamation 2014c).
 21 Results from this analysis were used to inform the impact assessment of potential
 22 effects of water transfers under the alternatives as compared to the No Action
 23 Alternative and the Second Basis of Comparison.

24 **14.4.2 Conditions in Year 2030 without Implementation of** 25 **Alternatives 1 through 5**

26 This EIS includes two bases of comparison, as described in Chapter 3,
 27 Description of Alternatives: the No Action Alternative and the Second Basis of
 28 Comparison. Both of these bases are evaluated at 2030 conditions. Changes that
 29 would occur over the next 15 years without implementation of the alternatives are
 30 not analyzed in this EIS. However, the changes to visual resources that are
 31 assumed to occur by 2030 under the No Action Alternative and the Second Basis
 32 of Comparison are summarized in this section. Many of the changed conditions
 33 would occur in the same manner under both the No Action Alternative and the
 34 Second Basis of Comparison.

35 **14.4.2.1 Common Changes in Conditions under the No Action Alternative** 36 **and Second Basis of Comparison**

37 Conditions in 2030 would be different than existing conditions due to:

- 38 • Climate change and sea-level rise
- 39 • General plan development throughout California, including increased water
 40 demands in portions of Sacramento Valley
- 41 • Implementation of reasonable and foreseeable water resources management
 42 projects to provide water supplies

1 It is anticipated that climate change would result in more short-duration high-
2 rainfall events and less snowpack in the winter and early spring months. The
3 reservoirs would be full more frequently by the end of April or May by 2030 than
4 in recent historical conditions. However, as the water is released in the spring,
5 there would be less snowpack to refill the reservoirs. This condition would
6 reduce reservoir storage and available water supplies to downstream uses in the
7 summer. The reduced end-of-September storage would also reduce the ability to
8 release stored water to downstream regional reservoirs. These conditions would
9 occur for all reservoirs in the California foothills and mountains, including non-
10 CVP and SWP reservoirs.

11 These changes would result in a decline of the long-term average CVP and SWP
12 water supply deliveries by 2030 as compared to recent historical long-term
13 average deliveries under the No Action Alternative and the Second Basis of
14 Comparison. However, the CVP and SWP water deliveries would be less under
15 the No Action Alternative as compared to the Second Basis of Comparison, as
16 described in Chapter 5, Surface Water Resources and Water Supplies, which
17 could result in more crop-idling.

18 Under the No Action Alternative and the Second Basis of Comparison, land uses
19 in 2030 would occur in accordance with adopted general plans. Development
20 under the general plans would change visual resources, especially near municipal
21 areas.

22 The No Action Alternative and the Second Basis of Comparison assumes
23 completion of water resources management and environmental restoration
24 projects that would have occurred without implementation of Alternatives 1
25 through 5, including regional and local recycling projects, surface water and
26 groundwater storage projects, conveyance improvement projects, and desalination
27 projects, as described in Chapter 3, Description of Alternatives. The No Action
28 Alternative and the Second Basis of Comparison also assumes implementation of
29 actions included in the 2008 U.S. Fish and Wildlife Service (USFWS) Biological
30 Opinion (BO) and 2009 National Marine Fisheries Service (NMFS) BO that
31 would have been implemented without the BOs by 2030, as described in Chapter
32 3, Description of Alternatives. These projects would include several projects that
33 would affect visual resources, including:

- 34 • Restoration of more than 10,000 acres of intertidal and associated subtidal
35 wetlands in Suisun Marsh and Cache Slough; and at least 17,000 to
36 20,000 acres of seasonal floodplain restoration in Yolo Bypass
- 37 • Restoration of Battle Creek
- 38 • Implementation of Red Bluff Pumping Plant

39 **14.4.3 Evaluation of Alternatives**

40 Alternatives 1 through 5 have been compared to the No Action Alternative; and
41 the No Action Alternative and Alternatives 1 through 5 have been compared to
42 the Second Basis of Comparison.

1 During review of the numerical modeling analyses used in this EIS, an error was
 2 determined in the CalSim II model assumptions related to the Stanislaus River
 3 operations for the Second Basis of Comparison, Alternative 1, and Alternative 4
 4 model runs. Appendix 5C includes a comparison of the CalSim II model run
 5 results presented in this chapter and CalSim II model run results with the error
 6 corrected. Appendix 5C also includes a discussion of changes in the comparison
 7 of groundwater conditions for the following alternative analyses.

- 8 • No Action Alternative compared to the Second Basis of Comparison
- 9 • Alternative 1 compared to the No Action Alternative
- 10 • Alternative 3 compared to the Second Basis of Comparison
- 11 • Alternative 5 compared to the Second Basis of Comparison

12 **14.4.3.1 No Action Alternative**

13 The No Action Alternative is compared to the Second Basis of Comparison.

14 **14.4.3.1.1 Trinity River Region**

15 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 16 *SWP Water*

17 Changes in CVP water supplies and operations under the No Action Alternative
 18 as compared to the Second Basis of Comparison would result in similar end-of-
 19 September reservoir elevations (changes within 5 percent) and related visual
 20 resources at Trinity Lake in all water year types, as described in Chapter 5,
 21 Surface Water Resources and Water Supplies.

22 **14.4.3.1.2 Central Valley Region**

23 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 24 *SWP Water*

25 Changes in CVP water supplies and operations under the No Action Alternative
 26 as compared to the Second Basis of Comparison would result in similar end-of-
 27 September reservoir elevations and related visual resources at Shasta Lake, Lake
 28 Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and
 29 at San Luis Reservoir in above-normal, below-normal, and dry years, as described
 30 in Chapter 5, Surface Water Resources and Water Supplies. Changes in visual
 31 resources at San Luis Reservoir would be reduced in wet year and critical dry
 32 years because the end-of-September surface water elevations would be reduced by
 33 6.2 percent in wet and critical dry years.

34 *Effects Related to Cross Delta Water Transfers*

35 Potential effects to visual resources could be similar to those identified in a recent
 36 environmental analysis conducted by Reclamation for long-term water transfers
 37 from the Sacramento to San Joaquin valleys (Reclamation 2014c). Potential
 38 effects to visual resources were identified as changes in reservoir surface water
 39 elevations, streams, irrigated acreage, and water elevations in canals that would
 40 convey transferred water. The analysis indicated that these potential impacts
 41 would not be substantial because the conditions with and without the water
 42 transfers would be similar.

1 Under the No Action Alternative, the timing of cross Delta water transfers would
2 be limited to July through September and include annual volumetric limits, in
3 accordance with the 2008 USFWS BO and 2009 NMFS BO. Under the Second
4 Basis of Comparison, water could be transferred throughout the year without an
5 annual volumetric limit. Overall, the potential for cross Delta water transfers
6 would be less under the No Action Alternative than under the Second Basis of
7 Comparison.

8 **14.4.3.1.3 San Francisco Bay Area, Central Coast, and Southern California** 9 **Regions**

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 11 *SWP Water*

12 Changes in visual resources at reservoirs that store CVP and SWP water supplies
13 are assumed to be related to changes in water deliveries over long-term conditions
14 for this EIS analysis. Monthly deliveries are not necessarily indicative of
15 reservoir storage because all or a portion of the water deliveries could be directly
16 conveyed to water users in any specific month. Therefore, annual deliveries are
17 considered to be relatively proportional to the amount of water that could be
18 stored over all water year types. In the San Francisco Bay Area Region, values
19 for the CVP municipal and industrial water deliveries and the SWP south of the
20 Delta water deliveries (without Article 21 deliveries) were considered; and SWP
21 south of the Delta water deliveries (without Article 21 deliveries) were considered
22 for the Central Coast and Southern California regions. Under the No Action
23 Alternative as compared to the Second Basis of Comparison CVP water deliveries
24 would be reduced by 10 percent and SWP water deliveries would be reduced by
25 18 percent. Therefore, for this EIS analysis, it is assumed that visual resources
26 related to surface water elevations in reservoirs that store CVP and SWP water
27 supplies would be reduced by 10 to 18 percent in the San Francisco Bay Area
28 Region and 18 percent in the Central Coast and Southern California regions.

29 **14.4.3.2 Alternative 1**

30 Alternative 1 is identical to the Second Basis of Comparison. Alternative 1 is
31 compared to the No Action Alternative and the Second Basis of Comparison.
32 However, because visual resource conditions under Alternative 1 are identical to
33 visual resource conditions under the Second Basis of Comparison; Alternative 1 is
34 only compared to the No Action Alternative.

35 **14.4.3.2.1 Alternative 1 Compared to the No Action Alternative**

36 *Trinity River Region*

37 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 38 *SWP Water*

39 Changes in CVP water supplies and operations under Alternative 1 as compared
40 to the No Action Alternative would result in similar end-of-September reservoir
41 elevations and related visual resources at Trinity Lake in all water year types, as
42 described in Chapter 5, Surface Water Resources and Water Supplies.

1 *Central Valley Region*

2 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
 3 *SWP Water*

4 Changes in CVP water supplies and operations under Alternative 1 as compared
 5 to the No Action Alternative would result in similar end-of-September reservoir
 6 elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom
 7 Lake, and New Melones Reservoir in all water year types; and at San Luis
 8 Reservoir in above-normal, below-normal, and dry years, as described in Chapter
 9 5, Surface Water Resources and Water Supplies. Changes in visual resources at
 10 San Luis Reservoir would be reduced in wet year and critical dry years because
 11 the end-of-September surface water elevations would be increased by 6.6 percent
 12 in wet and critical dry years.

13 *Effects Related to Cross Delta Water Transfers*

14 Potential effects to visual resources could be similar to those identified in a recent
 15 environmental analysis conducted by Reclamation for long-term water transfers
 16 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
 17 above under the No Action Alternative compared to the Second Basis of
 18 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
 19 would occur during implementation of cross Delta water transfers under
 20 Alternative 1 and the No Action Alternative, and that impacts on visual resources
 21 would not be substantial in the seller’s service area due to implementation
 22 requirements of the transfer programs.

23 Under Alternative 1, water could be transferred throughout the year without an
 24 annual volumetric limit. Under the No Action Alternative, the timing of cross
 25 Delta water transfers would be limited to July through September and include
 26 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
 27 NMFS BO. Overall, the potential for cross Delta water transfers would be
 28 increased under Alternative 1 as compared to the No Action Alternative.

29 *San Francisco Bay Area, Central Coast, and Southern California Regions*

30 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
 31 *SWP Water*

32 Changes in visual resources at reservoirs that store CVP and SWP water supplies
 33 are assumed to be related to changes in water deliveries over long-term conditions
 34 for this EIS analysis, as described above under the No Action Alternative as
 35 compared to the Second Basis of Comparison. Therefore, under Alternative 1 as
 36 compared to the No Action Alternative, visual resources related to surface water
 37 elevations in reservoirs that store CVP and SWP water supplies would be
 38 increased by 11 to 21 percent in the San Francisco Bay Area Region and
 39 21 percent in the Central Coast and Southern California regions.

40 **14.4.3.2.2 Alternative 1 Compared to the Second Basis of Comparison**

41 Alternative 1 is identical to the Second Basis of Comparison.

1 **14.4.3.3 Alternative 2**

2 The CVP and SWP operations under Alternative 2 are identical to the CVP and
3 SWP operations under the No Action Alternative; therefore, Alternative 2 is only
4 compared to the Second Basis of Comparison.

5 **14.4.3.3.1 Alternative 2 Compared to the Second Basis of Comparison**

6 The CVP and SWP operations under Alternative 2 are identical to the CVP and
7 SWP operations under the No Action Alternative. Therefore, changes to visual
8 resources conditions under Alternatives 2 as compared to the Second Basis of
9 Comparison would be the same as the impacts described in Section 14.4.3.1, No
10 Action Alternative.

11 **14.4.3.4 Alternative 3**

12 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
13 under Alternative 3 are similar to the Second Basis of Comparison with modified
14 Old and Middle River flow criteria and New Melones Reservoir operations. As
15 described in Chapter 4, Approach to Environmental Analysis, Alternative 3 is
16 compared to the No Action Alternative and the Second Basis of Comparison.

17 **14.4.3.4.1 Alternative 3 Compared to the No Action Alternative**

18 *Trinity River Region*

19 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
20 *SWP Water*

21 Changes in CVP water supplies and operations under Alternative 3 as compared
22 to the No Action Alternative would result in similar end-of-September reservoir
23 elevations and related visual resources at Trinity Lake in all water year types, as
24 described in Chapter 5, Surface Water Resources and Water Supplies.

25 *Central Valley Region*

26 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
27 *SWP Water*

28 Changes in CVP water supplies and operations under Alternative 3 as compared
29 to the No Action Alternative would result in similar end-of-September reservoir
30 elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom
31 Lake, and New Melones Reservoir in all water year types; and at San Luis
32 Reservoir in below-normal, dry, and critical dry years, as described in Chapter 5,
33 Surface Water Resources and Water Supplies. Changes in visual resources at San
34 Luis Reservoir would be reduced in wet year and critical dry years because the
35 end-of-September surface water elevations would be increased by 7.9 percent in
36 wet years and 5.7 percent in above-normal years.

37 *Effects Related to Cross Delta Water Transfers*

38 Potential effects to visual resources could be similar to those identified in a recent
39 environmental analysis conducted by Reclamation for long-term water transfers
40 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
41 above under the No Action Alternative compared to the Second Basis of

1 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
 2 would occur during implementation of cross Delta water transfers under
 3 Alternative 3 and the No Action Alternative, and that impacts on visual resources
 4 would not be substantial in the seller's service area due to implementation
 5 requirements of the transfer programs.

6 Under Alternative 3, water could be transferred throughout the year without an
 7 annual volumetric limit. Under the No Action Alternative, the timing of cross
 8 Delta water transfers would be limited to July through September and include
 9 annual volumetric limits, in accordance with the 2008 USFWS BO and 2009
 10 NMFS BO. Overall, the potential for cross Delta water transfers would be
 11 increased under Alternative 3 as compared to the No Action Alternative.

12 *San Francisco Bay Area, Central Coast, and Southern California Regions*

13 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 14 *SWP Water*

15 Changes in visual resources at reservoirs that store CVP and SWP water supplies
 16 are assumed to be related to changes in water deliveries over long-term conditions
 17 for this EIS analysis, as described above under the No Action Alternative as
 18 compared to the Second Basis of Comparison. Therefore, under Alternative 3 as
 19 compared to the No Action Alternative, visual resources related to surface water
 20 elevations in reservoirs that store CVP and SWP water supplies would be
 21 increased by 9 to 17 percent in the San Francisco Bay Area Region and 17 percent
 22 in the Central Coast and Southern California regions.

23 **14.4.3.4.2 Alternative 3 Compared to the Second Basis of Comparison**

24 *Trinity River Region*

25 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 26 *SWP Water*

27 Changes in CVP water supplies and operations under Alternative 3 as compared
 28 to the Second Basis of Comparison would result in similar end-of-September
 29 reservoir elevations and related visual resources at Trinity Lake in all water year
 30 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

31 *Central Valley Region*

32 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 33 *SWP Water*

34 Changes in CVP water supplies and operations under Alternative 3 as compared
 35 to the Second Basis of Comparison would result in similar end-of-September
 36 reservoir elevations and related visual resources at Shasta Lake, Lake Oroville,
 37 Folsom Lake, New Melones Reservoir, and San Luis Reservoir in all water year
 38 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

39 *Effects Related to Cross Delta Water Transfers*

40 Potential effects to visual resources could be similar to those identified in a recent
 41 environmental analysis conducted by Reclamation for long-term water transfers
 42 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described

1 above under the No Action Alternative compared to the Second Basis of
2 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
3 would occur during implementation of cross Delta water transfers under
4 Alternative 3 and the Second Basis of Comparison, and that impacts on visual
5 resources would not be substantial in the seller's service area due to
6 implementation requirements of the transfer programs.

7 Under Alternative 3 and the Second Basis of Comparison, water could be
8 transferred throughout the year without an annual volumetric limit. Overall, the
9 potential for cross Delta water transfers would be similar under Alternative 3 and
10 the Second Basis of Comparison.

11 *San Francisco Bay Area, Central Coast, and Southern California Regions*

12 *Potential Changes in Visual Resources at Reservoirs that Store CVP and* 13 *SWP Water*

14 Changes in visual resources at reservoirs that store CVP and SWP water supplies
15 are assumed to be related to changes in water deliveries over long-term conditions
16 for this EIS analysis, as described above under the No Action Alternative as
17 compared to the Second Basis of Comparison. Therefore, under Alternative 3 as
18 compared to the Second Basis of Comparison, visual resources related to surface
19 water elevations in reservoirs that store CVP and SWP water supplies would be
20 similar (changes within 5 percent).

21 **14.4.3.5 Alternative 4**

22 The visual resources conditions under Alternative 4 would be identical to the
23 conditions under the Second Basis of Comparison; therefore, Alternative 4 is only
24 compared to the No Action Alternative.

25 **14.4.3.5.1 Alternative 4 Compared to the No Action Alternative**

26 The CVP and SWP operations under Alternative 4 are identical to the CVP and
27 SWP operations under the Second Basis of Comparison and Alternative 1.
28 Therefore, changes in visual resources conditions under Alternative 4 as
29 compared to the No Action Alternative would be the same as the impacts
30 described in Section 14.4.3.2.1, Alternative 1 Compared to the No Action
31 Alternative.

32 **14.4.3.6 Alternative 5**

33 As described in Chapter 3, Description of Alternatives, CVP and SWP operations
34 under Alternative 5 are similar to the No Action Alternative with modified Old
35 and Middle Rivers (OMR) flow criteria and New Melones Reservoir operations.
36 As described in Chapter 4, Approach to Environmental Analysis, Alternative 5 is
37 compared to the No Action Alternative and the Second Basis of Comparison.

1 **14.4.3.6.1 Alternative 5 Compared to the No Action Alternative**

2 *Trinity River Region*

3 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
 4 *SWP Water*

5 Changes in CVP water supplies and operations under Alternative 5 as compared
 6 to the No Action Alternative would result in similar end-of-September reservoir
 7 elevations and related visual resources at Trinity Lake in all water year types, as
 8 described in Chapter 5, Surface Water Resources and Water Supplies.

9 *Central Valley Region*

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
 11 *SWP Water*

12 Changes in CVP water supplies and operations under Alternative 5 as compared
 13 to the No Action Alternative would result in similar end-of-September reservoir
 14 elevations and related visual resources at Shasta Lake, Lake Oroville, Folsom
 15 Lake, New Melones Reservoir, and San Luis Reservoir in all water year types, as
 16 described in Chapter 5, Surface Water Resources and Water Supplies.

17 *Effects Related to Cross Delta Water Transfers*

18 Potential effects to visual resources could be similar to those identified in a recent
 19 environmental analysis conducted by Reclamation for long-term water transfers
 20 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
 21 above under the No Action Alternative compared to the Second Basis of
 22 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
 23 would occur during implementation of cross Delta water transfers under
 24 Alternative 5 and the No Action Alternative, and that impacts on visual resources
 25 would not be substantial in the seller’s service area due to implementation
 26 requirements of the transfer programs.

27 Under Alternative 5 and the No Action Alternative, the timing of cross Delta
 28 water transfers would be limited to July through September and include annual
 29 volumetric limits, in accordance with the 2008 USFWS BO and 2009 NMFS BO.
 30 Overall, the potential for cross Delta water transfers would be similar under
 31 Alternative 5 and the No Action Alternative.

32 *San Francisco Bay Area, Central Coast, and Southern California Region*

33 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
 34 *SWP Water*

35 Changes in visual resources at reservoirs that store CVP and SWP water supplies
 36 are assumed to be related to changes in water deliveries over long-term conditions
 37 for this EIS analysis, as described above under the No Action Alternative as
 38 compared to the Second Basis of Comparison. Therefore, under Alternative 5 as
 39 compared to the No Action Alternative, visual resources would be similar.

1 **14.4.3.6.2 Alternative 5 Compared to the Second Basis of Comparison**

2 *Trinity River Region*

3 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
4 *SWP Water*

5 Changes in CVP water supplies and operations under Alternative 5 as compared
6 to the Second Basis of Comparison would result in similar end-of-September
7 reservoir elevations and related visual resources at Trinity Lake in all water year
8 types, as described in Chapter 5, Surface Water Resources and Water Supplies.

9 *Central Valley Region*

10 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
11 *SWP Water*

12 Changes in CVP water supplies and operations under Alternative 5 as compared
13 to the Second Basis of Comparison would result in similar end-of-September
14 reservoir elevations and related visual resources at Shasta Lake, Lake Oroville,
15 Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis
16 Reservoir in wet, above-normal, and below-normal years, as described in Chapter
17 5, Surface Water Resources and Water Supplies. Changes in visual resources at
18 San Luis Reservoir would be reduced in dry year and critical dry years because
19 the end-of-September surface water elevations would be decreased by 6.2 percent
20 in dry years and 8.5 percent in critical dry years.

21 *Effects Related to Cross Delta Water Transfers*

22 Potential effects to visual resources could be similar to those identified in a recent
23 environmental analysis conducted by Reclamation for long-term water transfers
24 from the Sacramento to San Joaquin valleys (Reclamation 2014c) as described
25 above under the No Action Alternative compared to the Second Basis of
26 Comparison. For the purposes of this EIS, it is anticipated that similar conditions
27 would occur during implementation of cross Delta water transfers under
28 Alternative 5 and the Second Basis of Comparison, and that impacts on visual
29 resources would not be substantial in the seller's service area due to
30 implementation requirements of the transfer programs.

31 Under Alternative 5, the timing of cross Delta water transfers would be limited to
32 July through September and include annual volumetric limits, in accordance with
33 the 2008 USFWS BO and 2009 NMFS BO. Under the Second Basis of
34 Comparison, water could be transferred throughout the year without an annual
35 volumetric limit. Overall, the potential for cross Delta water transfers would be
36 reduced under Alternative 5 as compared to the Second Basis of Comparison.

37 *San Francisco Bay Area, Central Coast, and Southern California Regions*

38 *Potential Changes in Visual Resources at Reservoirs that Store CVP and*
39 *SWP Water*

40 Changes in visual resources at reservoirs that store CVP and SWP water supplies
41 are assumed to be related to changes in water deliveries over long-term conditions
42 for this EIS analysis, as described above under the No Action Alternative as
43 compared to the Second Basis of Comparison. Therefore, under Alternative 5 as

1 compared to the Second Basis of Comparison, visual resources related to surface
 2 water elevations in reservoirs that store CVP and SWP water supplies would be
 3 reduced by 10 to 18 percent in the San Francisco Bay Area Region and 18 percent
 4 in the Central Coast and Southern California regions.

5 **14.4.3.7 Summary of Impact Assessment**

6 The results of the impact assessment of implementation of Alternatives 1 through
 7 5 as compared to the No Action Alternative and the Second Basis of Comparison
 8 are presented in Tables 14.1 and 14.2.

9 **Table 14.1 Comparison of Alternatives 1 through 5 to No Action Alternative**

Alternative	Potential Change	Consideration for Mitigation Measures
Alternative 1	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be increased by 6 percent in wet and critical dry years at San Luis Reservoir, by 11 to 21 percent in the San Francisco Bay Area Region, and by 21 percent in the Central Coast and Southern California regions.	None needed.
Alternative 2	No effects on visual resources.	None needed.
Alternative 3	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be increased by 8 percent in wet years and 6 percent in above-normal years at San Luis Reservoir, by 9 to 17 percent in the San Francisco Bay Area Region, and by 17 percent in the Central Coast and Southern California regions.	None needed.
Alternative 4	Same effects as described for Alternative 1 compared to the No Action Alternative.	None needed.
Alternative 5	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.	None needed.

10 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other
 11 analytical tools, incremental differences of 5 percent or less between alternatives and the
 12 Second Basis of Comparison are considered to be “similar.”

1 **Table 14.2 Comparison of No Action Alternative and Alternatives 1 through 5 to**
 2 **Second Basis of Comparison**

Alternative	Potential Change	Consideration for Mitigation Measures
No Action Alternative	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be reduced by 6 percent in wet and critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.	Not considered for this comparison.
Alternative 1	No effects on visual resources.	Not considered for this comparison.
Alternative 2	Same effects as described for No Action Alternative as compared to the Second Basis of Comparison.	Not considered for this comparison.
Alternative 3	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, and other reservoirs that store CVP and SWP water in the San Francisco Bay Area, Central Coast, and Southern California regions.	Not considered for this comparison.
Alternative 4	No effects on visual resources.	Not considered for this comparison.
Alternative 5	Visual resources would be similar at Trinity Lake, Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir in all water year types; and at San Luis Reservoir in above-normal, below-normal, and dry years. Visual resources would be reduced by 6 percent in dry years and 9 percent in critical dry years at San Luis Reservoir, by 10 to 18 percent in the San Francisco Bay Area Region, and by 18 percent in the Central Coast and Southern California regions.	Not considered for this comparison.

3 Note: Due to the limitations and uncertainty in the CalSim II monthly model and other
 4 analytical tools, incremental differences of 5 percent or less between alternatives and the
 5 Second Basis of Comparison are considered to be “similar.”

6 **14.4.3.8 Potential Mitigation Measures**

7 Mitigation measures are presented in this section to avoid, minimize, rectify,
 8 reduce, eliminate, or compensate for adverse environmental effects of
 9 Alternatives 1 through 5 as compared to the No Action Alternative. Mitigation
 10 measures were not included to address adverse impacts under the alternatives as

1 compared to the Second Basis of Comparison because this analysis was included
 2 in this EIS for information purposes only.

3 Changes in CVP and SWP operations under Alternatives 1 through 5, as
 4 compared to the No Action Alternative, would not result in changes in visual
 5 resources. Therefore, there would be no adverse impacts to visual resources and
 6 no mitigation measures are required.

7 **14.4.3.9 Cumulative Effects Analysis**

8 As described in Chapter 3, the cumulative effects analysis considers projects,
 9 programs, and policies that are not speculative and are based upon known or
 10 reasonably foreseeable long-range plans, regulations, operating agreements, or
 11 other information that establishes them as reasonably foreseeable.

12 The cumulative effects analysis for Alternatives 1 through 5 for Visual Resources
 13 are summarized in Table 14.3.

14 **Table 14.3 Summary of Cumulative Effects on Visual Resources with**
 15 **Implementation of Alternatives 1 through 5 as Compared to the No Action**
 16 **Alternative**

Scenarios	Actions	Cumulative Effects of Actions
Past & Present, and Future Actions included in the No Action Alternative in All Alternatives in Year 2030	Consistent with Affected Environment conditions plus: Actions in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.2 (of Chapter 3, Descriptions of Alternatives), including climate change and sea level rise Actions not included in the 2008 USFWS BO and 2009 NMFS BO that would have occurred without implementation of the BOs, as described in Section 3.3.1.3 (of Chapter 3, Descriptions of Alternatives): <ul style="list-style-type: none"> - Implementation of Federal and state policies and programs, including Clean Water Act (e.g., Total Maximum Daily Loads); Safe Drinking Water Act; Clean Air Act; and flood management programs - General plans for 2030. - Trinity River Restoration Program. - Central Valley Project Improvement Act programs - Folsom Dam Water Control Manual Update - FERC Relicensing for the Middle Fork of the American River Project - Lower Mokelumne River Spawning Habitat Improvement Project 	<u>These effects would be the same under all alternatives.</u> Climate change and sea level rise, development under the general plans, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September storage in CVP and SWP reservoirs compared to past conditions, and to reduce CVP and SWP water supply reliability which could result in less irrigated lands compared to past conditions. General plans would be completed for projected conditions by 2030, as described in Chapter 13, Land Use. Restoration plans for the ongoing programs would be completed which would change visual resources of the restored lands.

Scenarios	Actions	Cumulative Effects of Actions
	<ul style="list-style-type: none"> - Dutch Slough Tidal Marsh Restoration - Suisun Marsh Habitat Management, Preservation, and Restoration Plan Implementation - Tidal Wetland Restoration: Yolo Ranch, Northern Liberty Island Fish Restoration Project, Prospect Island Restoration Project, and Calhoun Cut/Lindsey Slough Tidal Habitat Restoration Project - San Joaquin River Restoration Program - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects with completed environmental documents) 	
<p>Future Actions considered as Cumulative Effects Actions in All Alternatives in Year 2030</p>	<p>Actions as described in Section 3.5 (of Chapter 3, Descriptions of Alternatives):</p> <ul style="list-style-type: none"> - Bay-Delta Water Quality Control Plan Update - FERC Relicensing Projects - Bay Delta Conservation Plan (including the California WaterFix alternative) - Shasta Lake Water Resources, North-of-the-Delta Offstream Storage, Los Vaqueros Reservoir Expansion Phase 2, and Upper San Joaquin River Basin Storage Investigations - El Dorado Water and Power Authority Supplemental Water Rights Project - Sacramento River Water Reliability Project - Semitropic Water Storage District Delta Wetlands - North Bay Aqueduct Alternative Intake - San Luis Reservoir Low Point Improvement Project - Future water supply projects, including water recycling, desalination, groundwater banks and wellfields, and conveyance facilities (projects that did not have completed environmental documents during preparation of the EIS) 	<p><u>These effects would be the same under all alternatives.</u></p> <p>Most of the future reasonably foreseeable actions are anticipated to reduce water supply impacts due to climate change, sea level rise, increased water allocated to improve habitat conditions, and future growth.</p> <p>Some of the future reasonably foreseeable actions related to improved water quality and habitat conditions (e.g., Water Quality Control Plan Update and FERC Relicensing Projects), could in further reductions in CVP and SWP water deliveries and associated extent of irrigated lands.</p>

Scenarios	Actions	Cumulative Effects of Actions
No Action Alternative with Associated Cumulative Effects Actions in Year 2030	Full implementation of the 2008 USFWS BO and 2009 NMFS BO	<p>Climate change and sea level rise, FERC relicensing projects, and some future projects to improve water quality and/or habitat are anticipated to reduce end of September CVP and SWP reservoir storage as compared to past conditions.</p> <p>Community development would occur in accordance with general plan projections for 2030. Restoration plans for the ongoing programs would be completed.</p> <p>Future water supply projects are anticipated to both increase water supply reliability due to reduced surface water supplies and to accommodate planned growth in the general plans.</p>
Alternative 1 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 1 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 2 with Associated Cumulative Effects Actions in Year 2030	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO CVP and SWP operational actions</p> <p>No implementation of structural improvements or other actions that require further study to develop a more detailed action description.</p>	Implementation of Alternative 2 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 3 with Associated Cumulative Effects Actions in Year 2030	<p>No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)</p> <p>Slight increase in positive Old and Middle River flows in the winter and spring months</p>	Implementation of Alternative 3 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 4 with Associated Cumulative Effects Actions in Year 2030	No implementation of the 2008 USFWS BO and 2009 NMFS BO actions unless the actions would have been implemented without the BO (e.g., Red Bluff Pumping Plant)	Implementation of Alternative 4 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with the added actions.
Alternative 5 with Associated Cumulative Effects Actions in Year 20530	<p>Full implementation of the 2008 USFWS BO and 2009 NMFS BO</p> <p>Positive Old and Middle River flows and increased Delta outflow in spring months</p>	Implementation of Alternative 5 with future reasonably foreseeable actions would result in similar changes as under the No Action Alternative with added actions.

1 **14.5 References**

- 2 BCDC (San Francisco Bay Conservation and Development Commission). 1976.
3 *Suisun Marsh Protection Plan*. Site accessed February 13 and March 25,
4 2013. http://www.bcdc.ca.gov/laws_plans/plans/suisun_marsh.shtml
- 5 BLM et al. (Bureau of Land Management, National Park Service, U.S. Fish and
6 Wildlife Service, and Forest Service). 2012. *River Mileage*
7 *Classifications for Components of the National Wild and Scenic Rivers*
8 *System*. September.
- 9 BVWSD (Buena Vista Water Storage District). 2015. *Buena Vista Water*
10 *Storage District, James Groundwater Storage and Recovery Project*. Site
11 accessed February 15, 2015. <http://bvh2o.com/James.html>
- 12 CALFED (CALFED Bay-Delta Program). 2000. *Final Programmatic*
13 *Environmental Impact Report/Environmental Impact Statement*. July.
14 Sacramento.
- 15 CalTrans (California Department of Transportation). 2014a. California Scenic
16 Highway Program. Site accessed February 16, 2014.
17 http://www.dot.ca.gov/hq/LandArch/scenic_hi67ghways/trinity.htm.
- 18 CalTrans (California Department of Transportation). 2014b. California Scenic
19 Highway Program. Site accessed February 16, 2014.
20 http://www.dot.ca.gov/hq/LandArch/scenic_highways/humboldt.htm.
- 21 CalTrans (California Department of Transportation). 2014c. California Scenic
22 Highway Program. Site accessed February 16, 2014.
23 http://www.dot.ca.gov/hq/LandArch/scenic_highways/delnorte.htm.
- 24 CalTrans (California Department of Transportation). 2014d. California Scenic
25 Highway Program. Site accessed February 17, 2014.
26 http://www.dot.ca.gov/hq/LandArch/scenic_highways/shasta.htm.
- 27 CalTrans (California Department of Transportation). 2014e. California Scenic
28 Highway Program. Site accessed February 17, 2014.
29 http://www.dot.ca.gov/hq/LandArch/scenic_highways/Tehama.htm.
- 30 CalTrans (California Department of Transportation). 2014f. California Scenic
31 Highway Program. Site accessed February 18, 2014.
32 http://www.dot.ca.gov/hq/LandArch/scenic_highways/yolo.htm.
- 33 CalTrans (California Department of Transportation). 2014g. California Scenic
34 Highway Program. Site accessed February 18, 2014.
35 http://www.dot.ca.gov/hq/LandArch/scenic_highways/solano.htm.
- 36 CalTrans (California Department of Transportation). 2014h. California Scenic
37 Highway Program. Site accessed February 18, 2014.
38 http://www.dot.ca.gov/hq/LandArch/scenic_highways/napa.htm.

- 1 CalTrans (California Department of Transportation). 2014i. California Scenic
2 Highway Program. Site accessed February 17, 2014.
3 http://www.dot.ca.gov/hq/LandArch/scenic_highways/butte.htm.
- 4 CalTrans (California Department of Transportation). 2014j. California Scenic
5 Highway Program. Site accessed February 17, 2014.
6 http://www.dot.ca.gov/hq/LandArch/scenic_highways/plumas.htm.
- 7 CalTrans (California Department of Transportation). 2014k. California Scenic
8 Highway Program. Site accessed February 17, 2014.
9 http://www.dot.ca.gov/hq/LandArch/scenic_highways/nevada.htm.
- 10 CalTrans (California Department of Transportation). 2014l. California Scenic
11 Highway Program. Site accessed February 17, 2014.
12 http://www.dot.ca.gov/hq/LandArch/scenic_highways/el_dorado.htm.
- 13 CalTrans (California Department of Transportation). 2014m. California Scenic
14 Highway Program. Site accessed February 18, 2014.
15 http://www.dot.ca.gov/hq/LandArch/scenic_highways/san_joaquin.htm.
- 16 CalTrans (California Department of Transportation). 2014n. California Scenic
17 Highway Program. Site accessed February 18, 2014.
18 http://www.dot.ca.gov/hq/LandArch/scenic_highways/alameda.htm
- 19 CalTrans (California Department of Transportation). 2014o. California Scenic
20 Highway Program. Site accessed February 18, 2014.
21 http://www.dot.ca.gov/hq/LandArch/scenic_highways/stanislaus.htm.
- 22 CalTrans (California Department of Transportation). 2014p. California Scenic
23 Highway Program. Site accessed February 18, 2014.
24 http://www.dot.ca.gov/hq/LandArch/scenic_highways/merced.htm.
- 25 CalTrans (California Department of Transportation). 2014q. California Scenic
26 Highway Program. Site accessed February 18, 2014.
27 http://www.dot.ca.gov/hq/LandArch/scenic_highways/fresno.htm.
- 28 CalTrans (California Department of Transportation). 2014r. California Scenic
29 Highway Program. Site accessed February 18, 2014.
30 http://www.dot.ca.gov/hq/LandArch/scenic_highways/kings.htm
- 31 CalTrans (California Department of Transportation). 2014s. California Scenic
32 Highway Program. Site accessed February 18, 2014.
33 http://www.dot.ca.gov/hq/LandArch/scenic_highways/tulare.htm.
- 34 CalTrans (California Department of Transportation). 2014t. California Scenic
35 Highway Program. Site accessed February 18, 2014.
36 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
- 37 CalTrans (California Department of Transportation). 2014u. California Scenic
38 Highway Program. Site accessed February 17, 2014.
39 http://www.dot.ca.gov/hq/LandArch/scenic_highways/sacramento.htm.

- 1 CalTrans (California Department of Transportation). 2014v. California Scenic
2 Highway Program. Site accessed February 18, 2014.
3 [http://www.dot.ca.gov/hq/LandArch/scenic_highways/](http://www.dot.ca.gov/hq/LandArch/scenic_highways/contra_costa.htm)
4 CalTrans (California Department of Transportation). 2014w. California Scenic
5 Highway Program. Site accessed February 18, 2014.
6 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
7 CalTrans (California Department of Transportation). 2014x. California Scenic
8 Highway Program. Site accessed February 18, 2014.
9 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
10 CalTrans (California Department of Transportation). 2014y. California Scenic
11 Highway Program. Site accessed February 18, 2014.
12 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
13 CalTrans (California Department of Transportation). 2014z. California Scenic
14 Highway Program. Site accessed February 18, 2014.
15 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
16 CalTrans (California Department of Transportation). 2014aa. California Scenic
17 Highway Program. Site accessed February 18, 2014.
18 http://www.dot.ca.gov/hq/LandArch/scenic_highways/ventura.htm
19 CalTrans (California Department of Transportation). 2014ab. California Scenic
20 Highway Program. Site accessed February 18, 2014.
21 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
22 CalTrans (California Department of Transportation). 2014ac. California Scenic
23 Highway Program. Site accessed February 18, 2014.
24 http://www.dot.ca.gov/hq/LandArch/scenic_highways/orange.htm
25 CalTrans (California Department of Transportation). 2014ad. California Scenic
26 Highway Program. Site accessed February 18, 2014.
27 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
28 CalTrans (California Department of Transportation). 2014ae. California Scenic
29 Highway Program. Site accessed February 18, 2014.
30 http://www.dot.ca.gov/hq/LandArch/scenic_highways/riverside.htm
31 CalTrans (California Department of Transportation). 2014af. California Scenic
32 Highway Program. Site accessed February 18, 2014.
33 http://www.dot.ca.gov/hq/LandArch/scenic_highways/
34 DOI and DFG (Department of the Interior and California Department of Fish and
35 Game [now known as Department of Fish and Wildlife]). 2012. *Klamath*
36 *Facilities Removal Final Environmental Impact Statement/Environmental*
37 *Impact Report*. December.
38 DOT (U.S. Department of Transportation, Federal Highway Administration).
39 1981, Reprinted 1989. *Visual Impact Assessment for Highway Projects*,
40 *Publication No. FHWA-HI-88-054*.

- 1 DWR (California Department of Water Resources). 2007. *Draft Environmental*
2 *Impact Report Oroville Facilities Relicensing—FERC Project No. 2100.*
3 May.
- 4 DWR (California Department of Water Resources). 2013a. *Upper Feather River*
5 *Lakes.* April.
- 6 DWR (California Department of Water Resources). 2013b. *North-of-the-Delta*
7 *Offstream Storage Preliminary Administrative Draft Environmental*
8 *Impact Report.* December.
- 9 DWR, Reclamation, USFWS, and NMFS (California Department of Water
10 Resources, Bureau of Reclamation, U.S. Fish and Wildlife Service, and
11 National Marine Fisheries Service). 2013. *Draft Environmental Impact*
12 *Report/Environmental Impact Statement for the Bay Delta Conservation*
13 *Plan.* November.
- 14 DWR et al. (California Department of Water Resources, Yuba County Water
15 Agency, Bureau of Reclamation). 2007. *Draft Environmental Impact*
16 *Report/Environmental Impact Statement for the Proposed Lower Yuba*
17 *River Accord.* June.
- 18 FERC (Federal Energy Regulatory Commission). 2015. *FERC: Hydropower-*
19 *General Information – Licensing.* Site accessed April 29, 2015.
20 <http://www.ferc.gov/industries/hydropower/gen-info/licensing.asp>
- 21 KRCD (Kings River Conservation District). 2012b. *Sustainable Groundwater*
22 *Management through an Integrated Regional Water Management Plan*
23 *(IRWMP).*
- 24 Los Angeles County (County of Los Angeles). 2011. *Public Review Draft 4/5/11*
25 *Text-Only Version, Los Angeles County General Plan 2035.* April.
- 26 MORE (Mokelumne River Water & Power Authority). 2015. *Status and*
27 *Timeline.* Site accessed January 14, 2015.
28 http://www.morewater.org/about_project/status_timeline.html
- 29 MWDC (Metropolitan Water District of Southern California). 2010. *Integrated*
30 *Water Resources Plan, 2010 Update.* October.
- 31 National Wild and Scenic Rivers System. 2013. State Listings. California. Site
32 accessed February 13 and March 25, 2013.
33 <http://www.rivers.gov/rivers/california.php>.
- 34 NCRWQCB et al. (California North Coast Regional Water Quality Control Board
35 and Bureau of Reclamation). 2009. *Channel Rehabilitation and Sediment*
36 *Management for Remaining Phase 1 and Phase 2 Sites, Draft Master*
37 *Environmental Impact Report and Environmental Assessment.* June.
- 38 NID (Nevada Irrigation District). n.d. (No date). *Combie Reservoir, Carrying*
39 *Capacity and Safety Study.*

- 1 NSJCGBA (Northeastern San Joaquin County Groundwater Banking Authority).
2 2007. *Eastern San Joaquin Integrated Regional Water Management Plan*.
3 July.
- 4 RCIP (Riverside County Integrated Project). 2000. *Existing Setting Report*.
5 March.
- 6 Reclamation (Bureau of Reclamation). 1997. *Central Valley Project*
7 *Improvement Act, Draft Programmatic Environmental Impact Statement*.
8 September.
- 9 Reclamation (Bureau of Reclamation). 2005a. *Delta Mendota Canal Unit,*
10 *Environmental Assessment, Long-Term Contract Renewal*. February.
- 11 Reclamation (Bureau of Reclamation). 2005b. *Central Valley Project Long-*
12 *Term Water Service Contract Renewal San Luis Unit, Public Draft*
13 *Environmental Impact Statement and Appendices*. September.
- 14 Reclamation (Bureau of Reclamation). 2005c. *Central Valley Project Long-Term*
15 *Water Service Contract Renewal American River Division Environmental*
16 *Impact Statement*. June.
- 17 Reclamation (Bureau of Reclamation). 2010. *New Melones Lake Area, Final*
18 *Resource Management Plan and Environmental Impact Statement*.
19 February.
- 20 Reclamation (Bureau of Reclamation). 2013a. *Shasta Lake Water Resources*
21 *Investigation Draft Environmental Impact Statement*. June.
- 22 Reclamation (Bureau of Reclamation). 2013b. *Record of Decision, Water*
23 *Transfer Program for the San Joaquin River Exchange Contractors Water*
24 *Authority, 2014-2038*. July 30.
- 25 Reclamation (Bureau of Reclamation). 2014a. *Findings of No Significant*
26 *Impact, 2014 Tehama-Colusa Canal Authority Water Transfers*. April 22.
- 27 Reclamation (Bureau of Reclamation). 2014b. *Findings of No Significant*
28 *Impact, 2014 San Luis & Delta-Mendota Water Authority Water*
29 *Transfers*. April 22.
- 30 Reclamation (Bureau of Reclamation). 2014c. *Long-Term Water Transfers*
31 *Environmental Impact Statement/Environmental Impact Report, Public*
32 *Draft*. September.
- 33 Reclamation (Bureau of Reclamation). 2014d. *Upper San Joaquin River Basin*
34 *Storage Investigation, Draft Environmental Impact Statement*. August.
- 35 Reclamation, CCWD, and Western (Bureau of Reclamation, Contra Costa Water
36 District, and Western Area Power Administration). 2010. *Los Vaqueros*
37 *Expansion Project, Environmental Impact Statement/Environmental*
38 *Impact Report*. March.
- 39 Reclamation and State Parks (Bureau of Reclamation and California Department
40 of Parks and Recreation). 2013. *San Luis Reservoir State Recreation*

- 1 *Area, Final Resource Management Plan/General Plan and Final*
 2 *Environmental Impact Statement/ Environmental Impact Report.* June.
- 3 Reclamation et al. (Bureau of Reclamation, U.S. Army Corps of Engineers,
 4 California Reclamation Board, Sacramento Area Flood Control Agency).
 5 2006. *Folsom Dam Safety and Flood Damage Reduction Draft*
 6 *Environmental Impact Statement/Environmental Impact Report.*
 7 December.
- 8 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
 9 Game [now known as Department of Fish and Wildlife], and U.S. Fish
 10 and Wildlife Service). 2010. *Suisun Marsh Habitat Management,*
 11 *Preservation, and Restoration Plan Draft Environmental Impact*
 12 *Statement/Environmental Impact Report.*
- 13 Reclamation et al. (Bureau of Reclamation, California Department of Fish and
 14 Game [now known as Department of Fish and Wildlife], and U.S. Fish
 15 and Wildlife Service). 2011b. *Suisun Marsh Habitat Management,*
 16 *Preservation, and Restoration Plan Final Environmental Impact*
 17 *Statement/Environmental Impact Report.*
- 18 San Bernardino County (County of San Bernardino). 2007. *County of San*
 19 *Bernardino 2006 General Plan Program, Final Environmental Impact*
 20 *Report and Appendices.* February.
- 21 Santa Barbara County (County of Santa Barbara). 2009. *Coastal Land Use Plan.*
 22 June.
- 23 Santa Clara County (County of Santa Clara). 1994. *Santa Clara County General*
 24 *Plan Draft Environmental Impact Report.* September.
- 25 SBCAG (Santa Barbara County Association of Governments). 2013. *2040 Santa*
 26 *Barbara County Regional Transportation Plan and Sustainable*
 27 *Communities Strategy, Draft Environmental Impact Report.* May.
- 28 SEWD (Stockton East Water District). 2012. *Farmington Groundwater*
 29 *Recharge Program.* Site accessed November 30, 2012.
 30 <http://www.farmingtonprogram.org/index.html>
- 31 SJRRP (San Joaquin River Restoration Program). 2011a. *Friant-Kern Canal*
 32 *Capacity Restoration, Draft Environmental Assessment, San Joaquin*
 33 *River Restoration Program.* June.
- 34 SWRCB (State Water Resources Control Board). 2006. *Water Quality Control*
 35 *Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.*
 36 December 13.
- 37 SWRCB (State Water Resources Control Board). 2013. *Comprehensive (Phase*
 38 *2) Review and Update to the Bay-Delta Plan, DRAFT Bay-Delta Plan*
 39 *Workshops Summary Report.* January
- 40 SWSD (Semitropic Water Storage District). 2011. *Delta Wetlands Project Place*
 41 *of Use, Final Environmental Impact Report.* August.

Chapter 14: Visual Resources

- 1 USACE (U.S. Army Corps of Engineers). 2012. *Lower Yuba River Large*
2 *Woody Material Management Plan Pilot Study, Yuba County, California,*
3 *Final Environmental Assessment.* August.
- 4 USDA (U.S. Department of Agriculture, Forest Service). 1995. *Landscape*
5 *Aesthetics, A Handbook for Scenery Management, Agriculture Handbook*
6 *Number 701.* December.
- 7 USDA (U.S. Department of Agriculture, Forest Service). 2011. Shasta-Trinity
8 National Recreation Area (NRA). Site accessed December 22, 2011.
9 http://www.fs.usda.gov/detail/stnf/about-forest/?cid=fsm9_008651.
- 10 USFS (U.S. Department of Agriculture, Forest Service). 2006a. *Lake Davis*
11 *Recreation Area.* May.
- 12 USFS (U.S. Department of Agriculture, Forest Service). 2006b. *Frenchman*
13 *Lake Recreation Area.* May.
- 14 USFS (U.S. Department of Agriculture, Forest Service). 2011. *Antelope Lake*
15 *Recreation Area.* July.
- 16 WTA (Water Transit Authority). 2003. *Final Program Environmental Impact*
17 *Report Expansion of Ferry Transit Service in the San Francisco Bay Area.*
18 June.