3.13 Air Quality

3.13.1 Affected Environment

The proposed project is located in the Northern Sacramento Valley Air Basin, which includes Shasta, Tehama, Glenn, Butte, Colusa, Sutter, and Yuba counties. Air quality in the basin is regulated under the authority of both the federal Clean Air Act and the California Clear Air Act with the Tehama County Air Pollution Control District as the local agency responsible for regulating air quality in Tehama County. Pursuant to the federal Clean Air Act of 1970, EPA has established national ambient air quality standards for several major pollutants. Pollutants of primary concern for this project are ozone and its precursors, and particulate matter less than 10 microns in aerodynamic diameter (PM_{10}). The State of California has established ambient air quality standards pursuant to the California Clean Air Act (see Table 3.13-1).

TABLE 3.13-1
State and National Ambient Air Quality Standards

			Federal Standard	
Pollutant	**Averaging Time**	**State Standard**	**Primary Standard**	**Secondary Standard**
PM_{10}	Annual Geometric Mean	30 $\mu g/m^3$		Same as primary
	24-hour	50 $\mu g/m^3$	150 $\mu g/m^3$	Same as primary
	Annual Arithmetic Mean	---	50 $\mu g/m^3$	Same as primary
Ozone	1-hour	0.09 ppm (180 $\mu g/m^3$)	0.12 ppm (235 $\mu g/m^3$)	Same as primary
	8-hour	---	0.08 ppm (157 $\mu g/m^3$)	Same as primary

ppm = parts per million.
$\mu g/m^3$ = micrograms per cubic meter.

Currently, Tehama County is not in attainment with the state standard for PM_{10} and ozone. Tehama County is in attainment with the federal PM_{10} standard, and was in attainment with the federal 1-hour ozone standard. Recent monitoring suggests that the area would not be in attainment with the federal 8-hour ozone standard. Because of this status, the County Air Pollution Control District has developed an Air Quality Attainment Plan. The intent of this plan is to implement control strategies for the County to bring the air district into a level of attainment. Table 3.13-2 shows the attainment status for Tehama County.

Ozone is a pollutant formed through a complex series of temperature-dependent photochemical reactions involving precursor pollutants such as nitrogen oxide (NO_X) and reactive organic gases (ROG). High ozone concentrations typically occur during multi-day periods of hot, sunny days accompanied by stagnant weather patterns. Under these conditions, pollution from outside the region is transported into the area, compounding the problem. This makes ozone a regional-scale pollutant and can affect rural areas outside major metropolitan areas.

TABLE 3.13-2
Tehama County Attainment Status

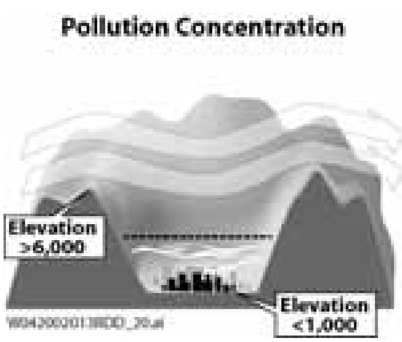
Pollutant	Attainment with State Standard?	Attainment with Federal Standard?
CO[a]	Yes	Yes
PM_{10}	No	Yes
$PM_{2.5}$[b]	---	---
NO_X	Yes	Yes
Ozone	No	Yes/No[c]
SO_2[d]	Yes	Yes
Other	Yes	Yes

[a]Carbon monoxide.

[b]Attainment status for $PM_{2.5}$ will not be determined until the year 2005.

[c]The area was in attainment with the old federal 1-hour standard. Recent monitoring suggests that the area would not be in attainment with the new federal 8-hour standard.

[d]Sulfur dioxide.



The topography of the basin enhances the accumulation of ozone. Mountain ranges surrounding the Tehama County area reach heights of over 6,000 feet, making a barrier to locally created pollution as well as pollution transported northward from the Sacramento metropolitan area. Because of these conditions, the valley portion of the air basin (i.e., those areas below Elevation 1,000 feet) is often subjected to temperature inversions that restrict vertical mixing and dilution of pollutants.

In 1996, EPA promulgated a new 8-hour standard for ozone (61 Federal Register 65752, December 3, 1996) to replace the previous 1-hour ozone standard. When this rule took effect, the County was in attainment with the old federal 1-hour standard. Table 3.13-3 shows 1-hour ozone concentrations at the Red Bluff Oak Street monitoring site and the Tuscan Butte monitoring site. However, recent monitoring suggest that the area may not be in attainment with the new federal 8-hour standard. The attainment status for this area is not yet available for the year 2000.

The California Air Resources Board conducts a basinwide study to quantify the relative contributions of local emissions, upwind transported, and non-local vehicle emissions to exceedances of the California ozone standard in Tehama County. The major finding of the 2000 study was that substantial transport of ozone and ozone precursors from the broader Sacramento Valley was responsible for Tehama County's ozone violations. The study also concluded that localized pollution sources by themselves did not exceed the ozone standard. Tehama County's emissions are a small part (around 4.7 percent) of the entire Sacramento Valley emissions inventory. It is clear from this study that sources in Tehama County do not cause ozone violations. Table 3.13-4 shows the criteria pollutant emissions inventory for Tehama County in relation to the overall air basin.

Tehama County's emissions are a small part (around 4.7 percent) of the entire Sacramento Valley emissions inventory. It is clear from this study that sources in Tehama County do not cause ozone violations.

TABLE 3.13-3
Ozone Monitoring at Red Bluff Oak Street and Tuscan Butte

Location	Year	High 1-hour Ozone (ppm)	Second High 1-hour Ozone (ppm)
Red Bluff – Oak Street	1999	0.110	0.110
Red Bluff – Oak Street	1998	0.120	0.120
Red Bluff – Oak Street	1997	0.100	0.090
Red Bluff – Oak Street	1996	0.090	0.090
Tuscan Butte	1999	0.128	0.114
Tuscan Butte	1998	0.120	0.108
Tuscan Butte	1997	0.101	0.092
Tuscan Butte	1996	0.108	0.099

TABLE 3.13-4
2000 Estimated Annual Average Emissions—Tehama County

	Emission in Tons/Day						
	TOG[a]	ROG	CO	NO_x	SO_x[b]	PM	PM_{10}
Stationary Sources	2.74	1.35	1.12	1.05	0.01	0.74	0.45
Areawide Sources	3.87	2.44	15.97	0.31	0.06	24.02	14.15
Mobile Sources	5.76	5.26	48.52	9.62	0.66	0.42	0.42
Natural Sources	1.07	0.60	14.91	0.65	-	3.00	2.89
Total	**13.44**	**9.65**	**80.52**	**11.62**	**0.73**	**28.18**	**17.91**

[a]Toxic organic gases.
[b]Sulfur oxide.
Source: California Air Resources Board, 2000, Emissions Inventory.
http://www.arb.ca.gov/emisinv/emsmain/emsmain.htm

Table 3.13-5 shows monitoring data for PM_{10} at the Red Bluff Riverside Drive monitoring stations.

Residential woodstove and fireplace use during wintertime inversion conditions is the major contributor of stationary source PM_{10}.

Mobile source emissions make up a significant portion of the ROG and NO_x emissions. Unpaved road emissions (areawide source) make up most of the PM_{10} emissions.

TABLE 3.13-5
PM_{10} Monitoring at Red Bluff Riverside Drive

Location	Year	High 24-hour PM_{10} ($\mu g/m^3$)	Second High 24-hour PM_{10} ($\mu g/m^3$)	Days > 24-hour State Standard	Annual PM_{10} ($\mu g/m^3$)	Days > Annual State Standard
Red Bluff – Riverside Drive	1999	98.0	75.0	8	28	48
Red Bluff – Riverside Drive	1998	119.0	67.0	8	21.3	48
Red Bluff – Riverside Drive	1997	58	52	2	19	12
Red Bluff – Riverside Drive	1996	56	49	1	22.3	6

3.13.2 Environmental Consequences

This section provides a discussion of the consequences of the project alternatives on air quality as compared to the No Action Alternative.

Methodology

Air quality impacts of the various alternatives were evaluated by determining the worst-case emission for each process. Vehicle emissions were calculated using the URBEMIS 7G computer model. The direct project emission and total project emissions were compared to the first-tier trigger thresholds.

The fugitive dust emissions were calculated from the CEQA equation:

$$E_{ce}(lbs/day) = 0.77 tons/acre/month * acres$$

Diesel- and gasoline-powered vehicle exhaust contains CO, ROG, NO_x, SO_x, and PM_{10}. Exhaust emissions from worker vehicles traveling to and from the site and onsite construction activities were considered. For the onsite construction vehicles, the daily emission rates were estimated based on the projected amount of material removed and added for the project, assuming each phase of the project takes 60 days. Specifically, the daily emissions from construction exhaust (E_{ce}) were assumed to be:

$$E_{ce}(lbs/day) = \frac{M(CY) * EF(g/CY)}{60 days * 454(g/lbs)}$$

Where M is the total amount of material removed and added (in cubic yards), EF is the pollutant-specific emission factor from the Bay Area Air Quality Management District CEQA Guidelines.

The maximum number of vehicle trips was considered, and emissions were estimated using the URBEMIS 7G computer software. During the peak of construction activity, it was assumed that there would be

20 workers, each with his or her own car and a maximum of three trucks per day. The URBEMIS 7G program requires the number of one-way trips, so the number of one-way trips is double the number of vehicles.

Additionally, thresholds were established to determine significance and are shown in Table 3.13-6.

TABLE 3.13-6
Thresholds for Determining Significance

Pollutant/Source	Threshold	Applicable Rule
CO	550 lb/day	PSD
NO_x	219 lb/day	PSD
PM_{10}	82 lb/day	PSD
ROG	219 lb/day	PSD
SO_2	219 lb/day	PSD

Source: Prevention of Significant Deterioration.

lb/day = pounds per day.

Significance Criteria

Significance criteria represent the thresholds that were used to identify whether an impact would be potentially significant. These criteria are based on Appendix G of the *CEQA Guidelines* and professional judgment.

Impacts on air quality would be significant if they would result in any of the following:

- Conflict with or obstruct implementation of the applicable air quality plan.
- Violate any air quality standard or contribute substantially to an existing or projected air quality violation.
- Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions that exceed quantitative thresholds for ozone precursors).
- Expose sensitive receptors to substantial pollutant concentrations.
- Create objectionable odors affecting a substantial number of people.

The main area of concern for construction impacts is fugitive dust emissions. If project impacts are found to be significant, then mitigation should be applied. If standard mitigation measures are applied, then the impacts are considered to be insignificant for the construction impacts.

The main area of concern for construction impacts is fugitive dust emissions.

No Action Alternative

No changes to hydrology or surface-water management would occur. Gates would be operated during the current 4-month gates-in period. Construction activity would be limited to the installation of the fourth pump at RPP. No other construction activity would occur as a result of the No Action Alternative.

1A: 4-month Improved Ladder Alternative

Construction-related Impacts.

Impact 1A–AQ1: Fugitive Dust Emissions. During ground surface preparation for this alternative, most of the PM_{10} emissions would be composed of fugitive dust. Emission sources would include vehicles and construction equipment traveling over dirt surfaces, site clearing, grading, cut and fill operations, and wind-blown dust.

Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedance of the state PM_{10} standards.

Impact 1A–AQ2: Construction Equipment and Vehicle Exhaust Emissions. Table 3.13-7 shows the vehicle emissions that would be expected during project construction. CO and NO_x would exceed the significance threshold. No significant or unusual odors are anticipated to be generated during construction.

TABLE 3.13-7
Impact 1A–AQ2: Construction Equipment and Vehicles Exhaust Emissions and Fugitive Dust

Location	PM_{10}	CO	ROG	NO_x	SO_x
Mill Site	6.94	435.54	29.04	133.82	14.52
Left Bank Fish Ladder	1.03	64.62	4.31	19.85	2.15
Right Bank Fish Ladder	0.37	23.00	1.53	7.07	0.77
Conveyance Facility	4.03	253.30	16.89	77.83	8.44
Disturbed Land	51.33				
Worker Vehicle Trips	0.10	1.36	0.16	0.27	0.10
Entrained Road Dust	0.61				
Total (lb/day)	**64.41**	**777.82**	**57.93**	**238.84**	**25.98**
Significance Threshold (lb/day)	***82***	***550***	***219***	***219***	***219***

The impact on air quality under Alternative 1A would be temporary but significant for CO and NO_x. Construction impacts would be temporary, and when mitigation is applied, the impacts would be less than significant.

Operations-related Impacts. *Impacts from operations under Alternative 1A would not be significant since the project would not*

increase traffic flow to the area and the pumps would only be turned on at limited times; therefore, no mitigation is required.

1B: 4-month Bypass Alternative

Construction-related Impacts.

Impact 1B–AQ1: Fugitive Dust Emissions. Impacts from construction under Alternative 1B would be the same as those identified for Alternative 1A (see Impact 1A–AQ1).

Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedances of the state PM_{10} standards.

Impact 1B–AQ2: Construction Equipment and Vehicle Exhaust Emissions. Table 3.13-8 shows the vehicle emissions that would be expected during project construction. CO and NO_x would exceed the significance threshold. No significant or unusual odors would be anticipated to be generated during construction.

TABLE 3.13-8
Impact 1B–AQ2: Construction Equipment and Vehicles Exhaust Emission and Fugitive Dust

Location	PM_{10}	CO	ROG	NO_x	SO_x
Mill Site	6.94	435.54	29.04	133.82	14.52
Bypass Channel	6.92	434.37	28.96	133.46	14.48
Right Bank Fish Ladder	0.37	23.00	1.53	7.07	0.77
Conveyance Facility	4.03	253.30	16.89	77.83	8.44
Disturbed Land	51.33				
Worker Vehicle Trips	0.10	1.36	0.16	0.27	0.10
Entrained Road Dust	0.61				
Total (lb/day)	**70.30**	**1,147.57**	**76.58**	**352.45**	**38.31**
Significance Threshold (lb/day)	***82***	***550***	***219***	***219***	***219***

The impact on air quality under Alternative 1B would be temporary but significant for CO and NO_x. Construction impacts would be temporary, and when mitigation is applied, the impacts would be less than significant.

Operations-related Impacts. ***Impacts from operations under Alternative 1B would not be significant since the project would not increase traffic flow to the area and the pumps would only be turned on at limited times; therefore, no mitigation is required.***

2A: 2-month Improved Ladder Alternative

Construction-related Impacts.
Impact 2A–AQ1: Fugitive Dust Emissions. Impacts from construction under Alternative 2A would be the same as those identified for Alternative 1A (see Impact 1A–AQ1).

Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedances of the state PM_{10} standards.

Impact 2A–AQ2: Construction Equipment and Vehicle Exhaust Emissions. Table 3.13-9 shows the vehicle emissions that would be expected during project construction. CO and NO_x would exceed the significance threshold. No significant or unusual odors would be anticipated to be generated during construction.

TABLE 3.13-9
Impact 2A–AQ2: Construction Equipment and Vehicles Exhaust Emissions and Fugitive Dust

Location	PM_{10}	CO	ROG	NO_x	SO_x
Mill Site	9.91	621.45	41.43	190.94	20.72
Left Bank Fish Ladder	1.03	64.62	4.31	19.85	2.15
Right Bank Fish Ladder	0.37	23.00	1.53	7.07	0.77
Conveyance Facility	4.03	253.30	16.89	77.83	8.44
Disturbed Land	51.33				
Worker Vehicle Trips	0.10	1.36	0.16	0.27	0.10
Entrained Road Dust	0.61				
Total (lb/day)	**67.38**	**963.73**	**64.32**	**295.96**	**32.18**
Significance Threshold (lb/day)	***82***	***550***	***219***	***219***	***219***

The impact on air quality under Alternative 2A would be temporary but significant for CO and NO_x. Construction impacts would be temporary, and when mitigation is applied, the impacts would be less than significant.

Operations-related Impacts. ***Impacts from operations under Alternative 2A would not be significant since the project would not increase traffic flow to the area and the pumps would only be turned on at limited times; therefore, no mitigation is required.***

2B: 2-month with Existing Ladders Alternative

Construction-related Impacts.
Impact 2B–AQ1: Fugitive Dust Emissions. Impacts from construction under Alternative 2B would be the same as those identified for Alternative 1A (see Impact 1A–AQ1).

Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedances of the state PM_{10} standards.

Impact 2B–AQ2: Construction Equipment and Vehicle Exhaust Emissions. Table 3.13-10 shows the vehicle emissions that would be expected during project construction. CO and NO_x would exceed the significance threshold. No significant or unusual odors are anticipated to be generated during construction

TABLE 3.13-10
Impact 2B–AQ2: Construction Equipment and Vehicles Exhaust Emissions and Fugitive Dust

Location	PM_{10}	CO	ROG	NO_x	SO_x
Mill Site	9.91	621.45	41.43	190.94	20.72
Conveyance Facility	4.03	253.30	16.89	77.83	8.44
Disturbed Land	51.33				
Worker Vehicle Trips	0.10	1.36	0.16	0.27	0.10
Entrained Road Dust	0.61				
Total (lb/day)	**65.98**	**876.11**	**58.48**	**269.04**	**29.26**
Significance Threshold (lb/day)	***82***	***550***	***219***	***219***	***219***

The impact on air quality under Alternative 2B would be temporary but significant for CO and NO_x. Construction impacts would be temporary, and when mitigation is applied, the impacts would be less than significant.

Operations-related Impacts. Impacts from operations under Alternative 2B would not be significant since the project would not increase traffic flow to the area and the pumps would only be turned on at limited times; therefore, no mitigation is required.

3: Gates-out Alternative

Construction-related Impacts.
Impact 3–AQ1: Fugitive Dust Emissions. Impacts from construction under Alternative 3 would be the same as those identified for Alternative 1A (see Impact 1A–AQ1).

Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedances of the state PM_{10} standards.

Impact 3–AQ2: Construction Equipment and Vehicle Exhaust Emissions. Table 3.13-11 shows the vehicle emissions that would be expected during project construction. CO and NO_x would exceed the significance threshold. No significant or unusual odors would be anticipated to be generated during construction.

TABLE 3.13-11
Impact 3–AQ2: Construction Equipment and Vehicles Exhaust Emissions and Fugitive Dust

Location	PM_{10}	CO	ROG	NO_x	SO_x
Mill Site	19.71	1236.43	82.43	379.89	41.21
Conveyance Facility	4.03	253.30	16.89	77.83	8.44
Disturbed Land	51.33				
Worker Vehicle Trips	0.10	1.36	0.16	0.27	0.10
Entrained Road Dust	0.61				
Total (lb/day)	**75.78**	**1,491.09**	**99.48**	**457.99**	**49.75**
Significance Threshold (lb/day)	***82***	***550***	***219***	***219***	***219***

The impact on air quality under Alternative 3 would be temporary but significant for CO and NO_X. Construction impacts would be temporary, and when mitigation is applied, the impacts would be less than significant.

Operations-related Impacts. ***Impacts from operations under Alternative 3 would not be significant since the project would not increase traffic flow to the area and the pumps would only be turned on at limited times; therefore, no mitigation is required.***

3.13.3 Mitigation

This section discusses mitigations for each significant impact described in Environmental Consequences.

1A: 4-month Improved Ladder Alternative

Mitigation 1A–AQ1. To mitigate for short-term air quality impacts associated with the proposed project from dust generated during periods of construction activities, a dust control program would be implemented with the following components:

- Equipment and manual watering would be conducted on all stockpiles, dirt/gravel roads, and exposed or disturbed soil surfaces, as necessary, to reduce airborne dust.
- The contractor or builder would designate a person to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite. This person would respond to citizen complaints.
- Dust-producing activities would be suspended when high winds create construction-induced visible dust plumes moving beyond the site in spite of dust control.
- All trucks hauling soil and other loose material would be covered, or would be required to have at least 2 feet of freeboard.

- All unpaved access roads and staging areas at construction sites would have soil stabilizers applied as necessary.
- Streets in and adjacent to construction area would be kept swept and free of visible soil and debris.
- Traffic speeds on all unpaved roads would be limited to 15 miles per hour.

Mitigation 1A–AQ2. To mitigate for short-term air quality impacts associated with the proposed project from construction equipment emission, an equipment control program would be implemented with the following components:

- Properly maintain equipment.
- Limit idling time when the equipment is not in operation.

1B: 4-month Bypass Alternative

Mitigation 1B–AQ1. See Mitigation 1A–AQ1.

Mitigation 1B–AQ2. See Mitigation 1A–AQ2.

2A: 2-month Improved Ladder Alternative

Mitigation 2A–AQ1. See Mitigation 1A–AQ1.

Mitigation 2A–AQ2. See Mitigation 1A–AQ2.

2B: 2-month with Existing Ladders Alternative

Mitigation 2B–AQ1. See Mitigation 1A–AQ1.

Mitigation 2B–AQ2. See Mitigation 1A–AQ2.

3: Gates-out Alternative

Mitigation 3–AQ1. See Mitigation 1A–AQ1.

Mitigation 3–AQ2. See Mitigation 1A–AQ2.

3.14 Traffic and Circulation

3.14.1 Affected Environment

Regional access to the project area is provided by I-5 and California State Highway 99.

Regional Access

Regional access to the project area is provided by I-5 and California State Highway 99. I-5 is the principle north-south arterial along the west side of the Central Valley. Highway 99 is also a main north-south arterial for California, extending from Red Bluff south along the east side of the Central Valley. Figure 3.14-1 illustrates transportation access near the project site.

Union Pacific Railroad

Union Pacific Railroad tracks traverse the City of Red Bluff along State Highway 36, intersect South Main Street, and continue along Old Highway 99. Train traffic generally passes through the area between the hours of 4 p.m. and 8 a.m. and is mainly general freight. The nearest passenger stops are at Redding and Chico. An average of 12 trains pass through the area on a daily basis, with an estimated average traffic delay of approximately 2 minutes (City of Red Bluff, 1991).

The diversion dam is accessed via County Road 99 West and Altube Avenue.

Roadways

The diversion dam is accessed via County Road 99 West and Altube Avenue. Road 99 West, accessible from the northbound and southbound lanes of I-5, is classified by Tehama County as an arterial and collector road (see Figure 3.14-1). Table 3.14-1 shows the peak-hour (PH) average traffic counts from the City of Red Bluff Department of Public Works for Road 99 West south of I-5 (this traffic count does not include truck traffic from Wal-Mart).

TABLE 3.14-1
Road 99 West Peak-hour Average Traffic Counts[a]

Hour	Northbound	Southbound
6:00 A.M.	443.25	--
11:00 A.M.	--	365.75
3:00 P.M.	735.5	681.5

[a]Traffic counts from 1997.

Altube Avenue, classified by Tehama County as a minor local street, primarily serves USBR traffic and occasional traffic for adjacent orchards.

The Mill Site is accessible via Diamond Avenue.

The Mill Site is accessible via Diamond Avenue. Diamond Avenue is classified by the City of Red Bluff as a two-lane collector road and is directly accessed from southbound I-5. To access the avenue from the northbound lane, it is necessary to exit I-5 to South Main Street and follow South Main Street north to Diamond Avenue. A driveway that once served the Diamond Mill site still exists on Diamond Avenue. The majority of traffic that uses this road is heavy trucks and commuters. Traffic counts are not available.

Access to recreation facilities on the left bank is provided by Sale Lane.

Access to recreation facilities on the left bank is provided by Sale Lane. Sale Lane is classified by the City of Red Bluff as a two-lane major rural and urban collector road, and is accessed by northbound and southbound lanes of I-5 to Antelope Boulevard/Highway 36 East. Antelope Boulevard/Highway 36 East is classified by the City of Red Bluff as a major arterial/rural highway, and is located in central Red Bluff. Sale Lane exists in both the City of Red Bluff and Tehama County; therefore, both entities have jurisdiction of the road. Table 3.14-2 shows the PH traffic counts from the Tehama County Department of Public Works for Sale Lane.

TABLE 3.14-2
Sale Lane Peak-hour Traffic Counts[a]

Hour	Northbound	Southbound
2:00 P.M.	161	--
1:00 P.M.	--	179

[a]This traffic count data was collected in February of 2001, and may change significantly in the summer months because of an increase in recreation activity at Lake Red Bluff.

Pedestrian/Bicycle Access

Short-range bicycle and pedestrian facilities for Tehama County have not been programmed but will be developed, primarily in urbanized areas, as the need arises (Tehama County, 1997). The City has developed bicycle route designations denoting the type and quality of the route. The majority of the bikeway system comprises Class III routes. Class III routes are defined as bicycle pathways that are shared usage of streets with no specific separation of different modes of traffic. Street signage is often used to designate a roadway as a bicycle route. Routes include all major and minor arterials and collector streets of the City, including Main Street and Antelope Boulevard. A portion of the designated City bicycle route extends along Sale Lane, toward the Recreation Area.

3.14.2 Environmental Consequences

Methodology

Level of Service (LOS) was established by the Institute of Transportation Engineers as a guideline for quantifying the subjective measure of traffic tolerance. Three distinct guidelines can be used to determine the LOS of a section of roadway: segmental volumes, volume to capacity (V/C) ratios, or delays at intersections. Once LOS is determined, a letter designation ranging from A to F is applied to the section of roadway

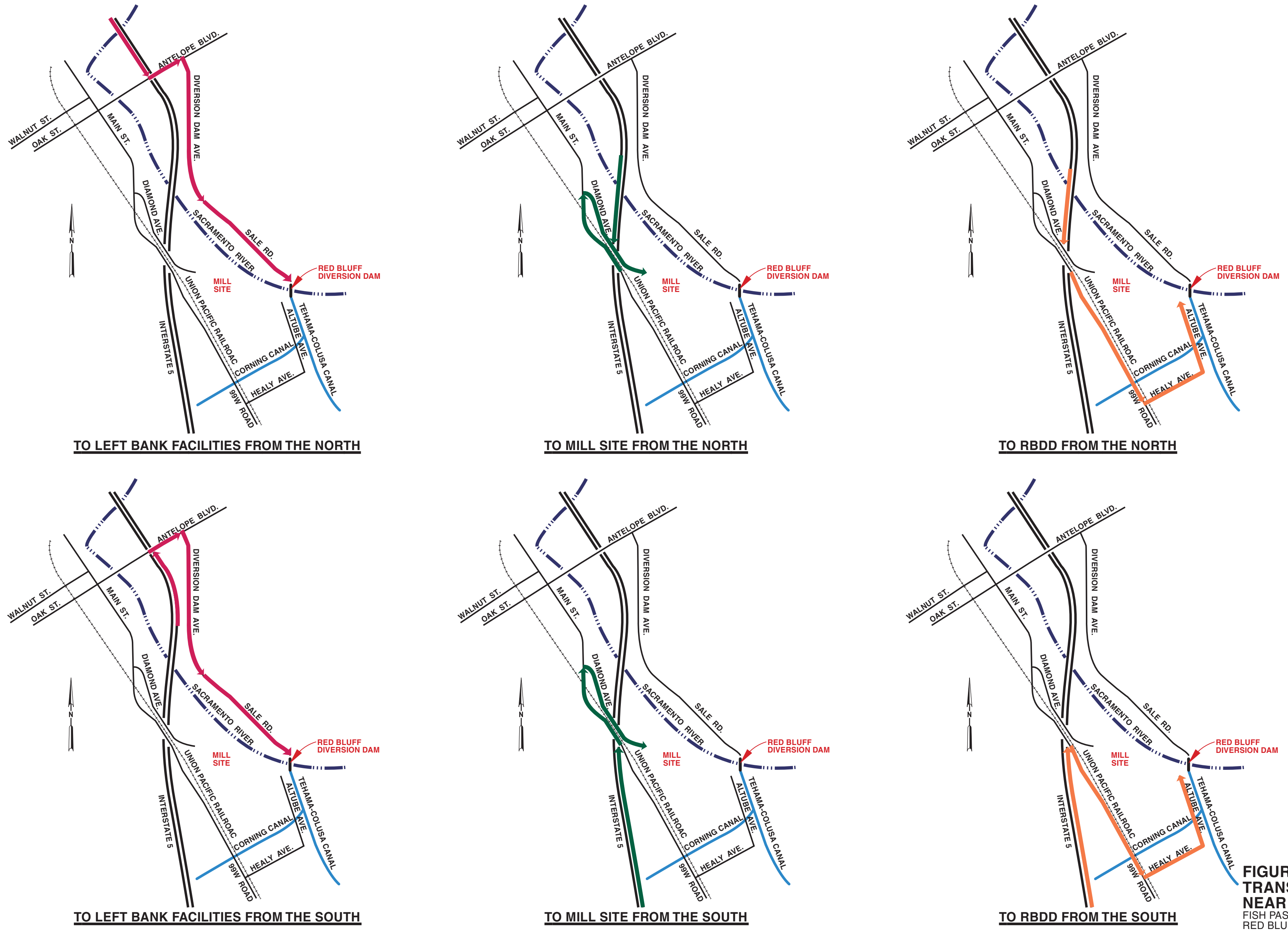


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FIGURE 3.14-1
TRANSPORTATION ACCESS NEAR PROJECT SITE
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

being analyzed. LOS "A" represents fully unconstrained traffic flow, and LOS "F" represents an unstable flow situation bordering on grid-lock. The Federal Highway Administration (FHA) Capacity Manual Update (1985) provides the formulas used to evaluate roadway LOS. Data provided in Table 3.14-3 represent the V/C method of computing LOS.

TABLE 3.14-3
Level of Service Threshold Volume to Capacity Ratios for Urban/Suburban Roadway Types

Level of Service	Freeway Conditions	Highway/Urban Conditions
LOS A	V/C 0 to 0.35 Free flow. Individual users virtually unaffected by presence of others in traffic stream. Freedom to select desired speed and maneuver within traffic stream is extremely high. General level of comfort and convenience is excellent.	V/C 0 to 0.05 Free-flow operations at average travel speeds of about 90 percent of free-flow speed. Vehicles unimpeded in ability to maneuver. Stopped delay at signalized intersections is minimal.
LOS B	V/C 0.36 to 0.54 Stable flow. Presence of other users in traffic stream begins to be noticeable. Freedom to select speed relatively unaffected, but slight decline in freedom to maneuver within traffic stream from LOS A. Level of comfort and convenience somewhat less than LOS A.	V/C 0.06 to 0.17 Reasonably unimpeded operations at average speeds of about 70 percent of free flow. Ability to maneuver only slightly restricted, and stopped delays not bothersome.
LOS C	V/C 0.55 to 0.77 Stable flow, but begins range of flow where individuals are significantly affected by interactions with others in traffic stream. Selection of speed is affected; maneuvering requires substantial vigilance. General level of comfort and convenience declines noticeably at this level.	V/C 0.18 to 0.34 Stable operations, but ability to maneuver and change lanes more restricted than LOS B. Longer signal delays and lower speeds reduce average speed to about 50 percent of free flow. Motorists experience appreciable tension.
LOS D	V/C 0.78 to 0.93 High-density, but stable flow. Speed and freedom to maneuver severely restricted. Poor level of comfort and convenience. Small increases in flow would generally cause operational problems at this level.	V/C 0.35 to -0.58 Small increases in flow may cause substantial increases in approach delay and decreases in speed to about 40 percent of average free flow.
LOS E	V/C 0.94 to 1.00 Operating conditions at or near capacity level. Speeds reduced to low but relatively uniform value. Freedom to maneuver extremely difficult. Comfort and convenience extremely poor and frustration generally high. Operations usually unstable; small increases in flow or minor perturbations would cause breakdown.	V/C 0.59 to 1.00 Significant approach delays and average speed of about one-third free flow or lower.
LOS F	V/C 1.01+ Forced or breakdown flow. Traffic exceeds capacity. Queues form where traffic flow is characterized by stop-and-go waves.	V/C 1.01+ Extremely low speeds from one-third to one-quarter of free-flow speed. Intersection congestion likely at critical signalized locations.

Source: FHA, 1985.
Note: V/C ratios are analyzed with PH volumes.

The significance of construction-related traffic is based on the addition of construction and detour traffic to the roadway system and the impact to existing operations of these roadways.

The significance of construction-related traffic is based on the addition of construction and detour traffic to the roadway system and the impact to existing operations of these roadways. Standards have not been established by FHA for LOS of roadways during construction. However, for the purposes of this report, Appendix G of the *CEQA Guidelines* is used to define the standard of significance for temporary traffic impacts in the project area.

Tehama County and the City of Red Bluff do not have an established LOS. The City of Red Bluff has PH intersection and roadway volume and LOS measurements for several key roadways and intersections. Both the City and County Public Works departments determine the significance level of a project on a case-by-case basis. Typically, a project's level of impact is determined by the type, location, and duration of construction.

City of Red Bluff

The objective of the City of Red Bluff Circulation Element of the General Plan is to efficiently transport people and goods throughout Red Bluff. Several objectives and respective policies have been established in the Circulation Element that implement the goal of creating problem-free circulation throughout the City of Red Bluff. The Circulation Element addresses factors such as noise, land use, housing, and safety as integral parts of its overall circulation plan.

The City of Red Bluff defines their roadways using the 1985 Highway Capacity Manual. Table 3.14-4 provides the definitions used to classify roadways within the City's jurisdiction.

Tehama County

The Tehama County General Plan Circulation Element covers all territory within the County boundaries. It also takes into account any area outside of its jurisdiction which, "bears relation to its planning (Government Code Section 65300)." The overall goals of the Circulation Element are to work toward a circulation and transportation system that will maintain and improve the social, natural, and economic quality of life in Tehama County (Tehama County, 1997).

Tehama County has assigned functional classifications to its roads. These classifications group roads and highways by the character of service they provide, and help guide the improvement of the existing and future circulation network. Table 3.14-5 provides the definition of the seven classifications assigned to Tehama County's roads.

TABLE 3.14-4
City of Red Bluff Circulation Element, Roadway Classifications

Roadway Designation	Definition
Freeway	Characterized by high speed and limited and controlled access, freeways primarily serve regional and long-distance travel.
Rural Highway	Rural highways are generally higher-speed, medium-capacity, two-lane roadways with one lane for travel in each direction. Passing of slower vehicles requires the use of the opposing lane where traffic gaps allow. Undivided multi-lane highways without full control of access as found in freeways may also be classified as rural highways.
Arterial	Major: These streets are generally higher-speed, higher-capacity transportation corridors that link the community with highways and freeways. Minor: Medium-speed and medium-capacity transportation corridors, these roads are principally for travel between larger land uses within the community.
Collector	Relatively low-speed and low-capacity transportation corridors, collector streets are generally two lanes connecting neighborhoods with other neighborhoods as well as with the arterial system.
Local Street	Local streets are low-speed, low-capacity streets that provide direct access to adjacent land uses and are typically meant only for local, as opposed to through, traffic.

Source: City of Red Bluff, 1991.

TABLE 3.14-5
Tehama County Circulation Element, Functional Classifications

Roadway Designation	Definition
Highway	Provides regional, statewide, and national transportation connections and includes I-5 and all other state highways. Access from highways to adjacent properties shall be limited for safety and traffic efficiency. Right-of-way widths are to be determined by the California Department of Transportation (Caltrans).
Arterial	Provides connections between links in the highway network and connects major destinations within the highway network. Major community facilities such as community-serving retail centers, industrial parks, office and business parks, and educational facilities should be located in proximity to arterial. Access from arterial to adjoining properties should be limited for safety and traffic efficiency. Curbside parking should be prohibited where feasible. Average daily traffic (ADT) on arterial can range from 3,000 ADT in rural areas to 36,000 ADT in urban areas. For the purpose of Section 66484 of the Subdivision Map Act, an arterial shall be considered a major thoroughfare.
Collector	Accommodates traffic between arterial streets and/or activity centers. Within residential areas, traffic is funneled onto collectors and then to connecting arterials. Small-scale retail, industrial, or commercial establishments may have direct access to collectors, but direct access to individual residential lots should be limited where feasible to improve traffic safety and efficiency. Curbside parking should be prohibited where feasible. Average daily traffic can range from 600 ADT in rural areas to 20,000 ADT in urban areas. For the purpose of Section 66484 of the Subdivision Map Act, a collector shall be considered a major thoroughfare.

TABLE 3.14-5
Tehama County Circulation Element, Functional Classifications

Roadway Designation	Definition
Subcollector	Provides connection between local streets and collector or arterial streets. Subcollectors generally serve 300 or more housing units with average daily traffic ranging from 400 to 1,000 ADT. Direct access from adjoining parcels is permitted. Curbside parking is permitted, but should be discouraged for safety and aesthetic reasons, where densities are concentrated such as in clustered or planned unit developments.
Major Local Street	Provides access from 500 to 300 housing units to a subcollector, collector, or arterial. Minor local streets may funnel into a major local street. Major local streets provide direct access to individual adjoining properties.
Local Street	Provides access for 25 to 49 potential residences. Local streets provide direct access to individual adjoining properties.
Minor Local Street	Provides access for 5 to 24 potential residences. The number of units served depends on the road length and type of housing unit. Minor local streets are the only streets that may dead end in a cul-de-sac or court; however, if such is the case, the number of potential residences to be served shall not exceed 25 without some form of emergency access. The maximum length of street should not exceed 1,000 feet with only a single means of egress.

Source: Tehama County, 1997.

Significance Criteria

Significance criteria represent the thresholds that were used to identify whether an impact would be potentially significant. These criteria are based on Appendix G of the *CEQA Guidelines* and professional judgment.

Impacts on traffic would be significant if they would result in any of the following:

- An increase in traffic that is substantial in relation to the existing traffic load and capacity of the street system.
- Exceed, either individually or cumulatively, a LOS standard established by the County congestion/management agency for designated roads or highways.

No Action Alternative

No changes to hydrology or surface-water management would occur. Gates would be operated during the current 4-month gates-in period. Construction activity would be limited to the installation of the fourth pump at RPP. No other construction activity would occur as a result of the No Action Alternative.

1A: 4-month Improved Ladder Alternative

Construction-related Impacts.

Impact 1A–TC1: Left Bank Construction. Traffic generated during construction of the proposed project would temporarily increase traffic to Sale Lane and Antelope Boulevard/Highway 36 East. Table 3.14-6 lists the LOS and PH intersection and roadway volumes of the local roads and corresponding intersections that are expected to be traveled during construction.

TABLE 3.14-6
LOS for Existing Roadways and Intersections[a]

Traffic Type	Location	Existing LOS	PH Volume[b]
Roadway	Antelope Boulevard between Highway 36 East/Sale Lane	B	620
Intersect	Antelope Boulevard between Sale Lane/Belle Mill Road	D	1,804
	Antelope Boulevard/ Highway- 36 East	A	724
	Antelope Boulevard at Belle Mill Road	E	2,444

[a]City of Red Bluff, 1991.
[b]Traffic volumes measured in June 1990 through February 1991.

Many of the vehicles associated with construction would be heavy-duty trucks, including 20-yard earth-moving trucks, 10-yard concrete trucks, and commuter traffic. Table 3.14-7 shows the approximate daily number of vehicles needed for construction of the left bank fish ladder.

Traffic impacts from construction of the proposed left bank fish ladder are anticipated to be minimal on Antelope Boulevard between Sale Lane and Belle Mill Road. However, large construction vehicles could exceed the capacity of Sale Lane. Sale Lane is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.

Because the traffic increase to Antelope Boulevard/Highway 36 East would be temporary, impacts to traffic from construction of the left bank fish ladder would be less than significant; therefore, no mitigation is required.

The impact from construction-related vehicles on Sale Lane could directly damage roadways. This would be a significant impact.

TABLE 3.14-7
Anticipated Vehicles Needed for Construction of Left Bank Fish Ladder

Construction Activity	Description/Location	Vehicle Type	Vehicles per Day
Earthwork	Cut and fill work on the left bank fish ladder would be require the removal of approximately 16,000 CY of material. Approximately 5,000 CY would be disposed of onsite. The remainder of the excavated material would be hauled to an offsite disposal area.	20-yard trucks Personal vehicles (for construction crew)	40-50 25
Concrete Trucks	Concrete lining of fish ladder would require a steady supply of concrete material. It is unknown whether a construction contractor would use a portable batch plant to supply materials onsite.	8- to 10-yard trucks Personal vehicles (for construction crew)	25 25
Miscellaneous	If a portable batch plan is used, it would require material to make concrete on-site. Additional miscellaneous traffic includes pile-driving equipment, construction inspectors, painters, carpenters, iron workers, repair trucks.	20-yard trucks Varying types	15 25
Total			**165**

Impact 1A–TC2: Right Bank Construction. The remainder of construction traffic would be to the proposed Mill Site fish screen and conveyance facilities and right bank fish ladder. Access to the Mill Site would be via Diamond Avenue off Main Street and I-5. Currently, Diamond Avenue predominantly consists of heavy truck and commuter traffic. Existing LOS have not been measured for the Diamond Avenue/Main Street intersection. Construction of the fish screen would require a large amount of earth movement and transport, as well as commuter traffic.

Table 3.14-8 shows the approximate number of daily vehicles needed for construction of the Mill Site fish screen and conveyance facilities.

Access to the right bank fish ladder would be via County Road 99 West to Altube Avenue. Traffic impacts from construction of the proposed right bank fish ladder are anticipated to be minimal on Altube Avenue. However, large construction vehicles could exceed the capacity of the road. Altube Avenue is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface. Table 3.14-9 shows the approximate number of daily vehicles needed for construction of the right bank fish ladder.

TABLE 3.14-8
Anticipated Vehicles Needed for Construction of Mill Site Fish Screen and Conveyance Facilities

Construction Activity	Description/Location	Vehicle Type	Vehicles per Day
Earthwork and Material Import	Cut and fill work on Mill Site fish screen and conveyance facilities would require the removal of approximately 750,000 CY of material. Approximately 580,000 CY would be disposed of onsite. The remainder of the excavated material would be hauled to an offsite disposal area. Large volumes of fill material would be brought onsite.	20-yard trucks Personal vehicles (for construction crew)	52 30
Concrete Trucks	Concrete lining of fish ladder would require a steady supply of concrete material. It is unknown whether a construction contractor would use a portable batch plant to supply materials onsite.	8- to 10-yard trucks Personal vehicles (for construction crew)	25 30
Miscellaneous	If a portable batch plan is used, it would require material to make concrete on-site. Additional miscellaneous traffic includes pile-driving equipment, construction inspectors, painters, iron workers, carpenters, repair trucks.	20-yard trucks Varying types	15 25
Total			**177**

TABLE 3.14-9
Anticipated Vehicles Needed for Construction of Right Bank Fish Ladder

Construction Activity	Description/Location	Vehicle Type	Vehicles per Day
Earthwork	Cut and fill work on the left bank fish ladder would require the removal of approximately 4,000 CY of material. Approximately 1,400 CY would be disposed of onsite. The remainder of the excavated material would be hauled to an offsite disposal area.	20-yard trucks Personal vehicles (for construction crew)	20-30 15
Concrete Trucks	Concrete lining of fish ladder would require a steady supply of concrete material. It is unknown whether a construction contractor would use a portable batch plant to supply materials onsite.	8- to 10-yard trucks Personal vehicles (for construction crew)	25 25
Miscellaneous	If a portable batch plan is used, it would require material to make concrete on-site. Additional miscellaneous traffic includes pile-driving equipment, construction inspectors, painters, iron workers, carpenters, repair trucks.	20-yard trucks Varying types	15 25
Total			**135**

Because Diamond Avenue is currently designed to accommodate heavy commuter traffic, and construction traffic impacts would be temporary, traffic impacts to Diamond Avenue would be less than significant; therefore, no mitigation is required.

The impact from construction-related vehicles on Altube Avenue could directly damage roadways. This would be a significant impact.

Operations-related Impacts. ***No operations-related impacts are anticipated under Alternative 1A; therefore, no mitigation is required.***

1B: 4-month Bypass Alternative

Construction-related Impacts.

Impact 1B–TC1: Bypass Construction. Traffic generated during construction of the proposed project would temporarily increase traffic to Sale Lane and Antelope Boulevard/Highway 36 East. Table 3.14-6 lists the LOS and PH intersection and roadway volumes of the local roads and corresponding intersections that are expected to be traveled during construction.

Many of the vehicles associated with construction would be heavy-duty trucks, including 20-yard earth moving trucks, 10-yard concrete trucks, and commuter traffic. Table 3.14-10 shows the approximate number of daily vehicles needed for construction of the bypass channel.

TABLE 3.14-10
Anticipated Vehicles Needed for Construction of Bypass Channel

Construction Activity	Description/Location	Vehicle Type	Vehicles per Day
Earthwork and Material Import	Cut and fill work on the bypass channel would require the removal of approximately 230,000 CY of material. The majority of the excavated material would be hauled to an offsite disposal area. Large volumes of riprap and gravel fill material would be brought onsite.	20-yard trucks	52
		Personal vehicles (for construction crew)	25
Concrete Trucks	Concrete lining of bypass channel would require a steady supply of concrete material. It is unknown whether a construction contractor would use a portable batch plant to supply materials onsite.	8- to 10-yard trucks	25
		Personal vehicles (for construction crew)	25
Miscellaneous	If a portable batch plan is used, it would require material to make concrete onsite. Additional miscellaneous traffic includes pile-driving equipment, construction inspectors, painters, iron workers, carpenters, repair trucks.	20-yard trucks	15
		Varying types	25
Total			**177**

Construction-related traffic impacts from construction of the proposed bypass channel are anticipated to be significant on Antelope Boulevard between Sale Lane and Belle Mill Road, although the roadway currently has a measured LOS of D in the affected area. In addition, large construction vehicles could exceed the capacity of Sale Lane. Sale Lane is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.

Impacts to traffic caused by construction of the bypass channel would be significant and unavoidable.

The impact of construction-related vehicles on Sale Lane could directly damage roadways. This would be a significant impact.

Impact 1B–TC2: Right Bank Construction. The remainder of construction traffic would be to the proposed Mill Site fish screen and conveyance facilities and right bank fish ladder. Access to the Mill Site would be via Diamond Avenue off Main Street and I-5. Currently, Diamond Avenue predominantly consists of heavy truck and commuter traffic. Existing LOS have not been measured for the Diamond Avenue/Main Street intersection. Construction of the fish screen would require a large amount of earth movement and transport, as well as commuter traffic. Table 3.14-8 shows the approximate number of daily vehicles needed for construction of the Mill Site fish screen and conveyance facilities.

Access to the right bank fish ladder would be via County Road 99 West to Altube Avenue. Traffic impacts from construction of the proposed right bank fish ladder are anticipated to be minimal on Altube Avenue. However, large construction vehicles could exceed the capacity of the road. Altube Avenue is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface. Table 3.14-9 shows the approximate number of daily vehicles needed for construction of the right bank fish ladder.

Because Diamond Avenue is currently designed to accommodate heavy commuter traffic, and construction traffic impacts would be temporary, traffic impacts to Diamond Avenue would be less than significant; therefore, no mitigation is required.

The impact of construction-related vehicles on Altube Avenue could directly damage roadways. This would be a significant impact.

Operations-related Impacts. ***No operations-related impacts are anticipated under Alternative 1B; therefore, no mitigation is required.***

2A: 2-month Improved Ladder Alternative

Construction-related Impacts.

Impact 2A–TC1: Left Bank Construction. Traffic generated during construction of the proposed project would temporarily increase traffic to Sale Lane and Antelope Boulevard/Highway 36 East. Table 3.14-6 lists the LOS and PH intersection and roadway volumes of the local roads and corresponding intersections that are expected to be traveled during construction.

Many of the vehicles associated with construction would be heavy-duty trucks, including 20-yard earth moving trucks, 10-yard concrete trucks, and commuter traffic. Table 3.14-7 shows the approximate number of daily vehicles needed for construction of the left bank fish ladder.

Traffic impacts from construction of the proposed left bank fish ladder are anticipated to be minimal on Antelope Boulevard between Sale Lane and Belle Mill Road. However, large construction vehicles could exceed the capacity of Sale Lane. Sale Lane is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.

Because the traffic increase to Antelope Boulevard/Highway 36 East would be temporary, impacts to traffic from construction of the left bank fish ladder would be less than significant; therefore, no mitigation is required.

The impact of construction-related vehicles on Sale Lane could directly damage roadways. This would be a significant impact.

Impact 2A–TC2: Right Bank Construction. The remainder of construction traffic would be to the proposed Mill Site fish screen and conveyance facilities and right bank fish ladder. Access to the Mill Site would be via Diamond Avenue off Main Street and I-5. Currently, Diamond Avenue predominantly consists of heavy truck and commuter traffic. Existing LOS have not been measured for the Diamond Avenue/Main Street intersection. Construction of the fish screen would require a large amount of earth movement and transport, as well as commuter traffic. Table 3.14-8 shows the approximate number of daily vehicles needed for construction of the Mill Site fish screen and conveyance facilities.

Access to the right bank fish ladder would be via County Road 99 West to Altube Avenue. Traffic impacts from construction of the proposed right bank fish ladder are anticipated to be minimal on Altube Avenue. However, large construction vehicles could exceed the capacity of the road. Altube Avenue is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface. Table 3.14-9 shows the approximate number of daily vehicles needed for construction of the right bank fish ladder.

Because Diamond Avenue is currently designed to accommodate heavy commuter traffic, and construction traffic impacts would be temporary, traffic impacts to Diamond Avenue would be less than significant; therefore, no mitigation is required.

The impact of construction-related vehicles on Altube Avenue could directly damage roadways. This would be a significant impact.

Operations-related Impacts. ***No operations-related impacts are anticipated under Alternative 2A; therefore, no mitigation is required.***

2B: 2-month with Existing Ladders Alternative

Construction-related Impacts.

Impact 2B–TC1: Right Bank Construction. The majority of traffic generated during construction of the proposed project would be to the proposed Mill Site fish screen and conveyance facilities. Access to the Mill Site would be via Diamond Avenue off Main Street and I-5. Currently, Diamond Avenue predominantly consists of heavy truck and commuter traffic. Existing LOS have not been measured for the Diamond Avenue/Main Street intersection. Construction of the fish screen would require a large amount of earth movement and transport, as well as commuter traffic. Traffic impacts from construction are anticipated to be minimal on Altube Avenue. However, large construction vehicles could exceed the capacity of the road. Altube Avenue is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.

Construction of the fish screen would require a large amount of earth movement and transport. Many of the vehicles associated with construction would be heavy-duty trucks, including 20-yard earth moving trucks, 10-yard concrete trucks, and commuter traffic. Table 3.14-8 shows the approximate number of daily vehicles needed for construction of the Mill Site fish screen and conveyance facilities.

Because Diamond Avenue is currently designed to accommodate heavy commuter traffic, and construction traffic impacts would be temporary, traffic impacts to Diamond Avenue would be less than significant; therefore, no mitigation is required.

The impact of construction-related vehicles on Altube Avenue could directly damage roadways. This would be a significant impact.

Operations-related Impacts. ***No operations-related impacts are anticipated under Alternative 2B; therefore, no mitigation is required.***

3: Gates-out Alternative

Construction-related Impacts

Impact 3–TC1: Fish Screen. The majority of traffic generated during construction of the proposed project would be to the proposed Mill Site fish screen and conveyance facilities. Access to the Mill Site would be via Diamond Avenue off Main Street and I-5. Currently, Diamond Avenue predominantly consists of heavy truck and commuter traffic. Existing LOS have not been measured for the Diamond Avenue/Main Street intersection. Construction of the fish screen would require a large amount of earth movement and transport, as well as commuter traffic. Traffic impacts from construction are anticipated to be minimal on Altube Avenue. However, large construction vehicles could exceed the capacity of the road. Altube Avenue is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.

Construction of the fish screen would require a large amount of earth movement and transport. Many of the vehicles associated with construction would be heavy-duty trucks, including 20-yard earth moving trucks, 10-yard concrete trucks, and commuter traffic. Table 3.14-8 shows the approximate number of daily vehicles needed for construction of the Mill Site fish screen and conveyance facilities.

Because Diamond Avenue is currently designed to accommodate heavy commuter traffic, and construction traffic impacts would be temporary, traffic impacts to Diamond Avenue would be less than significant; therefore, no mitigation is required.

The impact of construction-related vehicles on Altube Avenue could directly damage roadways. This would be a significant impact.

Operation-related Impacts. ***No operations-related impacts are anticipated under Alternative 3; therefore, no mitigation is required.***

3.14.3 Mitigation

This section discusses mitigations for each significant impact described in Environmental Consequences.

1A: 4-month Improved Ladder Alternative

Mitigation 1A–TC1. To reduce construction-related impacts on traffic and roadways, the construction contractor would be required to develop a traffic control plan (TCP) with the Tehama County Public Works, City of Red Bluff Public Works, and Caltrans, which would be subject to review by Caltrans and the Public Works Director. This plan would ensure that construction traffic is routed in a way that maintains acceptable LOS levels on all affected roadways and intersections that are currently measured and used by project-related vehicles.

The TCP would address the structural capacity of roads and bridges along routes that could be traveled by construction-related vehicles. The TCP would ensure that the structural integrity of those roads and bridges would not be damaged by construction-related vehicle trips. This mitigation would reduce the impact to a less than significant level.

Mitigation 1A–TC2. To reduce construction-related impacts on traffic and roadways, the construction contractor would be required to develop a TCP with the Tehama County Public Works, City of Red Bluff Public Works, and Caltrans, which would be subject to review by Caltrans and the Public Works Director. This plan would ensure that construction traffic is routed in a way that maintains acceptable LOS levels on all affected roadways and intersections that are currently measured and used by project-related vehicles.

The TCP would address the structural capacity of roads and bridges along routes that could be traveled by construction-related vehicles. The TCP would ensure that the structural integrity of those roads and bridges would not be damaged by construction-related vehicle trips. This mitigation would reduce the impact to a less than significant level.

1B: 4-month Bypass Alternative

Mitigation 1B–TC1. See Mitigation 1A–TC1.

Mitigation 1B–TC2. See Mitigation 1A–TC2.

2A: 2-month Improved Ladder Alternative

Mitigation 2A–TC1. See Mitigation 1A–TC1.

Mitigation 2A–TC2. See Mitigation 1A–TC2.

2B: 2-month with Existing Ladders Alternative

Mitigation 2B–TC1. See Mitigation 1A–TC2.

3: Gates-out Alternative

Mitigation 3–TC1. See Mitigation 1A–TC1.

3.15 Noise

3.15.1 Affected Environment

This section presents an evaluation of potential noise resulting from the construction and operation of proposed right bank and left bank fish ladders; fish screen, pump station, and conveyance facility; and bypass channel. An essential part of this assessment is a comparison of expected noise levels from the operation of the proposed project with acceptable noise levels presented in applicable regulations.

An essential part of this assessment is a comparison of expected noise levels from the operation of the proposed project with acceptable noise levels presented in applicable regulations.

Fundamentals of Acoustics

Airborne sound is a rapid fluctuation of air pressure above and below atmospheric pressure. Noise can be measured in several ways depending on the source of the noise, the receiver, and the reason for the noise measurement. Table 3.15-1 summarizes the technical noise terms used in this subsection.

In this section, some statistical noise levels are stated in terms of decibels on the A-weighted scale (dBA). Noise levels stated in terms of dBA reflect the response of the human ear by filtering out some of the noise in the low- and high-frequency ranges that the ear does not detect well. The A-weighted scale is used in most ordinances and standards. The equivalent sound pressure level (L_{eq}) is defined as the average noise level, on an energy basis, for a stated period of time (such as hourly).

In practice, the level of a sound source is conveniently measured using a sound-level meter that includes an electrical filter corresponding to the A-weighted curve. The sound-level meter also performs the calculations required to determine the L_{eq} for the measurement period. The following measurements relate to the noise level distribution during the measurement period. The L_{90} measurement represents the noise level exceeded during 90 percent of the measurement period. Similarly, L_{10} represents the noise level exceeded for 10 percent of the measurement period.

The effects of noise on people fall into three general categories:

- Subjective effects of annoyance, nuisance, and dissatisfaction
- Interference with such activities as speech, sleep, and learning
- Physiological effects such as startling and hearing loss

In most cases, environmental noise produces effects in the first two categories only. However, workers in industrial plants may experience noise effects in the third category. No completely satisfactory way exists to measure the subjective effects of noise, nor to measure the corresponding reactions to annoyance and dissatisfaction. This lack of a common standard is primarily a result of the wide variation in

In general, the more the level or the tonal (frequency) variations of a noise exceed the previously existing ambient noise level or tonal quality, the less acceptable the new noise will be.

individual thresholds of annoyance and habituation to noise. Thus, an important way to determine a person's subjective reaction to a new noise is to compare the noise with the existing or "ambient" environment to which that person has adapted. In general, the more the level or the tonal (frequency) variations of a noise exceed the previously existing ambient noise level or tonal quality, the less acceptable the new noise will be, as judged by the exposed individual (California Energy Commission, 2001).

TABLE 3.15-1
Definitions of Acoustical Terms

Term	Definitions
Ambient noise level	The composite of noise from all sources near and far. The normal or existing level of environmental noise at a given location.
Intrusive	Noise that intrudes over and above the existing ambient noise at a given location. The relative intrusiveness of a sound depends upon its amplitude, duration, frequency, time of occurrence, and tonal or informational content, as well as the prevailing ambient noise level.
Decibel (dB)	A unit describing the amplitude of sound, equal to 20 times the logarithm to the base 10 of the ratio of the reference pressure to the sound pressure, which is 20 micropascals (20 micronewtons per square meter).
Frequency (hertz)	The number of complete pressure fluctuations per second above and below atmospheric pressure.
A-weighted sound level (dBA)	The sound pressure level in decibels as measured on a sound-level meter using the A-weighted filter network. The A-weighted filter de-emphasizes the very low and very high frequency components of the sound in a manner similar to the frequency response of the human ear and correlates well with subjective reactions to noise. All sound levels in this report are A-weighted unless stated otherwise.
C-weighted sound level (dBC)	The sound pressure level in decibels as measured on a sound-level meter using the C-weighted filter network. The C-weighted filter does not de-emphasize the very low and very high frequency components of the sound. It is a flatter weighting where each frequency has an almost equal weighting. It is therefore more sensitive to low frequencies than the A-weighting.
Equivalent noise level (L_{eq})	The energy average A-weighted noise level during the measurement period.
Percentile noise level (L_n)	The A-weighted noise level exceeded during "n" percent of the measurement period, where "n" is a number between 0 and 100 (e.g., L_{90}).
Community noise equivalent level	The average A-weighted noise level during a 24-hour day, obtained after the addition of five decibels to sound levels from 7 p.m. to 10 p.m. and after the addition of ten decibels to sound levels between 10 p.m. and 7 a.m.
Day-night noise level (L_{dn} or DNL)	The average A-weighted noise level during a 24-hour day, obtained after the addition of 10 decibels from 10 p.m. to 7 a.m.

Sources: Beranek, 1988; California Department of Health Services, 1976.

With regard to increases in A-weighted noise level, knowledge of the following relationships will be helpful in understanding this subsection (Kryter, 1970):

- Except in carefully controlled laboratory experiments, the human ear cannot perceive a change of 1 dB.
- Outside the laboratory, a 3-dB change is considered a just-perceivable difference.
- A change in level of at least 5 dB is required before any noticeable change in community response can be expected.
- A 10-dB change is subjectively heard as approximately a doubling in loudness and will almost certainly cause an adverse community response.

Table 3.15-2 shows the relative A-weighted noise levels of common sounds measured in the environment and in industry for various sound levels.

TABLE 3.15-2
Typical Sound-level Measurements

Noise Source or Environment	A-Weighted Sound Level in Decibels	Subjective Impression
	140	
Civil defense siren (100 feet)	130	
Jet takeoff (200 feet)	120	Pain threshold
Rock music concert	110	
Pile driver (50 feet)	100	Very loud
Ambulance siren (100 feet)	—	
Boiler room	90	
Freight cars (50 feet)	—	
Printing press plant		
Pneumatic drill (50 feet)	80	
Kitchen with garbage disposal running		
Freeway (100 feet)	—	
	70	Moderately loud
Vacuum cleaner (10 feet)	60	
Data processing center		
Department store	—	
Light traffic (100 feet)	50	
Private business office		
Large transformer (200 feet)	—	
	40	Quiet
Soft whisper (5 feet)	30	
Quiet bedroom		
Recording studio	20	
	10	Hearing threshold

Sources: Peterson and Gross, 1974; California Energy Commission, 2001.

Noise Standards

The project is located within the County of Tehama. Although the County requirements would ultimately apply to the project, because of the proposed project's proximity to the City of Red Bluff boundary, the City's guidance is included for comparison purposes. The County and City General Plan Noise Elements, Desired Ambient Exterior Noise Levels, and Land Use Compatibility for Community Noise Environments are summarized in Tables 3.15-3 and 3.15-4.

TABLE 3.15-3
Tehama County General Plan Land Use Classification, Desired Ambient Exterior Noise Levels

Land Use Category	Time Zones	Desired Ambient Level, dB(A)	
Residential, rural-suburban	10 p.m. to 7 a.m.	40 – 45	- 60[a]
	7 a.m. to 10 p.m.	45 – 50	
Residential, suburban	10 p.m. to 7 a.m.	45 – 50	- 60 [a]
	7 a.m. to 10 p.m.	50 – 55	
Residential, low density urban	10 p.m. to 7 a.m.	50 – 55	- 60 [a]
	7 a.m. to 10 p.m.	55 – 60	
Residential, med./high density	10 p.m. to 7 a.m.	55 – 60	- 60 [a]
	7 a.m. to 10 p.m.	60 – 65	
Commercial zones, districts	10 p.m. to 7 a.m.	65 – 70	
	7 a.m. to 10 p.m.	70 – 75	
Industrial zones, districts	24 hours	75	

[a]Proposed where transportation noise is a significant factor (Tehama County General Plan, 1974).

TABLE 3.15-4
City of Red Bluff General Plan Land Use Classification, Land Use Compatibility for Community Noise Environments [a]

	Community Noise Exposure L_{dn}, dB			
Land Use Category	Normally Acceptable	Conditionally Acceptable	Normally Unacceptable	Conditionally Unacceptable
Residential – Low-density single family, duplex, mobile homes	50 – 60	55 – 70	70 – 75	75 – 85
Residential – Multi-family	50 – 65	60 – 70	70 – 75	75 – 85
Transient Lodging – Motels, Hotels	50 – 65	60 – 70	70 – 80	80 – 85
Schools, Libraries, Churches, Hospitals, Nursing Homes	50 – 70	60 – 70	70 – 80	80 – 85
Auditoriums, Concert Halls, Amphitheaters		50 – 70	65 – 85	
Sports Arena, Outdoor Spectator Sports		50 – 75	70 – 85	
Playgrounds, Neighborhood Parks	50 – 70		67.5 – 75	72.5 – 85
Golf Courses, Riding Stables, Water Recreation, Cemeteries	50 – 75		70 – 80	80 – 85
Office Buildings, Business Commercial and Professional	50 – 70	67.5 – 77.5	75 – 85	
Industrial, Manufacturing Utilities, Agriculture	50 – 75	70 – 80	75 – 85	

[a]City of Red Bluff, 1993.

Definitions of noise standards are provided below.

Normally Acceptable. Specified land use is satisfactory, based upon the assumption that any buildings involved are of normal conventional construction, without any special noise insulation requirements.

Conditionally Acceptable. New construction or development should be undertaken only after a detailed analysis of the noise reduction requirements is made and necessary noise insulation features included in the design. Conventional construction, but with closed windows and fresh air supply systems or air conditioning will normally suffice.

Normally Unacceptable. New construction or development should generally be discouraged. If new construction or development does proceed, a detailed analysis of the noise reduction requirements must be made and needed noise insulation features included in the design.

Clearly Unacceptable. New construction or development should generally not be undertaken.

Existing Environment

The right bank consists primarily of industrial zoned and government land. The Mill Site and Pactiv land consist primarily of industrial activities. The most predominant sources of noise include general traffic in and out of the area, I-5 traffic, and train traffic.

Current noise sources at RBDD right bank facilities include the tailwater pump station and RPP.

The remainder of the right bank facilities are on land owned by USBR, and are under United States government jurisdiction. Current noise sources at RBDD facilities include the tailwater pump station and RPP (when the diversion dam is in the gates-in position). The closest sensitive receptor to the right bank facilities is the Discovery Center on the left bank, approximately 1,000 feet from the right bank.

The most predominant sources of noise at the left bank include general traffic in and out of the Recreation Area, airplanes, and birds.

Left Bank. The left bank primarily consists of the Recreation Area. Residential areas are well over 1,000 feet north of the Recreation Area, on Sale Lane. Located in the Recreation Area, are the Discovery Center and Sycamore Grove Campground. The Discovery Center is adjacent to the Sacramento River, just north of RBDD. It is used for educational purposes, and is open Tuesday through Sunday from 11 a.m. to 4 p.m. Schools in the surrounding area make daily trips to the Discovery Center during the spring months and use the Recreation Area grounds for riparian and oak lessons, nature walks, and classes. In addition, the Discovery Center Charter School meets in the area at least 2 days a week during the school year. The camping facilities are available year-round for overnight use. The most predominant sources of noise include general traffic in and out of the Recreation Area, airplanes, and birds.

3.15.2 Environmental Consequences

Methodology

Construction activities are expected to occur primarily during daytime hours (7 a.m. to 7 p.m.).

Construction noise levels were estimated using EPA's *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances* (1971). These noise levels are estimates because the amount and type of construction equipment to be used, the location and duration of use, and the exact noise characteristics of each piece of equipment cannot be predicted with certainty. The assumptions used in this analysis are, however, typical for construction of industrial developments. Construction activities are expected to occur primarily during daytime hours (7 a.m. to 7 p.m.).

The project is wholly located within the County of Tehama; therefore, County noise standards will be used for this analysis. The Tehama County noise element of the General Plan (1974) indicates that noise is a minor problem with respect to the total planning area of approximately 5,000 square miles. Because the general planning area does not contain a rapid transit system, and airports are not used for scheduled airline purposes or large commercial jet engine aircraft, the noise element is primarily directed to highway and freeway noise. The noise element does not set standards for items such as construction noise.

Significance Criteria

Significance criteria represent the thresholds that were used to identify whether an impact would be potentially significant. These criteria are based on Appendix G of the *CEQA Guidelines* and professional judgment.

Noise impacts would be significant if they would result in any of the following:

- Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.
- Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.
- A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project.
- A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.

No Action Alternative

No changes to hydrology or surface-water management would occur. Gates would be operated during the current 4-month gates-in period. Construction activity would be limited to the installation of the fourth pump at RPP. No other construction activity would occur as a result of the No Action Alternative.

1A: 4-month Improved Ladder Alternative

Construction-related Impacts.

Impacts 1A-N1: Discovery Center and Sycamore Grove Campground. Ambient noise levels would be expected to increase during project construction. The phases associated with project construction would include clearing, excavating, installing sheet pile, and constructing the fish ladders and screens. Noise emissions from construction equipment at a distance of 50 feet from noise sources would range from between 95 to 75 dBA. Table 3.15-5 lists the estimated noise emissions of the construction equipment likely to be used for project construction.

TABLE 3.15.5
U.S. General Services Administration Maximum Noise Levels Allowable for Government Contracts

Equipment	Sound Level (dBA) at 50 feet
Earthmoving	
Front Loader	75
Backhoe	75
Dozer	75
Tractor	75
Scraper	80
Grader	75
Truck	75
Paver	80
Impact	
Pile driver	95
Jack hammer	75
Rock drill	80
Pneumatic drill	80
Materials handling	
Concrete mixer	75
Concrete pump	75
Crane	75
Derrick	75
Stationary	
Pump	75
Generator	75
Compressor	75
Other	
Saw	75
Vibrator	75

Source: Sincero and Sincero, 1996.

Impacts from construction would be less than significant because construction noise would not violate established noise standards for the County; therefore, no mitigation is required.

Operations-related Impacts.
Impact 1A–N2: Discovery Center. Operations of the proposed pump station would not significantly increase ambient noise levels at the Discovery Center; thus, the impact would be less than significant.

The impact from operations on ambient noise levels at the Discovery Center would be less than significant; therefore, no mitigation is required.

1B: 4-month Bypass Alternative

Construction-related Impacts.
Impacts 1B–N1: Discovery Center and Sycamore Grove Campground. Ambient noise levels would be expected to increase during project construction. The phases associated with project construction include clearing, excavating, installing sheet pile, and constructing the fish ladders and screens. Noise emissions from construction equipment at a distance of 50 from noise sources would range from between 95 to 75 dBA. Table 3.15-5 above lists the estimated noise emissions of the construction equipment likely to be used for project construction.

Temporary impacts would also occur as a result of construction to the use of, the Discovery Center. Schools from the area make daily trips to the center during the spring months. If construction of the bypass channel were to occur during the spring time, increased noise levels associated with construction activity might conflict with the riparian and oak lessons and hikes that occur with the daily trips.

Impacts from construction would be less than significant because construction noise would not violate established noise standards for the County; therefore, no mitigation is required.

Operations-related Impacts.
Impact 1B–N2: Discovery Center. Impacts from operations under Alternative 1B would be the same as those identified for Alternative 1A (see Impact 1A–N2).

The impact from operations on ambient noise levels at the Discovery Center would be less than significant; therefore, no mitigation is required.

2A: 2-month Improved Ladder Alternative

Construction-related Impacts.
Impacts 2A–N1: Discovery Center and Sycamore Grove Campground. Impacts from construction under Alternative 2A would be the same as those identified for Alternative 1A (see Impact 1A–N1).

Impacts from construction would be less than significant because construction noise would not violate established noise standards for the County; therefore, no mitigation is required.

Operations-related Impacts.
Impact 2A–N2: Discovery Center. Impacts from operations under Alternative 2A would be the same as those identified for Alternative 1A (see Impact 1A–N2).

2B: 2-month with Existing Ladders Alternative

Construction-related Impacts.
Impacts 2B–N1: Discovery Center and Sycamore Grove Campground. Impacts from construction under Alternative 2B would be the same as those identified for Alternative 1A (see Impact 1A–N1).

Impacts from construction would be less than significant because construction noise would not violate established noise standards for the County; therefore, no mitigation is required.

Operation-related Impacts.
Impact 2B–N2: Discovery Center. Impacts from operations under Alternative 2B would be the same as those identified for Alternative 1A (see Impact 1A–N2).

The impact from operations on ambient noise levels at the Discovery Center would be less than significant; therefore, no mitigation is required.

3: Gates-out Alternative

Construction-related Impacts.
Impact 3–N1: Discovery Center and Sycamore Grove Campground. Impacts from construction under Alternative 3 would be the same as those identified for Alternative 1A (see Impact 1A–N1).

Impacts from construction would be less than significant because construction noise would not violate established noise standards for the County; therefore, no mitigation is required.

Operation-related Impacts.
Impact 3A–N2: Discovery Center. Impacts from operations under Alternative 3 would be the same as those identified for Alternative 1A (see Impact 1A–N2).

The impact from operations on ambient noise levels at the Discovery Center would be less than significant; therefore, no mitigation is required.

3.15.3 Mitigation

Although mitigation is not required for construction-related noise, methods for reducing noise emissions are included in an effort to further reduce noise impacts, if necessary. If specific noise complaints are received during construction, one or more of the following noise mitigation measures would be implemented:

- Restrict construction within 1,000 feet of campground to daytime hours. No construction would be performed within 1,000 feet of camping facilities on Sundays, legal holidays, or between the hours of 7:00 p.m. and 7:00 a.m. on other days. Any variance from this condition must be approved by the USFS or County.
- All equipment would have sound-control devices no less effective than those provided on the original equipment. No equipment would have any unmuffled exhaust.

As directed by the USFS and/or the County, the contractor would implement appropriate noise mitigation measures, including, but not limited to, changing the location of stationary construction equipment, shutting off idling equipment, rescheduling construction activity, notifying the USFS or Discovery Center in advance of construction work, or installing acoustic barriers around stationary construction noise sources.

3.16 Environmental Justice

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," dated February 11, 1994, requires agencies to identify and address disproportionately high and adverse human health or environmental effects of their actions on minorities and low-income populations and communities, as well as the equity of the distribution of the benefits and risks of their decisions. Environmental justice addresses the fair treatment of people of all races and incomes with respect to actions affecting the environment. Fair treatment implies that no group of people should bear a disproportionate share of negative impacts from an environmental action. To comply with the environmental justice policy established by the Secretary of the Interior, all U.S. Department of Interior agencies are to identify and evaluate any anticipated effects, direct or indirect, from the proposed project, action, or decision on minority and low-income populations and communities, including the equity of the distribution of the benefits and risks. Accordingly, this section examines the anticipated impacts associated with the alternatives with respect to potentially affected minority and economically disadvantaged groups.

Environmental justice addresses the fair treatment of people of all races and incomes with respect to actions affecting the environment.

3.16.1 Affected Environment

In 1997, approximately 20 percent of the population in Tehama County was living in poverty. The 1997 median household income for Tehama County was approximately $28,000 per year, over $10,000 less than the average California income.

According to the 2000 Census, the vast majority of the population (approximately 85 percent) in Tehama County consists of white persons. The remainder of the populace comprises primarily persons of Hispanic or Latino origin. Specific demographic information about Tehama County is limited; however, the majority of the population in the County is centered around the City of Red Bluff and I-5. The large portion of the county's industry is based on agriculture. Of Tehama County's 1.9 million acres, approximately 900,000 acres (47 percent) is in farmland.

The Sacramento River flows through the center of the City of Red Bluff. When RBDD gates are in the down position, the river rises approximately 12 to 15 feet just south of the City of Red Bluff, and forms what is called Lake Red Bluff. The lake is used by local residents and visitors from out of town for recreational purposes. This provides economic benefits for the general surrounding area in the form of increased patronage of surrounding businesses. There is no known minority group that is associated disproportionately with this area. No specific group receives disproportionate economic or social benefits from the recreational uses of the lake.

Lake Red Bluff annually hosts the Nitro National drag boat races during Memorial Day weekend. The city receives beneficial economic impacts from this specific event. A large majority of the participants from this event are people who do not live in the area, and patron local motel and restaurant-type facilities.

3.16.2 Environmental Consequences

Methodology

The analysis of environmental justice impacts examined the extent to which each alternative would impact or benefit the local economy and how these impacts and benefits might affect different socioeconomic groups. Particular emphasis was given to economic, recreation, and aesthetic resources associated with Lake Red Bluff. For more information on these topics see Sections 3.5 (Recreation), 3.12 (Aesthetic and Visual Resources), and 3.10 (Socioeconomics).

No Action Alternative

No changes to hydrology or surface-water management would occur. Gates would be operated during the current 4-month gates-in period. Construction activity would be limited to the installation of the fourth pump at RPP. No other construction activity would occur as a result of the No Action Alternative.

1A: 4-month Improved Ladder Alternative

Construction-related Impacts.

Impact 1A–EJ1: City of Red Bluff Economy. Construction of the facilities would offer temporary beneficial impacts primarily to the City of Red Bluff economy. Increased patronage from construction personnel would benefit local facilities in addition to local companies that become directly involved in portions of the construction effort. No definable socioeconomic groups would be disproportionately affected by these activities.

Impacts from construction on defineable socioeconomic groups would be less than significant; therefore, no mitigation is required.

Operations-related Impacts.

Impact 1A–EJ2: Land. There would be no substantial environmental justice impacts under Alternative 1A. Currently, the land that would be developed for the proposed project is vacant.

There would be no construction- or operations-related impact on land; therefore, no mitigation is required.

1B: 4-month Bypass Alternative

Construction-related Impacts.

Impact 1B–EJ1: City of Red Bluff Economy. Construction impacts on the City's economy would be the same as those identified for Alternative 1A (see Impact 1A–EJ1).

Impacts from construction on defineable socioeconomic groups would be less than significant; therefore, no mitigation is required.

Impact 1B–EJ2: Sacramento River Discovery Center. There would be no substantial environmental justice impacts under this alternative. Currently, the land that would be developed for the pump station portion of the project is vacant; therefore, there would be no land impacts from the construction and operation of the pump station. However, the bypass channel would be constructed through an active park. The bypass would effectively cut off the Discovery Center and campground from the rest of the park, isolating them and reducing their value as recreational and educational amenities. Although this is not anticipated to have a disproportionate impact on any specific socioeconomic group, it would impact student groups that use the facility. Thus, impacts would be disproportionately borne by children.

Impacts on the Discovery Center from operations would be less than significant; therefore, no mitigation is required.

2A: 2-month Improved Ladder Alternative

Construction-related Impacts.

Impact 2A–EJ1: City of Red Bluff Economy. Construction impacts on the City's economy under Alternative 2A would be the same as those identified for Alternative 1A (see Impact 1A–EJ1).

Impacts from construction on defineable socioeconomic groups would be less than significant; therefore, no mitigation is required.

Operations-related Impacts.

Impact 2A–EJ2: Land. The main impact on land from the 2-month reduced gates alternative would be concentrated in the City of Red Bluff area. Recreational uses of the lake would be reduced as a result of reduced days that the lake would be formed. Revenue generated from the recreational uses of the lake benefit the local economy. One of the largest impacts of this alternative would be from the elimination of the drag boat event on Memorial Day weekend. This would negatively affect the local economy by significantly reducing seasonal patronage of local facilities. No specific socioeconomic group would be adversely affected more than any other group by the reduction of recreational uses on the lake. Currently, the land that would be developed for the proposed project is vacant.

There would be no construction- or operations-related impacts on land; therefore, no mitigation is required.

2B: 2-month with Existing Ladders Alternative

Construction-related Impacts.

Impact 2B–EJ1: City of Red Bluff Economy. Construction impacts on the City's economy under Alternative 2B would be the same as those identified for Alternative 1A (see Impact 1A–EJ1).

Impacts from construction on defineable socioeconomic groups would be less than significant; therefore, no mitigation is required.

Operations-related Impacts.

Impact 2B–EJ2: Land. Construction impacts on land under Alternative 2B would be the same as those identified for Alternative 2A (see Impact 2A–EJ2).

3: Gates-out Alternative

Construction-related Impacts.

Impact 3–EJ1: City of Red Bluff Economy. Impacts on the City's economy under Alternative 2A would be the same as those identified for Alternative 1A (see Impact 1A–EJ1).

Impacts from construction on defineable socioeconomic groups would be less than significant; therefore, no mitigation is required.

Operations-related Impacts.

Impact 3–EJ2: Land. The main impact from the year-round Gates-out Alternative would be concentrated in the City of Red Bluff area. Recreational uses of the lake would be reduced as a result of reduced days that the lake would be formed. Revenue generated from the recreational uses of the lake benefit the local economy. One of the largest impacts of this alternative would be from the elimination of the drag boat event on Memorial Day weekend. This would negatively affect the local economy by significantly reducing seasonal patronage of local facilities. No specific socioeconomic group would be adversely effected more than any other group by the reduction of recreational uses on the lake. Currently, the land that would be developed for the proposed project is vacant.

There would be no construction- or operations-related impacts on land; therefore, no mitigation is required.

3.16.3 Mitigation

No significant environmental justice impacts from construction or operations of the proposed alternatives have been identified; therefore no mitigation is provided.

4.0 Other Impacts and Commitments

4.1 Cumulative Conditions

Cumulative impacts are the impacts on the environment that result from the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or entity undertakes such other actions. It is recognized that the proposed action may be implemented in an interactive manner with other concurrent projects. In addition, these other projects may affect the impacts of the proposed actions. The cumulative analysis addresses impacts associated with several related actions including:

Cumulative impacts are the impacts on the environment that result from the incremental impacts of the proposed action when added to other past, present, and reasonably foreseeable future actions.

- Implementation of Central Valley Project Improvement Act (CVPIA)
- SWRCB water rights process and CALFED Bay-Delta Program
- Deregulation of electric industry in California
- Changes in demand for agricultural products
- Changes to fisheries management
- Urbanization
- Changes in demand for recreational opportunities
- Total maximum daily load (TMDL)
- Trinity River Restoration Program (EIS/EIR)
- Sacramento County municipal and industrial water supply contracts
- Sacramento River Conservation Area Program (federal, state, and local agencies and private interest groups)
- Stream restoration and other salmonid habitat improvements in the upper Sacramento River
- Integrated Storage Investigations Program, specifically the North-of-the-Delta Offstream Storage Project (Storage Project)

Many other water resource activities are planned in the State of California. These include water transfer actions and conveyance facilities in the Central Valley and central and southern coastal areas, as well as wetlands and other habitat restoration projects in the Central Valley. The cumulative impact of these programs on the proposed action have the potential to be significant. The following actions are described at length because, in some instances, they could potentially change the level of impacts to the natural or human environment from that which has been described in previous chapters. Given the uncertainty as to how, when, and to what degree each of these programs and activities will be implemented, this analysis identifies only the primary issues associated with each.

4.1.1 Implementation of Central Valley Project Improvement Act

On October 30, 1992, President Bush signed into law the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575) that included Title XXXIV, the CVPIA. The CVPIA amends the previous authorizations of CVP to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses, and fish and wildlife enhancement as a project purpose equal to power generation. The CVPIA identifies a number of specific measures to meet these new purposes and directs the Secretary of the Interior to (1) operate the CVP consistent with these purposes, (2) meet federal trust responsibilities to protect the fishery resources of affected federally recognized Indian tribes, (3) meet all requirements of federal and California law, and (4) achieve a reasonable balance among competing demands for the use of CVP water.

As stated above, the implementation of CVPIA was modeled and included in the cumulative impact analysis. The Draft CVPIA PEIS, which was released for public review in September 1997 and is available for review from USBR, evaluated:

- Anadromous Fishery Restoration Program using flow and non-flow restoration methods, fish passage improvements, and Shasta Temperature Control Device
- Reliable water supply program for refuges and wetlands
- Land retirement program for willing sellers for land with poor drainage
- CVP water contract provisions for contract renewals, water pricing, water metering/monitoring, water conservation methods, and water transfers

Implementation of the alternatives considered in the Draft CVPIA PEIS would improve fish and wildlife habitats, but would also reduce water supply reliability to CVP water service contractors.

Implementation of the alternatives considered in the Draft CVPIA PEIS would improve fish and wildlife habitats, but would also reduce water supply reliability to CVP water service contractors. Assumed increases in groundwater pumping to substitute for decreased surface-water supplies would increase the potential for ground subsidence in portions of the Central Valley, as well as increase the cost of groundwater pumping. Some of the alternatives would increase the amount of fallow land in portions of the Central Valley. The Draft CVPIA PEIS also considered acquisition of water from water rights holders for purposes of increasing in-stream fish flows. These actions could also lead to more fallowed lands. The regional economies could be impacted by primary and secondary impacts associated with the reduction in irrigated lands.

The Draft CVPIA PEIS alternatives also would modify the flow release patterns from CVP reservoirs by increasing releases in spring and reducing releases in summer. This change would reduce the amount of power generated at CVP facilities and substantially reduce the value of power produced. This would lead to an increase in power costs and a reduction in available CVP-generated power for preference power customers served by Western. In addition, changes in reservoir levels would potentially impact recreational use at various CVP and State Water Project reservoirs.

4.1.2 SWRCB Water Rights Process and CALFED Bay-Delta Program

The purpose of the SWRCB water rights process for Delta water quality and quantity is to develop a methodology to provide adequate flows to meet the new Delta water quality standards developed in 1995. The SWRCB process is evaluating several alternatives that would require different programs, including the CVP and State Water Project, to release water in a manner that would protect Delta quality. The purpose of the CALFED Bay-Delta Program is to develop a long-term solution to problems affecting the Delta. The CALFED program is evaluating alternatives to improve water quality and reliability, including several water storage options that include groundwater banking, off-stream surface-water storage, and conjunctive use, as well as several water conveyance alternatives in the Delta. Both the SWRCB and CALFED processes are intended to improve the Bay-Delta ecosystem and water quality, which would lead to increased salmon populations in Central Valley streams. Both processes may implement many of the same actions identified under the Draft CVPIA PEIS.

Both the SWRCB and CALFED processes are intended to improve the Bay-Delta ecosystem and water quality.

Under the SWRCB process, water rights holders use water in a new pattern that would reduce the need for releases by CVP and State Water Project to meet Delta water quality standards. These changes could increase water supply reliability of the CVP and State Water Project. However, the improvements to CVP water deliveries may be less than those realized by the State Water Project because of implementing CVPIA provisions, including increased in-stream flow releases in the Trinity River.

Under the CALFED process, storage, and conveyance alternatives are being evaluated that would restore water supply reliability, which was lost due to releases for habitat and water quality improvements. The new storage facilities could be designed to restore water supply reliability losses caused by increased in-stream flow releases on the

Trinity River. The Public Draft CALFED Bay-Delta PEIS/EIR was released for public review in June 1999 and is available from the CALFED Bay-Delta Program office.

The SWRCB is proceeding with a multi-phase water rights hearing on the Bay-Delta, including extension of the Bay-Delta Accord (Phase 1); the San Joaquin River Agreement (Phases 2, 2A, and 2B); the Suisun Marsh Agreement (Phase 3); Mokelumne and Sacramento River agreements (Phase 4); Compliance with the Flow-dependent Water Quality Objectives (Dissolved Oxygen and Salinity) of the Delta (Phase 5); the petition by USBR and DWR to combine their respective points of diversion in the southern Delta (Phase 6); the USBR's petition to expand and consolidate the CVP places and purposes of use (Phase 7); and Phase 8, which is intended to deal with the issues/water right holders remaining after the previous phases. Phase 8 spurred the creation of the Sacramento Valley Water Management Agreement (Agreement), in which a number of water agencies agreed to cooperate with regard to water management in the Sacramento Valley. The Agreement principles are as follows:

- The state and federal export projects will continue to meet water quality standards in the Delta until a long-term solution is negotiated as part of the Agreement
- The parties fully commit to an integrated water management and water supply development program for the Sacramento Valley that will meet 100 percent of the water needs in the Sacramento Valley, improve the water supplies and quality for other areas of the state, and provide water for environmental purposes
- The parties will work together to secure public funding for water management and supply projects in the Sacramento Valley that will help assure environmental restoration, optimize the use of existing water supplies, and enable local interests to develop additional water supplies in areas of origin
- The parties will prepare a joint work plan for short-term Sacramento Valley water management projects to implement the agreement; work plans on longer-term projects will follow
- The parties will evaluate projects and work plans against the Agreement's goals and principles on an ongoing basis to ensure that water needs are being met

The primary water management tools that will be used in implementing the Agreement are the following:

- Coordinated use of storage facilities
- Conjunctive management of surface water and groundwater

- Management and recovery of tailwater through major drains
- Water conservation
- Transfers and exchanges among Sacramento Valley water users and other water users in the state
- Increased surface storage

The action alternatives considered in the Fish Passage Improvement Project at the Red Bluff Diversion Dam could be a part of future water management actions in the Sacramento River. An example is discussed below, under the Integrated Storage Investigation.

4.1.3 Deregulation of Electric Industry in California

Assembly Bill 1890 (AB 1890) was passed in 1996 by the California State Legislature. AB 1890 provides the legal framework for a newly organized electric industry. The basic intent of AB 1890 is to increase competition and choices, lower prices, and assure the same reliable service. The power generation component of electric service was deregulated by the legislation because it is a "commodity." The two other components, transmission and distribution, will remain regulated under the legislation. A newly established Independent System Operator manages the entire long-distance transmission grid (the structure of large power lines, towers, and transformers connecting California consumers and power generation sources). An independent organization, the Power Exchange (PX), was created as a power pool for the state. Instead of selling electricity directly to customers, all investor-owned utilities in California compete to sell generation resources through PX. Other independent electricity producers may also sell through PX. The premise is that competitive bidding at PX will decrease overall generation prices.

As of March 31, 1998, customers of PG&E, San Diego Gas & Electric, and Southern California Edison Company were able to choose another electric service provider for the generation portion of their electricity. State law allows each municipally owned electric utility to decide whether or not their customers will have a choice of electric service providers.

Energy users have the opportunity to purchase electricity from independent generators that may or may not be located in the state. This will probably lead to a reduction in energy costs for large users or users that purchase electricity in a group manner. This also may lead to users transferring generators to "green power," which could include hydropower or other non-emission power sources.

The action alternatives considered as part of the Fish Passage Improvement Project could reduce the amount of CVP power available for use by preference power customers, requiring them to look to other sources of electricity to offset potential shortfalls.

The action alternatives considered as part of the Fish Passage Improvement Project could reduce the amount of CVP power available for use by preference power customers, requiring them to look to other sources of electricity to offset potential shortfalls.

Significant cumulative impacts (primarily air quality impacts) could occur if these reductions in power supplies induced increased generation from either existing gas-fired generators or the construction of new facilities. It is important to note however, that the facilities that generate power from fossil fuel sources are generally subject to stringent air quality regulation pursuant to the Federal Clean Air Act and, within California and many other states, state statutes and regulations. These regulations frequently require some sort of mitigation (e.g., offsets and/or best available control technology) to reduce the severity of localized and regional air quality impacts. Because electricity in the United States is supplied through a complicated grid covering numerous states, and because individual utilities decide where to purchase power based on a number of changing factors such as price, it is impossible at present to predict with any level of reliability where localized or regional air pollution increases might occur.

It is possible that future storage facilities considered under CALFED or other storage investigations could increase power generation. However, other aspects of the CALFED alternatives would probably reduce power availability from CVP and other hydropower facilities, and the timeframe for the construction of such facilities is speculative.

4.1.4 Changes in Demand for Agricultural Products

The analyses in this DEIS/EIR were not based on agricultural prices and costs. However, changes to prices and costs could change the crop mixes farmers choose to plant in the TCCA service area. If this occurs, then the estimated crop demands presented in this DEIS/EIR could change. Changes in demand could change the ratio of permanent to annual crops. If more permanent crops were planted, the effects of changes in annual water reliability could become more significant.

4.1.5 Changes to Fisheries Management

Artificial propagation of game fish, including West Coast anadromous fish, has been an important tool in fishery management. Numerous federal, state, and local fish hatcheries and rearing facilities have made successful and substantial contributions to the size of anadromous fish populations. Most of these programs are well funded by their respective agencies. Increased hatchery production could increase the number of salmon in the ocean, and therefore, increase the number of returning fish to all streams. However, concerns have been raised about the use of hatchery fish that are not subject to natural selection during reproduction and rearing. Hatchery-raised fish may also reduce genetic variability and lead to genetic abnormalities that are transferred to natural stock. Hatchery-raised fish may also be more subject to disease.

Salmon spend over two-thirds of their life cycle in the ocean. During this stage of their lives they are difficult to study. Both sport and commercial harvests appear to have a major role in returning fish populations. However, until harvest impacts can be discerned from natural phenomena of the sea (e.g., changes to temperature, upwellings, currents, and food availability), there is no exact method to assess the impacts of ocean fisheries. NMFS has made advances in resolving some of these issues and will continue to address these concerns, leading to improved management of ocean fisheries. All of the alternatives focus on restoring natural fish production and, thus, are projected to increase the number of fish produced and available for harvest accordingly.

4.1.6 Urbanization

California State Department of Finance, Demographic Research Unit has estimated that by the year 2020, California's population will reach 45.8 million. This is an increase of over 10 million people from the state's current population. The majority of the population increase is expected to occur in California's Central Valley. Tehama, Glenn, and Colusa counties are expected to have a greater than 50 percent population increase over the next 2 decades, and Yolo County is expected to have a 30 to 50 percent population increase.

Urbanization in these areas is expected to result in significant conversion of agricultural lands. Throughout California, it is estimated that low-density urban sprawl could consume more than 1 million acres of farmland by the year 2040. Conversion of agricultural land could be an issue faced by TCCA member districts in the foreseeable future.

Throughout California, it is estimated that low-density urban sprawl could consume more than 1 million acres of farmland by the year 2040. Conversion of agricultural land could be an issue faced by TCCA member districts in the foreseeable future.

4.1.7 Changes in Demand for Recreational Opportunities

The impact analyses in this DEIS/EIR assumed a constant demand for recreational opportunities not associated with the Sacramento River and a constant revenue source. Changes in demand for recreational opportunities are difficult to project. It is possible that an increase in Sacramento fish stocks could increase the demand for river fishing opportunities, which would offset any impacts to the loss of Lake Red Bluff. However, demand for flat-water recreation such as is provided by Lake Red Bluff could also be increasing, as evidenced by increasing gate receipts at the annual boat drag races. Forecasting the precise direction of this demand is speculative at this time.

4.1.8 Total Maximum Daily Load

The Sacramento River, from Shasta Dam to Red Bluff and from Red Bluff to Delta, is listed on the State of California's Clean Water Act Section 303(d) Impaired Water Bodies list (303(d) list). The 303(d) list describes waters that do not fully support all beneficial uses or are not meeting water quality objectives.

The Sacramento River from Shasta Dam to Red Bluff is identified as impaired by metals such as cadmium, copper, and zinc, and from Red Bluff to the Delta as impaired by diazinon and mercury. For such water bodies, the Clean Water Act requires the development of TMDL allocations for the pollutants of concern. A TMDL allocation must estimate the total maximum daily load, with seasonal variations and a margin of safety, for all suitable pollutants and thermal loads, at a level that would assure protection and propagation of a balanced indigenous population of fish, shellfish, and wildlife.

The Central Valley RWQCB completed a draft TMDL program in September 2001 for cadmium, copper, and zinc loading into the upper Sacramento River. The upper Sacramento River is designated as the area between Keswick Dam and Cottonwood Creek.

Implementation of the respective TMDLs would likely require incorporation into Central Valley RWQCB's Basin Plan through an amendment process. To date, the majority of the Sacramento River from Keswick Dam to the Delta has been incorporated into the Basin Plan. However, ultimate completion and adoption of TMDLs for the additional constituents listed in the Sacramento River could assist in the long-term improvement of water quality and fish habitat in the Sacramento River and Delta.

It is possible that TMDL management would require changes in diversions and discharges along the Sacramento River. Such changes could affect operation of any action alternative selected in this project.

4.1.9 Trinity River Restoration Program (EIS/EIR)

The Trinity River Division was authorized by Congress in part to increase the supply of water available for irrigation and other beneficial uses in the Central Valley. Facilities were authorized for control and storage of water from Clear Creek and Trinity River flows. Water from the Trinity River is stored in Trinity Lake (formerly Claire Engle Lake) behind Trinity Dam. Lewiston Dam regulates flows to meet the downstream requirement of the Trinity River basin. Water from the Trinity River is diverted through J. F. Carr and Spring Creek power plants to the Sacramento River to meet the water demands in the Sacramento Valley and other areas of CVP.

In October 2000, USFWS prepared a DEIS/EIR titled "Trinity River Mainstem Fishery Restoration Program." The DEIS/EIR addressed the environmental issues, alternatives, and impacts associated with restoration of the natural production of anadromous fish on the Trinity River mainstem downstream of Lewiston Dam.

The purpose for the project was to restore and maintain the natural production of anadromous fish on the Trinity River mainstem downstream of Lewiston Dam.

The need for this action resulted from Congress' (1) mandate that diversions of water from the Trinity River to the CVP not be detrimental to Trinity River fish and wildlife resources; (2) finding that construction and operation of the Trinity River Division has contributed to detrimental effects to habitat and has resulted in drastic reductions in anadromous fish populations; (3) finding that restoration of depleted stocks of naturally produced anadromous fish is critical to the dependent tribal, commercial, and sport fisheries; and (4) confirmation of the federal trust responsibility to protect tribal fishery resources affected by the Trinity River Division.

The ROD was signed by the Secretary of the Interior and issued in December 2000. However, the EIR was not certified by Trinity County and it is not a finalized document.

Just prior to the issuance of the ROD, the Westlands Water District, the Northern California Power Agency, and the Sacramento Municipal Utility District filed a lawsuit against the federal agencies materially involved in the decision-making process (USFWS, USBR, and NMFS). Plaintiffs claimed that they would suffer irreparable injury as a result of implementing the action set out in the ROD, specifically with regard to the effect of the ROD's flow regime on the changed condition of California's energy crisis and the effects that compliance with the biological opinions issued on the Trinity River Mainstem Fishery Restoration Program would have upon CVP operations. The court granted the plaintiffs' request by issuing a preliminary injunction that limits the increase in flows in the Trinity River that may be implemented under the ROD, but which allows all other actions outlined in the ROD to move ahead. The court suggested verbally that the range of alternatives evaluated in the EIS/EIR may not have been adequate, implying that it would be prudent for the U.S. Department of the Interior to analyze the alternative presented in outline form by the Sacramento Municipal District alternative during the public comment period.

A Supplemental Draft EIR is currently being prepared that addresses the issues discussed above, plus a number of additional actions, to ensure the adequacy of the document for CEQA, as well as NEPA, purposes.

Final resolution of the Trinity River flow decision could affect diversions and discharges in the Sacramento River and alter operations of the action alternatives.

Final resolution of the Trinity River flow decision could affect diversions and discharges in the Sacramento River and alter operations of the action alternatives.

4.1.10 Sacramento River Conservation Area Program

SB 1086, Upper Sacramento River Fisheries and Riparian Habitat Management Plan, was passed in 1986, and called for development of a management plan to protect, restore, and enhance the fish and riparian habitat and associated wildlife of the upper Sacramento River (from Keswick Dam to the confluence with the Feather River). The plan was prepared by a 25-member Advisory Council and a working-level Action Team, both representing a wide range of federal, state, and local agencies and private interests concerned with the upper Sacramento River. Following more than 50 lengthy meetings and workshops over a 2-year period, the plan was completed and submitted to the State Legislature in 1989. This was an early example of a "consensus planning" process, often cited as the "prototype" example in California.

The management plan contains a conceptual proposal for riparian habitat restoration along the main river and its tributaries, and a more specific fishery restoration plan with 20 specific actions intended to restore the salmon and steelhead fisheries of the river and its tributaries. In 1993, Secretary for Resources Wheeler reconvened the SB 1086 Council and asked it to advise state agencies responsible for implementing those portions of the CVPIA that are likely to affect the upper Sacramento River and adjacent lands and complete the earlier work concerning riparian habitat protection and management, including development of a specific implementation program.

Since 1993, the multi-agency Riparian Habitat Committee of the Advisory Council and a multitude of stakeholders have worked to develop a comprehensive Sacramento River Conservation Area Plan for the river. The group has now reached consensus and recently published the Sacramento River Conservation Area Handbook. The handbook is a creative way to provide a comprehensive understanding of the Sacramento River ecosystem for both the public and agencies managing the river. The committee has developed a Memorandum of Agreement (MOA) among these diverse groups, which is being reviewed prior to final agreement. The committee has hired a coordinator and plans to establish a non-profit organization to coordinate and manage the program.

The handbook, MOA, and non-profit organization represent the beginning of a new era in river corridor management where all stakeholders (including local, state, and federal agencies; public interest groups; and landowners) are closely involved in the planning and decision-making process, as well as the implementation.

Fish passage improvements resulting from the action alternatives considered in this DEIS/EIR could affect habitat programs in the Sacramento River Conservation Area.

4.1.11 Habitat Improvements in the Upper Sacramento River

Several large-scale habitat improvement projects have been initiated in the Sacramento Basin upstream of RBDD. These projects include:

- Battle Creek Restoration Project
- Clear Creek Restoration Project
- ACID Fish Passage Improvement Project
- Ongoing improvements to Iron Mountain Mine water quality discharges
- Temperature Control Device on Shasta Dam

All of these projects have improved habitat for salmonids in the reach of the Sacramento River between Keswick Dam and RBDD. Implementation of the action items considered in this project would increase access to habitat improvements provided under these efforts.

4.1.12 Integrated Storage Investigations Program, Specifically the North-of-the-Delta Offstream Storage Project

The Storage Project could result in offstream reservoir capacity of up to 1.9 million acre-feet north of the Bay-Delta in the northern Sacramento Valley. The concept of offstream storage north of the Delta is authorized by Proposition 204 and has been identified in concept through the CALFED 1999 Integrated Storage Investigations program. The storage concept was further developed through the CALFED 2000 Programmatic EIR/EIS (PEIR/EIS). The PEIR/EIS resulted in the adoption of a long-term comprehensive program to restore ecological health and improve water management for beneficial uses of the San Francisco Bay/Sacramento-San Joaquin River Delta system and its tributary watersheds. The Storage Project is a specific action that would implement, in part, the Preferred Programmatic Alternative adopted by the PEIR/EIS.

The objectives of the Storage Project are as directed in the PEIR/EIS ROD and consist of: enhanced water management flexibility in the Sacramento Valley, reduced water diversion on the Sacramento River during critical fish migration periods, increased reliability of supplies for a significant portion of the Sacramento Valley, storage, and operational benefits for other CALFED programs (including Delta water quality and the Environmental Water Account). Specific details on the beneficiaries of these objectives, conditions under which diversion could occur, means of conveyance, associated costs to beneficiaries for acquiring the water, and other implementation and operational details are being developed.

The Storage Project is currently undergoing separate environmental analysis and feasibility study. The lead agency for the EIR is DWR, and USBR for the EIS. Multiple federal, state, and local agencies have also been identified as participants in the analysis and study process, in addition to interested members of the public. Public scoping was conducted from October 2001 through January 2002. The DEIR/EIS and the Feasibility Study is expected to be available to the public in June 2003. It is expected that a ROD will be certified in August 2004.

Alternatives to the project, including a Preferred Alternative, are currently undergoing development. In addition to a No Project Alternative (the project would not be approved or constructed) and a No Action condition (anticipated 2020 conditions if the project is not approved), the possible project alternatives as presented in the Notice of Preparation/Notice of Intent are summarized in Table 4.1-1.

The Storage Project EIR/EIS will analyze a specific implementation action for program elements previously identified in the PEIR/EIS and therefore will tier from the programmatic document. The Storage Project EIR/EIS will specifically identify the benefits and impacts of the proposed offstream storage project and determine the significance of these impacts. Initial evaluation and scoping have identified that potential impacts may occur to environmental resources and socio-economic conditions as a result of the construction and operation of surface storage, diversions, conveyance, and groundwater storage facilities associated with the Storage Project. Table 4.1-2 summarizes the environmental resources and socioeconomic conditions that could be affected. The degree of the impact and potential mitigation if the impact is found to be significantly adverse is being developed as part of the EIR/EIS process.

4.1.13 Cumulative Impacts Analysis

The following presents a qualitative discussion of how the project alternatives may affect water management, water quality, fisheries, land use, biological resources, recreation, aesthetics, and power resources in the context of the cumulative condition. For this analysis, the CALFED PEIS/EIR best describes the applicable cumulative condition. At a programmatic level, the CALFED PEIS/EIR evaluated the environmental consequences of implementing the CALFED Program, which included the RBDD Fish Passage Improvement Project. This project-level EIS/EIR tiers from the CALFED PEIS/EIR. All of the action alternatives identified in this document were designed to meet the objectives of the CALFED Environmental Restoration Program as identified for RBDD. Fish Passage at RBDD was also identified as an item under CVPIA. Thus, this project-level EIS/EIR also tiers from the CVPIA PEIS, although functionally, the CALFED PEIS/EIR includes most of the considerations from the CVPIA PEIS Cumulative Analysis.

TABLE 4.1-1
Possible Project Alternatives for Storage Project EIR/EIS

Possible Project Alternative	Features of Alternative
Sites Reservoir Alternative	Offstream reservoir with capacity of up to 1.9 maf, approximately 10 miles west of Maxwell, California. The alternative would inundate the communities of Sites and most of Antelope Valley. The main dams would be constructed on Funks Creek and Stone Corral Creek; up to nine saddle dams would be needed. Sources and conveyance options for this alternative include: • The use of the Glenn-Colusa Irrigation District diversion and canal, either in its current capacity or in an enlarged capacity • The use of the Tehama-Colusa diversion and canal in its current capacity or enlarged • A new diversion and conveyance facility from the Sacramento River near Moutlon Weir • A new diversion and conveyance facility from the Colusa Basin Drain • Diversion and conveyance from East Park Reservoir and/or Stony Gorge Reservoir • A combination of these options A subalternative to the Sites Reservoir Alternative would include the integration of conjunctive use with operation of the reservoir.
Newville Reservoir	Offstream reservoir capacity between 1.9 to 3.0 maf, approximately 18 miles west of Orland, California. A single earth embankment on North Fork Stony Creek along with various saddle dams would create the impoundment area. Diversion and conveyance facilities would be needed because North Fork Stony Creek is a relatively small drainage area. Options being considered include: • Development of the Stony Creek Diversion to move water from Black Butte Lake to the proposed Newville Reservoir by canal to Tehenn Reservoir; Tehenn Reservoir would serve as a forebay/afterbay to the Thomes-Newville Reservoir • A direct canal from Black Butte Reservoir to Thomes-Newville Reservoir (to avoid a historical cemetery) • A diversion nearby Thomes Creek, which has an annual runoff of approximately 200 thousand acre-feet, would require a small dam and a pipeline over a ridge separating the creek from Thomas-Newville Reservoir • Diversion and conveyance facility from the Sacramento River • A combination of the above options A subalternative to the Newville Reservoir Alternative would include the integration of conjunctive use with operation of the reservoir.
Other Possible Alternatives	Other possible alternatives that meet the project objectives but would not likely require the construction and operation of the Storage Project, such as conjunctive use or enlargement of the Shasta Reservoir as identified in CALFED's Onstream Storage Enlargement (Enlarged Shasta) investigation.

TABLE 4.1-2
Potential Environmental Resources and Socioeconomic Conditions Affected by Storage Project

Land Use Planning	Transportation and Traffic[a]	Aesthetics
Geology and Soils	Biological Resources	Cultural Resources
Geomorphology	Energy and Mineral Resources	Indian Trust Assets
Air Quality	Noise	Recreation[a]
Hydrology and Water Quality	Utilities and Service Systems	Hazards and Hazardous Materials
Public Service	Environmental Justice	Mandatory Findings of Significance

[a]Note that potential impacts to transportation and traffic, and recreation resources have not been identified for groundwater storage facilities associated with the Storage Project.

The *Guide to Regulatory Compliance for Implementing CALFED Actions* (CALFED Bay-Delta Program, 2001) provides the following guidance for analyzing cumulative impacts in project-level environmental documents that tier from the CALFED PEIS/EIR.

> *Tiered EISs and/or EIRs should incorporate the relevant cumulative and long-term impact analyses of the CALFED PEIS/EIR and add detail about other "reasonably foreseeable future projects" and their contribution to cumulative impacts. Any significant environmental impacts, including contributions to a cumulative impact that the PEIS/EIR did not address, need to be evaluated in the tiered environmental reviews.*

A summary of the beneficial and potentially adverse consequences identified in the CALFED Final PEIS/EIR are outlined below in Table 4.1-3. For a more detailed description of the effects described in the CALFED PEIS/EIR, please see documentation regarding that program. Table 4.1-3 also includes a general discussion of impacts from implementation of an action alternative as described in this EIS/EIR.

TABLE 4.1-3
Summary of Beneficial and Potentially Adverse Consequences Identified in the CALFED Final PEIS/EIR

	Environmental Consequence	
Resource	**CALFED**	**RBDD**
Water Supply and Water Management	Improvements to water supply through coordinated implementation of programs, potentially including new storage programs.	Improvements to water reliability through construction of additional pumping capacity.
Water Quality	Improved water quality from reduced concentrations of contaminants. Potential decreases in water quality if increased diversions occur in the Bay-Delta.	Potential for temporary impacts to water quality during construction.
Vegetation and Wildlife	Net increases in targeted habitat types. Potential increases in habitat fragmentation resulting from storage projects.	Temporary impacts from construction. Potential increases in riparian habitat if the Gates-out Alternative is selected.
Fisheries	Improvement to ecological processes that sustain fish populations. Potential negative impacts from operations in the Bay-Delta intended to improve water delivery capacity or from changes in flow patterns resulting from new offstream storage projects.	Decreases in delays affecting upstream migrating fish in the Sacramento River. The amount of benefit would depend on the alternative selected.
Recreation	Increased open space, increased quality of recreational experience.	Loss of lake-based recreation resource at Lake Red Bluff under 2-month Gates-in and Gates-out alternatives.
Land Use (Agricultural)	Increased certainty in water deliveries to agriculture. Some conversions of prime agricultural land, and conflicts with adjacent land uses.	Increased certainty in water deliveries to agriculture.
Power Resources	Some increase in hydropower generation if new storage is constructed. Decrease in amount of energy available for non-project uses.	Decrease in the amount of energy available for non-project use if the facility is determined to be eligible for PUP.
Aesthetics	Negative visual impacts from construction and operations of new facilities.	Negative impacts to the aesthetic character of Red Bluff if the 2-month Gates-in or Gates-out alternatives are selected.

4.2 Growth-inducing Analysis

A project could result in growth-inducing impacts through several means, including the removal of obstacles to population growth, or actions that encourage and facilitate other activities beyond those proposed by the project. The availability of adequate water supplies, employment opportunities, and improved cultural amenities are examples of actions that could be growth-inducing impacts. Growth inducement may or may not be detrimental, beneficial, or significant. However, if the induced growth impacted the environment, or the ability of agencies to provide public services to an extent not envisioned due to the project actions, the impacts would be considered to be adverse.

The existing TC Canal has the physical ability to convey massive volumes of water from the Sacramento River at RBDD. Currently, the only limitation is the inability to introduce large amounts of water into the canal during winter periods. If a large pumping system were installed at RBDD, it would be more feasible to produce large amounts of water during the winter high-flow periods. This would increase amounts of water available at all times of the year.

The existence of a pump station on the TC Canal could make it more feasible to provide water to an offstream storage reservoir in the Sacramento Valley, such as Sites Reservoir, which would be located approximately 10 miles west of Maxwell, California. Construction of a new reservoir would increase the amount of water available for future use. At this point, it is unclear exactly how water in an offstream storage reservoir would be used; however, it is possible that it may be used for domestic or industrial purposes. Additional water available for domestic use would likely increase settlement and development in the Sacramento Valley. The Sacramento Valley is already experiencing high percentages of population increase, and because of that, agricultural land is being converted. Therefore, potential increase in settlement in the Sacramento Valley could have adverse impacts to the agricultural industry.

4.3 Irreversible and Irretrievable Commitments of Resources and Significant Impacts that Would Remain Unavoidable Even After Mitigation

Irreversible and irretrievable impacts are those that cause consumption of resources that cannot be restored or returned to original condition despite mitigation efforts.

Alternatives that would require construction of the fish screen and conveyance facilities, bypass channel, and fish ladders would result in use of construction materials that could not be restored (e.g., metal materials; excavation and/or importing of soils and rocks; and energy used to manufacture, transport, or construct the facilities), as well as the use of non-renewable resources (e.g., fuel) to operate construction equipment.

Those impacts that are found to be significant and unavoidable would require TCCA to prepare a Statement of Overriding Considerations per state *CEQA Guidelines* Section 15093. The following impacts are identified as potentially significant and unavoidable:

Fishery Resources. Construction-related impacts that could affect incubating embryos and adult and juvenile fish in the work area would be caused by pile-driving activities, earth movement and sheet-pile installation, dewatering activities, and sediment disturbances and turbidity.

Biological Resources. Up to 7.74 acres of riparian habitat would be removed for construction of the access bridge, conveyance pipeline, left fish ladder, and the fish screen and forebay. At least 0.05 acre of freshwater marsh habitat would be permanently lost with construction of the conveyance pipeline and access bridge. Up to 9 elderberry shrubs and three osprey nests would be removed as part of the proposed project.

Recreation. Construction of the bypass channel would result in loss of restored riparian woodlands for recreation and education/interpretive uses, and up to 10 camping spaces at the Sycamore Grove Campground. The reduced-gates and gates-out alternatives would result in a reduction in the amount of use, or complete elimination of, Lake Red Bluff. This would significantly reduce or eliminate several in-lake activities such as motor boating, jet skiing, swimming, water skiing, and boat racing.

Power. If a new pump station receives CVP-generated electricity (Project Use), it would result in a slight decrease in the amount of electricity available to preference power customers. Regardless of the ultimate source of electricity, any of the action alternatives would add to the overall electrical demand in California.

Aesthetics. The existing visual character and quality of the project vicinity would be permanently lost under all alternatives. In addition, the bypass channel would create a visual barrier from one location of the recreation area to another. This would substantially degrade the existing visual character of the Recreation Area.

Land Use. Several camping facilities at the Sycamore Grove Campground would be removed for construction of the bypass channel. The use of public and private boat docks and ramps located on the

Sacramento River would be permanently lost because of complete RBDD gates removal.

4.4 Short-term Uses of the Environment Versus Long-term Productivity

Short-term impacts are primarily related to construction activities and were identified in the impact assessment (e.g., construction-related impacts to fish). Specific resources that could be affected during implementation of many of the alternatives include fishery resources, biological resources, recreational opportunities, socioeconomics, power production and energy, aesthetics, and land use.

The proposed action does not detract from long-term environmental productivity. Rather, the action improves long-term conservation of fishery resources, enhancing the net productivity of the Sacramento River natural environment, and improves the long-term reliability of agricultural water deliveries. In turn, the action would reduce long-term productivity of the human environment with respect to socioeconomics associated with recreational activity.

4.5 Indian Trust Assets

U.S. Department of the Interior policy (Secretary of the Interior Order 3175) requires that actions under NEPA consider potential effects on Indian trust assets (ITA). It is USBR policy to carry out activities in a manner that protects ITAs and avoids adverse impacts when possible. ITAs are legal interest in property held in trust by the federal government for the benefit of Indian tribes or individuals. Examples of trust assets include lands, minerals rights, hunting and fishing rights, and water rights.

The nearest known ITA is 27 miles east of the project area. Two public domain allotments, one 80 acres and the other 4.5 acres, located along Mill Creek are the closest ITAs within the project area. These public domain allotments would not be affected by the proposed project. No other ITAs were identified within the proposed project area; therefore, there would be no impacts.

4.6 Environmental Commitments and Mitigation and Significant Unavoidable Impacts

A preliminary determination of impacts and mitigation is presented in Table 4.6-1.

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
		Fishery Resources	
Native Anadromous Salmonids, Other Native Anadromous Fish, Non-native Anadromous Fish, Resident Native and Non-native Fish			
1A: 4-month Improved Ladder	Construction: Direct and indirect losses of adult and/or juvenile fish would occur during the installation of cofferdams. Adult and juvenile fish may be stranded and lost during dewatering activities. Direct losses and adverse indirect effects would occur from sediment disturbances and turbidity.	Construction: To avoid impacts to the majority of the focus species, sheet pile installation and in-stream heavy equipment activity should occur only during July and August. Dewatered areas would be pumped down with a screened intake. Fish would be removed when water levels within the contained area are suitable for salvage.	Less than significant
1B: 4-month Bypass	Construction: Identical to 4-month Improved Ladder Alternative.	Construction: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Construction: Identical to 4-month Improved Ladder Alternative.	Construction: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Construction: Identical to 4-month Improved Ladder Alternative.	Construction: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Construction: Identical to 4-month Improved Ladder Alternative.	Construction: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
		Water Resources	
Surface-water Hydrology and Management – No negative impacts were identified.			
Surface Water Quality			
1A: 4-month Improved Ladder	Erosion: Construction of the proposed facilities would require extensive grading and excavation. Impacts to surface waters could occur during grading and excavation necessary for construction of the proposed fish ladders, as well as the proposed pumping plant and associated conveyance facilities.	Erosion: To reduce the potential for sedimentation in the Sacramento River or Red Bank Creek to a less than significant level: • Construction contractor shall obtain a General Construction Storm Water Permit, to comply with Clean Water Act Section 402(b) for construction of all facilities. As part of this permit, the contractor shall prepare a Stormwater Pollution Prevention Plan, which would include the following Best Management Practices: – All ground-disturbing activities would be limited to the dry season (mid-May through mid-October) to the extent possible – Vegetation would be left in place to the degree possible to reduce potential sedimentation – All stockpiled material would be placed so that potential erosion is minimized – Filter fabric, straw bales, and/or sediment basins would be used to reduce erosion and the potential for in-stream sedimentation	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
		– Seeding and re-vegetation would be initiated as soon as possible (timed properly to coincide with fall/winter precipitation) after construction completion	
1A: 4-month Improved Ladder	Hazardous Materials: Construction efforts would include use of materials and equipment that require hazardous materials. Examples include diesel fuel and cleaning solvents. Although not intentional, it is possible that the use and handling of hazardous materials could result in spills that could impact nearby waterways.	Hazardous Materials: Implementation of construction Best Management Practices and development of a Spill Prevention Control and Counter-measures would minimize the risk of an uncontrolled spill and consequent contamination. The identification of staging areas for fueling and main-tenance of heavy equipment would limit potential spills to designated areas where observation and cleanup could be readily accomplished. Should an oil or fuel spill occur during construction or maintenance activities, all work would cease immediately, the Central Valley RWQCB, CDFG, and USBR would be notified immediately if the quantity of the spill were above state and/or federal reporting requirements; and cleanup procedures would begin immediately.	Less than significant
1B: 4-month Bypass	Erosion and Hazardous Materials: Identical to 4-month Improved Ladder Alternative.	Erosion and Hazardous Materials: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Erosion and Hazardous Materials: Identical to 4-month Improved Ladder Alternative.	Erosion and Hazardous Materials: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Erosion and Hazardous Materials: Identical to 4-month Improved Ladder Alternative	Erosion and Hazardous Materials: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Erosion and Hazardous Materials: Identical to 4-month Improved Ladder Alternative.	Erosion and Hazardous Materials: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Groundwater Quality			
1A: 4-month Improved Ladder	Contaminants: Soil contamination at the Pactiv site represents potential impacts to local groundwater resources if contaminated soil is allowed to come in contact with groundwater as a result of project construction activities. Additionally, leaching of soluble or mobile contaminants from soil to groundwater may occur over time if contaminated soil is stockpiled onsite for a long period of time or relocated to a disposal area onsite, through infiltration and other transport processes.	Contaminants: In the event that contaminated soil is encountered, the contractor shall follow and comply with all applicable federal, state, and local regulations. Soil should be removed immediately from the project area, and taken to an appropriate disposal area. If soil should be temporarily stockpiled in the project area, an impermeable liner should be used to prevent direct contact with non-contaminated areas. The following mitigation measures would reduce the potential for con-tamination in groundwater in the proposed project area to a less than significant level: • Construction contractor shall obtain a General Construction Storm Water Permit, to comply with Clean Water Act Section 402(b) for construction of all facilities. As part of this permit, the contractor shall prepare a Stormwater Pollution Prevention Plan, which would include the following Best Management Practices:	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
		– All ground-disturbing activities would be limited to the dry season (mid-May through mid-October) to the extent possible – All stockpiled material would be placed so that potential erosion and contamination is minimized. Methods shall include, but not be limited to: – Covering the stockpile with plastic sheeting or tarps – Installing a berm around the stockpile to prevent runoff from leaving the area – Planting temporary vegetation if stockpiled material would be kept onsite for a longer duration	
1B: 4-month Bypass	Contaminants: Identical to 4-month Improved Ladder Alternative.	Contaminants: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Contaminants: Identical to 4-month Improved Ladder Alternative.	Contaminants: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Groundwater Quality: The reduced-gates alternative would result in a reduction in the amount of time Lake Red Bluff would be formed. This would ultimately change seasonal elevations of ground-water in the project area. There is some potential that additional wells may exist in the vicinity of Lake Red Bluff that have not been identified during the development of this EIR. Wells that depend on the additional groundwater recharge and head provided by Lake Red Bluff could require alternate water supplies if the gates remain out during the dry season. However, because the gates are currently out most of the year, wells in the aquifer areas influenced by the filling of Lake Red Bluff are probably already designed to supply water regardless of gate position.	Groundwater Quality: If it is determined that wells in the project area are affected by the seasonal fluctuation of Lake Red Bluff, these wells could be relocated or extended to greater depths to meet continuous or seasonal water demands.	Less than significant
2B: 2-month with Existing Ladders	Contaminants: Identical to 4-month Improved Ladder Alternative.	Contaminants: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Groundwater Quality: Identical to 2-month Improved Ladder Alternative.	Groundwater Quality: Mitigation identical to 2-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Contaminants: Identical to 4-month Improved Ladder Alternative.	Contaminants: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
3: Gates-out	Groundwater Quality: Identical to 2-month Improved Ladder Alternative.	Groundwater Quality: Mitigation identical to 2-month Improved Ladder Alternative.	Less than significant
		Biological Resources	
Wildlife Habitat			
1A: 4-month Improved Ladder	Riparian Habitat: Up to 7.74 acres of riparian habitat would be impacted, including the permanent loss of 2.18 acres for the access bridge, the conveyance pipeline, left fish ladder, and the fish screen and forebay. An additional 5.56 acres of riparian habitat could be removed for construction activities for the forebay/conveyance and left fish ladder.	Riparian Habitat: To the extent possible, areas of riparian vegetation temporarily disturbed during construction would be planted with native riparian trees and shrubs following construction. The permanent removal of riparian vegetation would be mitigated by creating riparian habitat at 3:1 ratio for the impacted acreage. TCCA and USBR would work with CDFG and USFWS to identify sites.	Less than significant
1A: 4-month Improved Ladder	Freshwater Marsh Habitat: At least 0.05 acre of freshwater marsh habitat would be permanently lost with construction of the conveyance pipeline and access bridge. An additional 0.71 acre of freshwater marsh are within the 200-foot construction area and could be impacted, for a total of 0.76 acre.	Freshwater Marsh Habitat: To the extent possible, areas of freshwater marsh temporarily disturbed during construction would be planted with native riparian trees and shrubs following construction. The permanent removal of freshwater marsh would be mitigated by creating freshwater marsh at a 3:1 ratio for the impacted acreage. TCCA and USBR would work with CDFG and USFWS to identify appropriate sites.	Less than significant
Special-status Species			
1A: 4-month Improved Ladder	VELB: VELB are entirely dependent on the elder-berry shrub. The six elderberry shrubs and/or groups of shrubs identified in the project area are within the 200-foot buffer area considered to be temporarily impacted in this analysis. Removal of the elderberry shrubs under this alternative has the potential to adversely affect the federal-listed VELB.	VELB: TCCA and USBR would attempt to avoid elderberry shrubs in locating staging areas, access roads, and other construction areas. Shrubs that can be avoided would be fenced and posted, and workers would be educated about VELB in accordance with the Conservation Guidelines. If elderberry shrubs cannot be avoided, they would be transplanted, and additional seedlings would be planted at a secure mitigation site in accordance with the Conservation Guidelines.	Less than significant
Other Special-status Species			
1A: 4-month Improved Ladder	Osprey: The three osprey nest platforms on the south side of the Sacramento River would need to be removed during construction.	Osprey: Prior to the start of construction activities the two platforms supporting osprey nesting would be removed. TCCA and USBR would work with CDFG to identify nearby location(s) to erect two platforms to serve as replacement nesting sites. The relocated platforms would be installed concurrently with the removal of the existing platforms and be completed prior to the start of the nesting season.	Less than significant
	Bats: Three bat species were visually confirmed, and a fourth species was acoustically detected in the project vicinity. Numerous roost locations were documented in the two abandoned storage buildings at the Mill Site. Evidence was found that bats roost	Bats: Exclusion and Building Removal: If the current project plans are modified and the buildings were to be demolished, impacts would be considered to be permanent and significant. Removal of the abandoned buildings would	

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	in some of the hydroelectric structures of RBDD in concrete weep holes and under metal overhangs. Several areas appeared to provide potential roosting and foraging habitat. The two abandoned buildings used as bat roosts are within the 200-foot buffer area. There are no plans to remove these buildings. No significant impacts to bats would occur. If at the time of project construction a decision is made to permanently impact the roosting habitat by removing the buildings, bats would be significantly impacted, and appropriate mitigation for exclusion of bats from the habitat would be prescribed. For detailed mitigation measures refer to Appendix F. To further ensure that there would be no significant impact, a 25-foot buffer area would be demarcated and flagged around the buildings. No construction activities would occur within this area. Construction materials would not be stored in the buildings occupied by bats, nor would workers enter the buildings. If these avoidance measures are not possible, TCCA would work with CDFG to coordinate an appropriate avoidance measure.	displace hundreds and possibly thousands of bats and be a significant loss of roosting habitat. The species currently identified are colonial, and displacement from the roosts may disrupt colony cohesion. Displaced bats may roost in exposed locations and be at increased risk of predation. If the buildings are to be removed, prior mitigation in the form of exclusion would be performed. Exclusion consists of two phases: allowing emergence while temporarily blocking re-entry for 1 week, followed by permanently blocking the roost entrances. Surveys must be conducted to ensure that all bats have exited the roost before the entrances are permanently blocked to avoid direct mortality by entombment. It is vital that exclusion only be performed in the winter (November through February) after any young of the year are mature. A qualified nuisance control professional should perform the exclusion. A qualified biologist should monitor the bats during the procedures to prevent any mortalities from bats becoming entangled in the netting, and to conduct surveys to ensure that bats are successfully excluded. With these mitigation measures, impacts to bats would be less than significant. Provision of Alternate Roosting Habitat: To mitigate for the loss of roosting habitat, provision of alternate roosting habitat in the form of offsite installation of large bat houses is recommended. Large bat houses (bat condos) may be erected. Bat condos are similar to raised wooden chicken coops with internal partitions to form roost crevices. The overall size should be 8 x 8 x 8 feet, and the width of the internal partitions should be approximately 0.75 to 1.0 inch for the free-tail bats and also 1.0 to 1.5 inches for the pallid bats. Bat condos should be oriented properly (usually southern or southeastern exposure), and the temperature regime and humidity inside the condo should replicate that found in the original roosts. It is recommended that the existing exterior wall of the abandoned storage building located at the Mill Site with the plywood-backed louvers be reconstructed in a suitable offsite location to provide for myotis bat roosting habitat. Alternately, bat houses mounted on poles may be erected that simulate the existing roost (the gap under the loose board attached to a pole). Managers at the Recreation Area are currently experimenting with bat house style and placement and may provide a cooperative bat management opportunity. With these mitigation measures, impacts to bats would be less than significant.	

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
Wildlife Habitat			
1B: 4-month Bypass	Riparian Habitat: Approximately 8.9 acres of riparian habitat would be permanently or temporarily removed. This includes the permanent loss of 2.6 acres of riparian habitat with land conversion resulting from installation of the bypass, access bride, conveyance pipeline, and the fish screen and forebay. Up to an additional 6.3 acres of riparian habitat could be removed to accommodate construction activities required for the bypass work area and the forebay/conveyance and right fish ladder work areas. These impacts would constitute a temporary impact. Following completion of construction, temporarily impacted areas of riparian habitat would be planted with native riparian tress and shrubs to restore the habitat.	Riparian Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
1B: 4-month Bypass	Freshwater Marsh Habitat: Identical to 4-month Improved Ladder Alternative.	Freshwater Marsh Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
1B: 4-month Bypass	Restored Habitat: Under this alternative, 9.76 acres of restored habitat would be impacted. Because the restored habitat was created as mitigation for removal of riparian habitat and/or oak woodland elsewhere, its removal would result in inadequate mitigation for the previous impact. Therefore, removal of restored habitat under this alternative is a significant impact.	Restored Habitat: To the extent possible, restored habitat disturbed during construction would be planted with similar trees and shrubs to restore the impacted habitat following construction. The permanent removal of restored habitat would be mitigated by creating restored habitat at a 3:1 ratio for the impacted acreage. TCCA and USBR would work with CDFG and USFWS to identify appropriate locations for restored habitat. With this mitigation, the impacts to restored habitat would be less than significant.	Less than significant
Special-status Species			
1B: 4-month Bypass	VELB: Identical to 4-month Improved Ladder Alternative.	VELB: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Other Special-status Species			
1B: 4-month Bypass	Osprey and Bats: Identical to 4-month Improved Ladder Alternative.	Osprey and Bats: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
Wildlife Habitat			
2A: 2-month Improved Ladder	Riparian Habitat: Up to 7.74 acres of riparian habitat would be impacted, including the permanent loss of 2.18 acres for the access bridge, the conveyance pipeline, left fish ladder, and the fish screen and forebay. An additional 5.56 acres of riparian habitat could be removed for construction activities for the forebay/conveyance and left fish ladder.	Riparian Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Freshwater Marsh Habitat: Identical to 4-month Improved Ladder Alternative.	Freshwater Marsh Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Special-status Species			
2A: 2-month Improved Ladder	VELB: Identical to 4-month Improved Ladder Alternative.	VELB: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Other Special-status Species			
2A: 2-month Improved Ladder	Osprey and Bats: Identical to 4-month Improved Ladder Alternative.	Osprey and Bats: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Wildlife Habitat			
2B: 2-month with Existing Ladders	Riparian Habitat: Up to 6.81 acres of riparian habitat would be impacted, including the permanent loss of 2.05 acres of riparian habitat for installation of the access bridge, the conveyance pipeline, and the fish screen and forebay, all on the south side of the river. Up to an additional 4.76 acres of riparian habitat could be temporarily removed to accommodate construction activities.	Riparian Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Freshwater Marsh Habitat: Identical to 4-month Improved Ladder Alternative.	Freshwater Marsh Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Special-status Species			
2B: 2-month with Existing Ladders	VELB: Identical to 4-month Improved Ladder Alternative	VELB: Mitigation identical to 4-month Improved Ladder Alternative.	
Other Special-status Species			
2B: 2-month with Existing Ladders	Osprey and Bats: Identical to 4-month Improved Ladder Alternative.	Osprey and Bats: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Wildlife Habitat			
3: Gates-out	Riparian Habitat: Identical to 2-month with Existing Ladders Alternative.	Riparian Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
3: Gates-out	Freshwater Marsh Habitat: Identical to 4-month Improved Ladder Alternative.	Freshwater Marsh Habitat: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Special-status Species			
3: Gates-out	VELB: Identical to 2-month with Existing Ladders Alternative.	VELB: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Other Special-status Species			
3: Gates-out	Osprey and Bats: Identical to 4-month Improved Ladder Alternative.	Osprey and Bats: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
		Recreation	
1B: 4-month Bypass	New Pump Station, Right Bank Fish Ladder, Conveyance Facility, and Bypass Channel: Temporary construction-related impacts associated with the 4-month Bypass Alternative include all impacts identified for the 4-month Improved Ladder Alternative and those noted below. Temporary impacts from construction of the bypass channel include: • Extensive excavation and earthmoving equipment within the Recreation Area. • Limited access to the Discovery Center/Charter School. • Limited access to the USFS/Sycamore Grove Campground. • The relocation of Sale Lane and the USFS/Sycamore Grove Campground Road. • Removal of approximately 10 camping spaces at the Sycamore Grove Campground. • Construction-related traffic increase on Sale Lane. • Construction of an access bridge over the bypass channel. • Construction of security fencing around the bypass channel.	New Pump Station, Right Bank Fish Ladder, Conveyance Facility, and Bypass Channel: Mitigation options to address the temporary construction-related impacts include: • Use the latest construction techniques to minimize impacts (i.e., noise blankets for pile-driving operations). • Conduct an ongoing public information campaign targeted at area recreation users. This campaign would provide information on construction activities/impacts as well as information on temporary alternate recreation sites. • Maintain temporary access for vehicles, pedestrians, and cyclists to all Recreation Area facilities throughout construction. • Maintain the existing access to the Discovery Center with the construction of a bridge. • Create a new alignment of Sale Lane to access the boat ramp south of RBDD. • Design security fencing in conjunction with USFS to be minimally intrusive in size, location, color, and materials. Alternative security measures would be investigated, such as use of rock walls or other natural materials to address safety issues around the bypass channel. • Develop 10 new campsites at an alternate location to offset those lost during construction.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
1B: 4-month Bypass	Mill Site Pumping Station and Bypass Channel: The Recreation Area would be directly impacted by the alignment of the bypass channel bisecting a portion of the property. The construction and operations of the bypass channel would result in the following: • Loss of restored riparian woodlands for recreation and educational/interpretative uses in the Recreation Area. • Creation of a physical barrier between the Sacramento River Discovery Center/Charter School, Sycamore Grove Campground, and the remainder of the Recreation Area. • Loss of 10 camping spaces at Sycamore Grove Campground. • Construction of security fencing around the bypass channel impacting the experience of visitors to the Recreation Area. • Limiting pedestrian and cycling access between the portions of the Recreation Area separated by the bypass channel to two crossings–one adjacent to a new bridge on Sale Lane crossing the channel and the second a footbridge east of the current Sycamore Grove campsites. The associated loss of riparian woodlands for educational/interpretive uses is in conflict with the Lake Red Bluff FEIS. The Lake Red Bluff FEIS stresses the importance of recreational uses in concert with the restoration of riparian habitat and public education of the area's natural environment.	Mill Site Pumping Station and Bypass Channel: Mitigation options to address the permanent operations-related impacts include: • Provide permanent access for vehicles, pedestrians, and cyclists to all Recreation Area facilities with an access bridge and pedestrian/cyclist bridge. • Incorporate extensive natural landscaping into the final construction of the bypass channel to blend the new construction with the surrounding riparian area. • Maintain the existing access to the Discovery Center with the construction of a bridge. • Create a new alignment of Sale Lane to access the boat ramp south of RBDD. • Design security fencing in conjunction with USFS to be minimally intrusive in size, location, color, and materials. Alternative security measures would be investigated, such as use of rock walls or other natural materials to address safety issues around the bypass channel. • Develop 10 new campsites at an alternate location to offset those lost during construction. • Use the bypass channel as an educational/interpretive element of the Recreation Area. This may include the development of fish-viewing locations along the bypass channel.	Significant
2A: 2-month Improved Ladder	Adjusted Gates-in Period: Recreational activities that would experience limitations associated with the loss of Lake Red Bluff for 2 additional months include: • Motor boating • Jet skiing	Adjusted Gates-in Period: Mitigation options to address the permanent operations-related impacts include: • Facilitate the development and implementation of a plan with the City of Red Bluff, Tehama County, local business organizations, appropriate permitting agencies, and local citizens groups to phase in the gate operations changes over a period of 5 years to:	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	• Swimming • Water skiing • Boat racing While recreational motor boating and jet skiing are possible on the Sacramento River during the gates-out period, the available water area is considerably reduced for the 2 additional gates-out months. Therefore, less time is available for these activities. Swimming is possible, but unlikely in the cold Sacramento River water. Boat racing and water skiing are not feasible during the additional 2-month gates-out period. The activities are lake- dependent activities and would assume the greatest impact. The Nitro National drag boat races could not be held over the Memorial Day holiday weekend.	– Allow the community to transition lake-dependent recreation activities to other opportunities. – Identify specific activities and events through the facilitated planning process with local stakeholders. • Facilitate the development of non-lake dependent recreational activities as part of the planning process mentioned above. This may include, but is not limited to: – Cooperating on the implementation of recreational trail plans. – Cooperating on the rehabilitation and expansion of existing area recreational parkland or facilities. – Facilitating identification and acquisition of future recreational parkland. • Facilitate the creation of other recreation-oriented events as part of the planning process mentioned above. This may include, but is not limited to: – Facilitating the rescheduling of the Nitro National Drag Boat Festival. – Facilitating the development of a land- or river-based festival event (river sports, and fishing) of similar size/impact as the Nitro National Drag Boat Festival.	
2B: 2-month with Existing Ladders	Adjusted Gates-in Period: Identical to 2-month Improved Ladder Alternative.	Adjusted Gates-in Period: Mitigation identical to 2-month Improved Ladder Alternative.	Significant
3: Gates-out	Gates-out Year-round: Recreational activities would experience limitations or elimination as a result of the loss of Lake Red Bluff, including: **Limited:** • Swimming • Jet skiing • Motor boating **Eliminated:** • Water skiing • Boat racing The Nitro National drag boat races, traditionally held on Lake Red Bluff over the Memorial Day holiday weekend, would not be viable at its current location.	Gates-out Year-round: Mitigation identical to 2-month Improved Ladder Alternative (Adjusted Gates-in Period).	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	The drag boat race would either move to another location or be replaced with another race in another location. Many stakeholders have expressed the importance of this high-profile event as a critical recreational opportunity in Red Bluff. The activities listed are characterized as lake-dependent activities and would assume the greatest impact as a result of this alternative.		
		Land Use	
1B: 4-month Bypass	Sycamore Grove Campground: Temporary and permanent construction-related impacts would also occur to the use of the Sycamore Grove Campground facilities located in the Recreation Area. Construction vehicles would need access to the campground area to construct the lower end of the channel. Approximately 10 camping facilities would be permanently removed as a result of construction of the bypass channel. A new road would need to be constructed to maintain access to the remaining camping facilities.	Sycamore Grove Campground: No mitigation is available.	Significant
1B: 4-month Bypass	Discovery Center: Temporary impacts would occur as a result of construction to the use of the Discovery Center. Schools from the area make daily trips to the center during the spring months. If construction of the bypass channel were to occur during the springtime, access to the valley oak, western red bud, California native sycamore, and Fremont cottonwood plantings would be blocked. This would conflict with the riparian and oak lessons and hikes that occur with the daily trips.	Discovery Center: No mitigation is available.	Significant
1B: 4-month Bypass	Recreation Area: Construction of the bypass channel does not comply with the current management direction in the Mendocino National Forest Land and Resource Management Plan.	Recreation Area: Amendment of Mendocino National Forest Land and Resource Management Plan under this alternative would reconcile management direction with the new situation, but would not avoid the impacts.	Significant
2A: 2-month Improved Ladder	Boat Docks and Ramps: Permanent impacts would occur to the use of public and private boat docks and ramps located on Sacramento River. Public and private boat docks and ramps currently existing along the shoreline of the river would not properly function when the gates are in the up position;	Boat Docks and Ramps: No mitigation is available.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	therefore, they would be unusable for 2 additional months.		
2B: 2-month with Existing Ladders	Boat Docks and Ramps: Identical to 2-month Improved Ladder Alternative.	Boat Docks and Ramps: No mitigation is available.	Significant
3: Gates-out	Boat Docks and Ramps: Permanent impacts would occur to the use of public and private boat docks and ramps located on Sacramento River. Public and private boat docks and ramps currently existing along the shoreline of the river would not properly function when the gates are in the up position. These boat docks and ramps would no longer access the lower elevations of the river in its natural, free-flowing state.	Boat Docks and Ramps: No mitigation is available.	Significant
Geology			
1A: 4-month Improved Ladder	Excavation: Approximately 800,000 CY of material would need to be excavated. Approximately 600,000 CY of this material would be stored onsite.	Excavation: To minimize soil erosion, movement of sediments, loss of topsoil, and associated water quality impacts, an approved drainage, grading, and erosion control plan would be completed prior to construction. This plan would meet all local requirements and incorporate construction site Best Management Practices to stabilize areas cleared of vegetation and soil stockpiles. Best Management Practices may include preservation of existing vegetation, silt fences, and/or straw bales. Covering soil stockpiles with mulch or matting as well as continuous maintenance of erosion control measures would be necessary. Timely re-vegetation of disturbed sites would minimize post-construction erosion impacts.	Less than significant
1B: 4-month Bypass	Excavation: Identical to 4-month Improved Ladder Alternative.	Excavation: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Excavation: Identical to 4-month Improved Ladder Alternative.	Excavation: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Excavation: Approximately 750,000 CY of material would need to be excavated to complete construction of this alternative. The primary excavation for this alternative is required to construct the Mil Site pump station and conveyance facilities. Approximately 580,000 CY of this material would remain onsite.	Excavation: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Excavation: Identical to 4-month Improved Ladder Alternative.	Excavation: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	Agricultural Resources – *No negative impacts were identified.*		
	Power Resources – *No significant impacts were identified.*		
	Socioeconomic		
3: Gates-out	Fish Runs/Spending/Property Value/Quality of Life and Community Cohesion: Although there have been gradual reductions in the amount of time the lake has been available each year, the total loss of Lake Red Bluff would have much more dramatic effects on the local economy than those in recent history. The sum total of the various impacts of this alternative would result in a significant economic impact to the local community. The potential for positive economic impact is uncertain and should be viewed as speculative at this stage of analysis. The combined impact from reduced recreation and tourism spending and from the loss of the Nitro National drag boat races is estimated to be about $4.2 million per year. This is small relative to total annual sales in Tehama County of $1.7 billion, but it would be a more substantial impact to the City of Red Bluff. One measure of this impact is the resulting loss of sales and use tax revenue of $89,000, which is about 1.9 percent of the City's total revenues from sales and use taxes. It is likely that the value of properties adjacent to the lake or with easy access to the lake would decline from the loss of the lake. While it is uncertain how large this impact would be, it is expected that, in general, the impact would be in the low end of national estimates of the value of lake views and proximity of 4 to 18 percent. This alternative would also result in a noticeable impact to local residents in a number of social aspects such a reduction in the quality of life and reduced community cohesion. Even though these impacts are hard to quantify, they are nonetheless real impacts to the local community.	Fish Runs/Spending/Property Value/Quality of Life and Community Cohesion: No mitigation is available.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
		Cultural Resources	
1A: 4-month Improved Ladder	Unidentified Cultural Resources: Construction activities include excavation and other grading and digging activities. It is possible that currently unidentified cultural resources could be discovered during these activities, and destruction of such resources could result in a significant impact.	Unidentified Cultural Resources: If during construction activities unusual amounts of non-native stone, bone, shell, or prehistoric or historic period artifacts are discovered, or if areas that contain dark-colored sediment that do not appear to have been created through natural processes are discovered, then work would cease in the immediate area of discovery, and a professionally qualified archeologist would be contacted immediately for an onsite inspection of the discovery. If any bone is uncovered that appears to be human, the Tehama County Coroner would be contacted. If the coroner determines the bone most likely represents a Native American interment, the coroner would contact the Native American Heritage Commission in Sacramento for identification of the most likely descendants.	Less than significant
1B: 4-month Bypass	Unidentified Cultural Resources: Identical to 4-month Improved Ladder Alternative.	Unidentified Cultural Resources: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Unidentified Cultural Resources: Identical to 4-month Improved Ladder Alternative.	Unidentified Cultural Resources: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Unidentified Cultural Resources: Identical to 4-month Improved Ladder Alternative.	Unidentified Cultural Resources: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Unidentified Cultural Resources: Identical to 4-month Improved Ladder Alternative.	Unidentified Cultural Resources: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
		Aesthetics	
1A: 4-month Improved Ladder	Construction Views of Mill Site: Construction of all facilities would take roughly 3 years to complete. During the construction period, viewers would experience substantially degraded sites, although some construction activity may be screened from sight by cofferdams.	Construction Views of Mill Site: No mitigation is available.	Significant
1A: 4-month Improved Ladder	Permanent Landscape Changes from Operations: Represents a substantial change to the landscape as viewed from the Sacramento River and the Recreation Area. Given the size of the new structure and the sensitivity of the viewing location, operation of these facilities represents a substantial degradation of the visual quality of the site.	Permanent Landscape Changes from Operations: To help mitigate visual impacts, a committee would be formed following selection of a Preferred Alternative to develop measures intended to help the new facility blend with the surrounding environment. Potential measures include selection of a concrete color and a finish for the fish screen panels (if available). The committee to evaluate visual resources mitigation measures would be based on the existing Stakeholder Working Group.	Significant
1B: 4-month Bypass	Construction Views of Mill Site: Identical to 4-month Improved Ladder Alternative.	Construction Views of Mill Site: No mitigation is available.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
1B: 4-month Bypass	Construction View of Bypass Channel: Construction of the bypass channel would take roughly 12 months to complete. During the construction period, viewers would experience substantially degraded views, including views of tree and other vegetation removal, channel trenching, temporary spoils piles, large construction equipment, concrete work, rock and gravel placement, and fence installation. Because of the sensitivity of the construction area and the number of recreational viewers in the immediate vicinity of construction, construction of the bypass pipeline would substantially degrade the visual character and quality of the site and its surroundings.	Construction Views of Bypass Channel: No mitigation is available.	Significant
1B: 4-month Bypass	Permanent Landscape Changes from Operations: Identical to 4-month Improved Ladder Alternative.	Permanent Landscape Changes from Operations: Mitigation identical to 4-month Improved Ladder Alternative.	Significant
1B: 4-month Bypass	Permanent Landscape Changes from Bypass Channel: The bypass channel would represent a substantial change to the landscape as viewed from the Sacramento River and throughout the Recreation Area. Regardless of the location from which the bypass channel is viewed, it represents a significant visual intrusion in the midst of a landscape that receives heavy recreational use. Because it crosses the Recreation Area, it effectively creates a visual barrier from one location of the Recreation Area to another. This visual barrier represents a substantial degradation of the existing visual character of the Recreation Area.	Permanent Landscape Changes from Bypass Channel: To help mitigate visual impacts, a committee would be formed following selection of a Preferred Alternative to develop measures intended to help the bypass channel blend with the surrounding environment. Potential measures include selection of fencing material and landscaping around the channel. The committee to evaluate visual resources mitigation measures would be based on the existing Stakeholder Working Group.	Significant
2A: 2-month Improved Ladder	Construction Views of Mill Site: Identical to 4-month Improved Ladder Alternative.	Construction Views of Mill Site: No mitigation is available.	Significant
2A: 2-month Improved Ladder	Permanent Landscape Changes from Operations: Identical to 4-month Improved Ladder Alternative.	Permanent Landscape Changes from Operations: Mitigation identical to 4-month Improved Ladder Alternative.	Significant
2A: 2-month Improved Ladder	Permanent Landscape Changes from Reduction of Gates-in Period: Under the 2-month Improved Ladder Alternative, the RBDD gates would remain in the up position for an additional 2 months, reducing the gates-in period from 4 months each year to 2 months each year.	Permanent Landscape Changes from Reduction of Gates-in Period: No mitigation is available.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	Because the quality of some of the views within the Middle River reach are considered moderate under the gates-out condition and moderately high under the gates-in condition, an increase in the gates-out condition may be considered to be a substantial degradation of the visual quality of the Middle River reach.		
2B: 2-month with Existing Ladders	Construction Views of Mill Site: Identical to 4-month Improved Ladder Alternative.	Construction Views of Mill Site: No mitigation is available.	Significant
2B: 2-month with Existing Ladders	Permanent Landscape Changes from Operations: Identical to 4-month Improved Ladder Alternative.	Permanent Landscape Changes from Operations: Mitigation is identical to 4-month Improved Ladder Alternative.	Significant
2B: 2-month with Existing Ladders	Permanent Landscape Changes from Reduction in Gates-in Time Period: Visual quality impacts are identical to 2-month Improved Ladder.	Permanent Landscape Changes from Reduction in Gates-in Time Period: No mitigation is available.	Significant
3: Gates-out	Construction Views of Mill Site: Identical to 4-month Improved Ladder Alternative.	Construction Views of Mill Site: No mitigation is available.	Significant
3: Gates-out	Permanent Landscape Changes from Operations: Identical to 4-month Improved Ladder Alternative.	Permanent Landscape Changes from Operations: Mitigation is identical to 4-month Improved Ladder Alternative.	Significant
3: Gates-out	Permanent Landscape Changes from Elimination of Gates-in Period: The impacts to visual resources resulting from the Gates-out Alternative would be the same as those described for the 2-month Improved Ladder Alternative. Because the change from the gates-in to gates-out appearance would be permanent, the ultimate effect of the Gates-out Alternative would be to have negative aesthetic effects on scenic views and to substantially degrade the existing visual character and quality of the project vicinity. This degradation would be particularly evident through the Lower River/Red Bluff Recreation Area, East Sand Slough, and the Middle River reach. Therefore, the impact of eliminating the annual gates-in period would be considered significant.	Permanent Landscape Changes from Elimination of Gates-in Period: To help mitigate visual impacts, a committee would be formed following selection of a Preferred Alternative to develop measures intended to help improve the appearance of those areas through the Sacramento River reaches that are particularly impacted by the loss of Lake Red Bluff. Potential measures include natural vegetation or landscaping through the east bank of the river adjacent to the Recreation Area and the East Sand Slough, and the creation of shallow lagoons or ponds adjacent to the Recreation Area and the City Park. The committee to evaluate visual resources mitigation measures would be based on the existing Stakeholder Working Group.	Significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
Air Quality			
1A: 4-month Improved Ladder	Fugitive Dust Emissions: During ground surface preparation, most of the PM_{10} emissions would be composed of fugitive dust. Short-term impacts with regard to dust generated during construction would be considered potentially significant because of the current exceedance of the state PM_{10} standards.	Fugitive Dust Emissions: A dust control program would be implemented with the following components: • Equipment and manual watering would be conducted on all stockpiles, dirt/gravel roads, and exposed or disturbed soil surfaces, as necessary, to reduce airborne dust. • The contractor or builder would designate a person to monitor the dust control program and to order increased watering, as necessary, to prevent transport of dust offsite. This person would respond to citizen complaints. • Dust-producing activities would be suspended when high winds create construction-induced visible dust plumes moving beyond the site in spite of dust control. • All trucks hauling soil and other loose material would be covered, or would be required to have at least 2 feet of freeboard. • All unpaved access roads and staging areas at construction sites would have soil stabilizers applied as necessary. • Streets in and adjacent to construction area would be kept swept and free of visible soil and debris. • Traffic speeds on all unpaved roads would be limited to 15 miles per hour.	Less than significant
1A: 4-month Improved Ladder	Construction Exhaust Emissions: Total daily emission levels of 777.82 lb/day of CO and 238.84 lb/day No_x would exceed their respective significance thresholds of 550 lb/day and 219 lb/day set in the National Ambient Air Quality Standards.	Construction Exhaust Emissions: An equipment control program would be implemented with the following components: • Properly maintain equipment. • Limit idling time when equipment is not in operation.	Less than significant
1B: 4-month Bypass	Fugitive Dust Emissions: Identical to 4-month Improved Ladder Alternative.	Fugitive Dust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
1B: 4-month Bypass	Construction Exhaust Emissions: Total daily emission levels of 1,147.57 lb/day of CO and 352.45 lb/day No_x would exceed their respective significance thresholds of 550 lb/day and 219 lb/day set in the National Ambient Air Quality Standards.	Construction Exhaust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2A: 2-month Improved Ladder	Fugitive Dust Emissions: Identical to 4-month Improved Ladder Alternative.	Fugitive Dust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
2A: 2-month Improved Ladder	Construction Exhaust Emissions: Total daily emission levels of 963.73 lb/day of CO and 295.96 lb/day No_x would exceed their respective. significance thresholds of 550 lb/day and 219 lb/day set in the National Ambient Air Quality Standards.	Construction Exhaust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Fugitive Dust Emissions: Identical to 4-month Improved Ladder Alternative.	Fugitive Dust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Construction Exhaust Emissions: Total daily emission levels of 876.11 lb/day of CO and 269.04 lb/day No_x would exceed their respective significance thresholds of 550 lb/day, and 219 lb/day set in the National Ambient Air Quality Standards.	Construction Exhaust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Fugitive Dust Emissions: Identical to 4-month Improved Ladder Alternative.	Fugitive Dust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Construction Exhaust Emissions: Total daily emission levels of 1,491.09 lb/day of CO and 457.99 lb/day No_x would exceed their respective significance thresholds of 550 lb/day and 219 lb/day set in the National Ambient Air Quality Standards.	Construction Exhaust Emissions: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
		Traffic and Circulation	
1A: 4-month Improved Ladder	Left and Right Banks: Large construction vehicles could exceed the capacity of Sale Lane and Altube Avenue. Neither roadway is designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.	Left and Right Banks: To reduce construction-related impacts on traffic and roadways, the construction contractor would be required to develop a traffic control plan with the Tehama County Public Works, City of Red Bluff Public Works, and California Department of Transportation, which would be subject to review by California Department of Transportation and the Public Works Director. This plan would ensure that construction traffic is routed in a way that maintains acceptable levels of service on all affected roadways and intersections that are currently measured and used by project-related vehicles. The traffic control plan would address the structural capacity of roads and bridges along routes that could be traveled by construction-related vehicles. The traffic control plan would ensure that the structural integrity of those roads and bridges would not be damaged by construction-related vehicle trips.	Less than significant
1B: 4-month Bypass	Bypass and Right Bank: Construction-related traffic impacts from construction of the proposed bypass channel are anticipated to be significant on Antelope Boulevard between Sale Lane and Belle Mill Road,	Bypass and Right Bank: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant

TABLE 4.6-1
Summary of Significant Adverse Environmental Impacts and Proposed Mitigation

DEIS/EIR Action Alternative	Description of Significant Impact	Mitigation	Level of Significance after Mitigation
	although the roadway currently has a measured level of service D in the affected area. In addition, large construction vehicles could exceed the capacity of Sale Lane and Altube Avenue. Neither roadway is designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.		
2A: 2-month Improved Ladder	Left and Right Banks: Large construction vehicles could exceed the capacity of Sale Lane and Altube Avenue. Neither roadway is designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.	Left and Right Banks: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
2B: 2-month with Existing Ladders	Right Bank: Large construction vehicles could exceed the capacity of Altube Avenue. This roadway is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.	Right Bank: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
3: Gates-out	Right Bank: Large construction vehicles could exceed the capacity of Altube Avenue. This roadway is not designed to accommodate heavy truck traffic, and daily commuting by heavy trucks could impact the road surface.	Right Bank: Mitigation identical to 4-month Improved Ladder Alternative.	Less than significant
Noise — *No significant impacts were identified*			
Environmental Justice — *No significant impacts were identified.*			

5.0 Consultation and Coordination

5.1 Lead and Participating Agencies

TCCA and USBR are co-lead agencies for this project. TCCA is the state lead agency responsible for CEQA. USBR is the federal lead agency responsible for NEPA. Throughout the project, both agencies have worked closely with a number of participating agencies, building upon a history of cooperation. Participating agencies have formally been incorporated into the project through TAG.

TAG has served as the principal resource for data and evaluation of the technical issues and alternatives. Research findings of TAG are reported to policy-level representatives of the various agencies. TAG is responsible for reviewing and commenting on technical studies and the EIS/EIR sections and approaches.

TAG includes representatives from the following agencies:

- DWR
- USBR
- NMFS
- CDFG
- USFWS
- TCCA

TAG has met regularly throughout the project and will continue to do so throughout the project, based on the need for technical evaluation of ongoing efforts. To date, TAG has met approximately twice every 3 months.

The project has also convened the SWG that served as the major mechanism for collaborative problem solving among interest groups most likely to be affected by the project. SWG has provided guidance on aspects of the alternatives and made recommendations to TAG. SWG meetings have included presentations and opportunities to discuss issues and alternatives. SWG has played a critical role in defining positions and concerns of the various interests.

The 4-month Bypass Alternative is not implementable without the Mendocino National Forest Supervisor's approval. Therefore, if the 4-month Bypass Alternative is chosen as the Preferred Alternative, the Mendocino National Forest, USFS, would play an integral role in its development in Phase III, Final Design.

5.1.1 Applicable Laws, Policies, and Programs

ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened.

Endangered Species Act. ESA, most recently amended in 1988 (16 USC 1536), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of ESA requires federal agencies to consult with USFWS and/or NMFS on any activities that may affect species listed as endangered or threatened. The federal co-leads will consult with USFWS and NMFS as appropriate.

California Endangered Species Act. The current version of CESA was enacted in 1984 and patterned after the federal ESA. CDFG is responsible for CESA implementation. CESA requires lead agencies to consult before implementing projects to ensure that any action carried out by the lead agency is not likely to jeopardize the continued existence of any listed endangered species, or destroy or adversely modify essential habitat. "Essential habitat" is defined as habitat necessary for the continued existence of the species. USBR will consult with CDFG regarding impacts to state-listed endangered and threatened species as appropriate.

Section 1601 Lake or Streambed Alteration Agreement. CDFG regulates work that will substantially affect resources associated with rivers, streams, and lakes in California, pursuant to Fish and Game Code Section 1600-1607. Authorization (known as a Lake or Streambed Alteration Agreement) is required from CDFG for projects prior to any action that substantially diverts, obstructs, or changes the natural flow of a river, stream, or lake, or uses material from a streambed. This agreement applies to any work undertaken within the 100-year floodplain of a body of water or its tributaries. The co-leads will work with CDFG to ensure that all applicable legal requirements are fulfilled.

National Historic Preservation Act. Section 106 of the National Historic Preservation Act (NHPA) requires that federal agencies evaluate the effects of federal undertakings on historical, archaeological, and cultural resources and afford the Advisory Council on Historic Preservation the opportunity to comment on the proposed undertaking. The first step in the process is to identify cultural resources included on (or eligible for inclusion on) NRHP that are located in or near the project area. The second step is to identify the possible effects of proposed actions. The lead agency must examine whether feasible alternatives exist that would avoid such effects. Compliance with NRHP is discussed in Section 3.11.

Central Valley Project. CVP was initially authorized under the Act of October 26, 1937 (50 Stat. 844,850), and re-authorized under the Act of October 17, 1940 (54 Stat. 1198, 1199). The TC Canal (at the time called the Tehama-Colusa Conduit), including all necessary dams, pumping plants, and other appurtenant works, was a unit of CVP as authorized under state law prior to 1946 (Senate Document 113 1949). Senate

Document 113 (1949), a report updating progress on CVP, proposed for further investigations the Red Bluff-Dunnigan Canal (similar in location to the TC Canal) and distribution system, with a cost of $22.4 million, length of 115 miles, and capacity of 3,000 cfs for irrigation of 100,000 acres.

Although Senate Document 113 does not mention RBDD, it does state that flow for the Red Bluff-Dunnigan Canal would be diverted by gravity from the west bank of the Sacramento River just below Red Bluff. A USFWS report included as part of Senate Document 113 recommended screens at the diversion point of the Red Bluff-Dunnigan Canal, siphons on the canal at stream crossings to reduce impacts on salmon, and estimated water requirements of 55 cfs (40,000 acre-feet/year) for the Sacramento National Wildlife Refuge.

On September 26, 1950, Public Law 839 (81st Congress; 64 Stat. 1036) was approved by President Truman, authorizing the Sacramento Canals Unit of the CVP, and re-authorizing the entire CVP, for the purposes of "…regulating flow…controlling floods, providing for the storage and for the delivery of the stored waters thereof…for the reclamation of arid lands and…other beneficial uses." The features authorized in the 1950 legislation included the "Tehama-Colusa Conduit, to be located on the west side of the Sacramento River and equipped with all necessary pumping plants…beginning at the Sacramento River near Red Bluff, California, and extending southerly through Tehama, Glenn, and Colusa Counties…"

Section 5 of the 1950 legislation provided that no expenditure of funds would be made for construction of the Sacramento canals until the Secretary of the Interior, with approval of the President, submitted to Congress a completed report finding the project feasible under provisions of the federal reclamation laws. The selected plan for development presented in that report (House Document No. 73, 83rd Congress, 1st Session) provided for the Corning Canal, the TC Canal, and RBDD.

1951 Preliminary Evaluation Report. USFWS issued a preliminary evaluation report on fish and wildlife resources affected by the Sacramento Canals Unit of the CVP. This report identified potential impacts, the need for fish passage and screening facilities, and the potential of incorporating fish spawning areas in the TC Canal as mitigation features of the canal complex. The service made an assessment of the project impacts that were based on the assumption that the RBDD gates would be open from November through March.

1963 Interim Evaluation Report. USFWS conducted further evaluation of RBDD in conjunction with USBR and CDFG. This led to an interim report that contained updated assessment of project impacts and mitigation and enhancement recommendations. The report stated that there would be a considerable loss of downstream migrant salmon without effective screening of the TC Canal intake. In addition, there would be a loss of spawning habitat as a result of inundation from the impoundment of Lake Red Bluff. As part of the proposed mitigation, a dual-purpose salmon spawning and water conveyance channel and a downstream access channel to the dual-purpose spawning channel was designed as part of the facility.

Support for fishery spawning in the canal was not shared by USBR because of the many problems and unknowns associated with the design criteria, the construction, and the O&M of said facilities.

1967 Fish and Wildlife Coordination Act Report. A Fish and Wildlife Coordination Act (FWCA) Report was submitted by USFWS to USBR on January 5, 1967. The report described RBDD and TC Canal project features, identified fish and wildlife resources, and addressed project impacts. The report also estimated that releases of water to Thomes and Stony creeks from the TC Canal would result in salmon enhancement and compensation from the proposed project. The report supported the Tehama-Colusa Fish Facilities plan for compensating salmon impacts and taking advantage of large-scale enhancement opportunities. In addition, the report listed several mitigation measures to reduce project impacts.

The Red Bluff Fish Passage Program was undertaken to develop solutions to identified causes of declines in anadromous fish populations attributed to RBDD.

1992 Appraisal Report. In 1992, together with USFWS, NMFS, and CDFG, USBR created the Red Bluff Fish Passage Program. The purpose and need for the Red Bluff Fish Passage Program was to improve fish passage capability at RBDD for salmon migrating upstream and downstream of the river. The Red Bluff Fish Passage Program was undertaken to develop solutions to identified causes of declines in anadromous fish populations attributed to RBDD. The primary objectives of the report included the following:

- Identify alternative solutions to the causes (Items 1 through 4, above)
- Perform a preliminary comparative evaluation and screening of those alternatives
- Determine if any of the alternatives are reasonable
- Identify additional analyses required to perform a final comparative evaluation of the reasonable alternatives for the ultimate purpose of selecting a preferred plan

The report summarized all of the proposed alternatives and reviewed details of the 11 selected alternatives. Additional analysis of the selected alternatives included hydrology, design and costs, economics, social factors, recreation, and water quality.

The report concluded that 4 of the 11 selected alternatives were reasonable to consider for further development.

1998 Supplemental Fish and Wildlife Coordination Act Report. The 1998 Supplemental FWCA Report was a joint effort by USBR and USFWS. The purpose of the Supplemental FWCA Report was to: (1) supplement the 1967 FWCA, (2) address previous and current impacts of RBDD and the TC Canal on fish and wildlife resources, (3) recommend interim mitigation actions that can be implemented in a short time frame, and (4) provide recommendations to identify the long-term solution at RBDD. Based on historical and current data, the Supplemental FWCA Report made several recommendations to USBR regarding short-term and long-term procedural and operational changes. These recommendations were made to further mitigate previously identified RBDD/TC Canal-specific impacts and also benefit fish and wildlife resources on a basinwide scope.

5.1.2 Required Permits

Section 1.6 presented a simplified list of permits required. Following is a more detailed discussion of permits the decisions reached on the particular requirements.

Clean Water Act, Section 404

USACE has jurisdictional authority to regulate discharge of dredging material and fill into "waters of the United States (including wetlands)" under Section 404 of the Clean Water Act. The Code of Federal Regulations (33 CFR Section 328.3) defines waters of the United States as all navigable waters, including: (1) all tidal waters; (2) all interstate waters and wetlands; (3) all other waters such as lakes, rivers, streams (perennial or intermittent), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation, or destruction of which could affect interstate commerce; (4) all impoundments of water mentioned above; (5) all tributaries to waters mentioned above; (6) territorial seas; and (7) all wetlands adjacent to waters mentioned above.

Wetlands are those areas that are inundated or saturated by surface or groundwater at a frequency and duration (wetland hydrology) sufficient to support, and that under normal circumstances do support, a prevalence of wetlands vegetation (hydrophytic vegetation) typically adapted for life in saturated soil conditions (hydric soils). Wetlands generally include swamps, marshes, bogs, and similar areas (40 CFR 230.3 and 33 CFR 328*)*. Any actions that involve the placement of fill material into jurisdictional waters and wetlands, including such activities as sidecasting material during ditch excavation or temporary fills to provide equipment access during construction, must comply with Section 404 of the Clean Water Act.

Clean Water Act, Section 10

Under Section 10 of the Rivers and Harbors Act of 1899, USACE also regulates the obstruction or alteration of navigable waters (including tidal waters) of the United States. It is important to note that Section 10 jurisdiction includes navigable waters within the mean high water line that have been diked or filled.

The 1987 Wetland Delineation Manual requires an examination for the presence of indicators of three mandatory diagnostic characteristics. These characteristics, or wetland parameters, are hydrophytic vegetation, wetland hydrology, and hydric soils. Except in limited instances, the 1987 Wetland Delineation Model requires that evidence of a minimum of one positive indicator from each of the three mandatory wetlands parameters be present for an area to be called a "wetland" under Section 404 jurisdiction.

Endangered Species Act, Section 7 Consultation

Pending biological assessment and decision on terrestrial compliance.

Federal Fish and Wildlife Coordination Act Report

Report from USFWS pending.

National Flood Insurance Program Letter of Map Revision

Pending determination on level of compliance necessary from Federal Emergency Management Agency.

California Fish and Game Streambed Alteration Agreement

Issued by CDFG.

Authorization from the Mendocino National Forest.

Pending information from USFS Mendocino National Forest.

California Endangered Species Act Consultation

Pending final determination from CDFG.

Clean Water Act Section 401 Water Quality Certification

Pending results from site investigation at the Mill Site (Central Valley RWQCB).

Federal Clean Water Act Section 402 General Construction Activity Stormwater

Pending results from site investigation at the Mill Site (Central Valley RWQCB).

Petition to Change Point of Diversion

Pending language from USBR and TCCA following selection of preferred alternatives.

State Lands Commission Public Agency Lease/Encroachment Permit

Issued by the State Lands Commission.

Encroachment Permit

Issued by the State Reclamation Board.

National Historic Preservation Act Section 106 Authorization

The proposed TCCA fish screen project requires compliance with Section 106 of NHPA of 1966. Section 106 requires that federal agencies take into account the effect of their actions on properties that may be eligible for, or listed in, the NRHP.

The Section 106 review process is implemented using a five-step procedure: (1) identification and evaluation of historic properties, (2) assessment of the effects of the undertaking on properties that are eligible for NRHP, (3) consultation with the State Historic Preservation Office and other agencies for the development of a MOA that addresses the treatment of historic properties, (4) receipt of Advisory Council on Historic Preservation comments on the MOA or results of consultation, and (5) the project implementation according to the conditions of the MOA.

The Section 106 compliance process may not consist of all the steps above, depending on the situation. For example, if identification and evaluation result in the documented conclusion that no properties included in or eligible for inclusion are present, the process ends with the identification and evaluation step. The proposed activity area incorporates two areas administered by federal agencies: USFS and USBR. Contact was made with both agencies regarding permitting requirements. An archaeological investigation prepared as part of this project concluded that no archaeological resources would be affected by implementation of the action alternatives. The results of the archaeological investigation are currently being reviewed by USBR.

Clean Air Act Permit

Issued by Tehama County Air Pollution Control District.

5.2 List of Contributing Individuals

This EIS/EIR is the product of a wide-ranging collaborative effort that has benefited from input, suggestions, and original content from the following partial list of contributing individuals:

Tehama-Colusa Canal Authority

Art Bullock, General Manager and Chief Engineer

Bob Williams, Board Chairman

Ken LaGrande, TCCA Vice Chairman, Member of Red Bluff Solutions Committee

Mike Alves, Committee Member, Member of Red Bluff Solutions Committee

Winnie Jones, Committee Member, Member of Red Bluff Solutions Committee

Mary Wells, Committee Member, Member of Red Bluff Solutions Committee

Doug Griffin, Committee Member, Member of Red Bluff Solutions Committee

U.S. Bureau of Reclamation

Max Stodolski, Chief, RBDD
Buford Holt, Shasta Dam
Sandy Borthwick, RBDD
Al Candlish, Sacramento
Alan Oto, Sacramento
Brent Mefford, Denver
Barry Mortimeyer, Sacramento
Dave Robinson, Sacramento

U.S. Fish and Wildlife Service

Jim Smith, Project Leader, Red Bluff
Tom Kisanuki, Assistant Project Leader, Red Bluff
Ryan Olah, Sacramento
Leigh Bartoo, Sacramento
Curt Brown, Red Bluff

National Marine Fisheries Service

Mike Tucker, Sacramento
John Johnson, Portland

U.S. Forest Service

Mike Van Dame, Mendocino National Forest
Fred Bell, Mendocino National Forest

California Department of Fish and Game

Harry Rectenwald, Redding
Doug Killam, Red Bluff
Steve Turek, Redding
Randy Benthin, Redding
George Heise, Sacramento

California Department of Water Resources

Ralph Hinton, Red Bluff
Dwight Russell, Chief Northern Division
Kevin Dossey, Red Bluff

CH2M HILL

Dale Cannon, Project Manager, Redding
Mike Urkov, Assistant Project Manager, Redding
Lenny Kerr, Redding
Tim Hamaker, Redding
Heather Waldrop, Redding
Ken Iceman, Redding
Andrew Sloan, Redding
Laurel Karren, Sacramento
Eric McClelland, Redding
Tim Carlton, Redding
Chris MacInnis, Redding
Beth Doolittle, Redding
Chris Proud, Oakland
Leslie Regos, Denver
Sharon Younkers, Redding
Sandi Staack, Redding
Al Farber, Redding
Jason DeGrasse, Oakland
Doug Simpson, Redding
Harold Robertson, Redding
Ron Fehringer, Redding
Kevin Butcher, Redding
Bob Gatton, Redding
Don Merideth, Redding
Vera Nevens, Redding
Alexa Stamets, Redding
Celeste Brandt, Redding
Brenda Eells, Redding
Russell Huddleston, Sacramento

Kent Ennis, Phoenix
Mike Pappalardo, Corvallis
Darryl Hayes, Sacramento
Pam Bates, Redding
Carol Hullinger, Redding
Bob Lawson, Redding
Dan Pitzler, Seattle
Sandy Taylor, Sacramento
Peter Griggs, Redding
Sara Monteith, Redding
Jan Loring, Redding
Howard Wilson, Redding
Heather Rectenwald, Redding
Matt Franck, Sacramento
Marjorie Eisert, Sacramento
Suzanne Moreland, Redding
Tim Hill, Redding
Cheri Randall, Redding
Katrina Reed, Redding
Jeff Morris, Redding
Sam Moss, Redding
Jeff Perry, Redding
Tom Priestly, Oakland
Mike Ostrom, Redding
Calvin Sugg, Redding
Nancy Horrick, Redding
Elisabeth Pierce, Redding
Mary Hall, Redding
Brad Shearer, Redding
Kevin Porter, Redding
Gary Brown, Denver
Bruce Straughan, Denver
Curt Bagnall, Portland
Mary Coe, Redding
Ted Stavedahl, Redding
Heather Johnson, Sacramento

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Attachment A
Acronyms and Abbreviations
and Glossary of Terms

ATTACHMENT A

Acronyms and Abbreviations and Glossary of Terms

Acronyms and Abbreviations

AB	Assembly Bill
ACID	Anderson-Cottonwood Irrigation District
ADT	average daily trip
Agreement	Sacramento Valley Water Management Agreement
Alternative 1A	4-month Improved Ladder Alternative
Alternative 1B	4-month Bypass Alternative
Alternative 2B	2-month with Existing Ladders Alternative
Alternative 3	Gates-out Alternative
Alternative2A	2-month Improved Ladder Alternative
AWS	Auxiliary Water System
Basin Plan	Regional Water Quality Control Board Basin Plan
BMP	Best Management Practices
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CHO	Constant Head Orifice
City	City of Red Bluff
CNDDB	California Natural Diversity Data Base
CNPS	California Native Plant Society
CO	carbon dioxide
COD	chemical oxygen demand
County	Tehama County
CVP	Central Valley Project

CVPIA	Central Valley Project Improvement Act
CY	cubic yard
dB	decibel
dBA	decibels on the A-weighted scale
DEIS/EIR	Draft Environmental Impact Statement/Environmental Impact Report
Delta	Sacramento-San Joaquin River Delta
Discovery Center	Sacramento River Discovery Center
DO	dissolved oxygen
DOC	dissolved organic carbon
DWR	California Department of Water Resources
EDR	Environmental Data Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	federal Endangered Species Act
ESU	Evolutionary Significant Unit
FEIS/EIR	Final Environmental Impact Statement/Environmental Impact Report
fps	feet per second
FWCA	Fish and Wildlife Coordination Act
gpm	gallons per minute
I-5	Interstate 5
I-O	input-output
IOU	investor-owned utilities
ITA	Indian trust asset
kW	kilowatt
kWh	kilowatt-hour
L_{10}	noise level exceeded for 10 percent of the measurement period
L_{90}	noise level exceeded during 90 percent of the measurement period
lb/day	pounds per day

L_{eq}	sound pressure level
LF	linear feet
LOS	level of service
maf	million acre-feet
MCL	Maximum Contaminant Limit
µg/L	micrograms per liter
mg/L	milligrams per liter
$\mu g/m^3$	micrograms per cubic meter
MIREC	Micro-Implan Recreation Economic Impact Estimation System
MOA	Memorandum of Agreement
MW	Monitoring Well
MWh	megawatt-hour
NAO	other native anadromous
NAS	native anadromous salmonid
NEC	not elsewhere classified
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NNA	non-native anadromous
NO_x	nitrogen oxide
NRHP	National Register of Historic Places
O&M	operations and maintenance
Pactiv	Pactiv Corporation
PEIS/EIR	Programmatic Environmental Impact Statement/Environmental Impact Report
PG&E	Pacific Gas and Electric Company
PH	peak hour
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
ppm	parts per million

PRG	Preliminary Remediation Goal
PUP	Project Use Power
PX	Power Exchange
RBDD	Red Bluff Diversion Dam
Recreation Area	Lake Red Bluff Recreation Area
RM	River Mile
RN	resident native
RNN	resident non-native
ROD	Record of Decision
ROG	reactive organic gas
RPP	Research Pumping Plant
RWQCB	Regional Water Quality Control Board
SO_2	sulfur dioxide
SO_x	sulfur oxide
Storage Project	North-of-the-Delta Offstream Storage Project
SWG	Stakeholder Working Group
SWPPP	Stormwater Pollution Prevention Plan
SWRCB	State Water Resources Control Board
TAG	Technical Advisory Group
TC	Tehama-Colusa
TCCA Board	Tehama-Colusa Canal Authority Board of Directors
TCCA	Tehama-Colusa Canal Authority
TCP	Traffic Control Plan
TDS	total dissolved solids
TMDL	total maximum daily load
TOC	total organic carbon
TOG	total organic gas
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation

USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VC	volume to capacity
VELB	valley elderberry longhorn beetle
Western	Western Area Power Administration

Glossary of Terms

Acre-feet—The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 1,233.5 cubic meters (43,560 cubic feet).

Air quality—Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Affected environment—Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Anadromous—In general, this term is used to refer to fish, such as salmon or steelhead, that hatch in freshwater, migrate to and mature in the ocean, and return to freshwater as adults to spawn. Section 3403(a) of the Central Valley Project Improvement Act (CVPIA) defines anadromous as "those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin Rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean.

Anadromous Fishery Restoration Program—A program authorized by the Central Valley Project Improvement Act to address anadromous fish resource issues in Central Valley streams that are tributary to the Delta. This program is lead by the U.S. Fish and Wildlife Service.

Aquatic—Living or growing in or on the water.

Aquifer—An underground geologic formation in which water can be stored.

Artificial propagation/production—As defined in Section 3403(b) of the CVPIA, "spawning, incubating, hatching, and rearing fish in a hatchery or other facility constructed for fish production."

Beneficial use—Those uses of water as defined in the State of California Water Code (Chapter 10 of Part 2 of Division 2), including but not limited to agricultural, domestic, municipal, industrial, power generation, fish and wildlife, recreation, and mining. Such use is beneficial to the extent of being consistent with Congressional directives concerning the project.

Biological Opinion—Document issues under the authority of the Endangered Species Act stating U.S. Fish and Wildlife Service and/or the National Marine Fisheries Service finding as to whether a federal action I likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat.

CALFED—Interagency effort involving state and federal agencies with management and regulatory responsibilities in the Bay-Delta.

Candidate species—As defined by the U.S. Fish and Wildlife Service, candidate species are plant or animal species not yet proposed for listing as threatened or endangered under the federal Endangered Species Act, but for which there is sufficient data to warrant listing (formerly designated Category 1 candidate species). As defined by the National Marine

Fisheries Service, candidate species are any species being considered for listing as endangered or threatened (including those with insufficient data), but not yet the subject of a proposed rule.

Central Valley Project— As defined by Section 3403(d) of the Central Valley Project Improvement Act, "All Federal reclamation project located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto,…"

Channel—Natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Cooperating agency—This is defined as a federal agency that (1) has study area-wide jurisdiction by law or special expertise on environmental quality issues; (2) has been invited by the lead agency to participate as a cooperating agency; or (3) has made a commitment of resources (staff and/or funds) for regular attendance at meetings, participation in work-groups, or in actual preparation of portions of a National Environmental Policy Act (NEPA) document.

Cubic feet per second— A measure of the volume rate of water movement. As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 cubic meters per second (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

Delivery—In general, deliveries are water diversions from CVP facilities to CVP contractors at the division level. This may be different than the amount delivered to irrigated land.

Delta—A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, delta usually refers to the delta formed by the Sacramento and San Joaquin Rivers.

Dissolved oxygen—A commonly employed measure of water quality.

Endangered species— Any species designated under the Endangered Species Act or California Endangered Species Act that is in danger of extinction throughout all, or a significant portion, of its range. Federally endangered species are under the jurisdiction of the U.S. Fish and Wildlife Service or National Marine Fisheries Service. State endangered species are under the jurisdiction of the California Department of Fish and Game.

Entrainment—The drawing of fish and other aquatic organisms into water diversions.

Environmental consequences— The impacts to the affected environment that are expected from implementation of a given alternative.

Escapement—For purposes of this report, escapement (sometimes referred to as inriver spawner escapement) is the number of salmon that "escape" harvest in ocean and inriver fisheries each year and return to a stream to spawn.

Estuary—A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Existing Conditions—Existing conditions, sometimes referred to as “1995 existing conditions” is required by CEQA for purposes of comparing future conditions under the Preferred Alternative to current conditions. For purposes of this DEIS/EIR, existing conditions typically consists of (1) a PROSIM simulation of water impacts and conditions based on 1995 assumptions and operating criteria, or (2) the best available data that represents 1995 conditions (e.g., Census Bureau economic data).

Federal Species of Concern—Species that may warrant consideration for listing as endangered or threatened; however, the data is inconclusive. Formerly designated Category 2 candidate species pursuant to the federal Endangered Species Act, the species were re-categorized in 1996. The species have no legal protection under the federal Endangered Species Act.

Fish ladders—A series of ascending pools constructed to enable salmon or other fish to swim upstream around or over a dam.

Fish population—The total number of fish alive for a defined life stage and/or area.

Fishery—The industry or occupation of catching fish, and a place where such fish are caught.

Flow—The volume of water passing a given point per unit of time.

> ***Fishery flow***—The total volume of water and its release pattern that are scheduled to maintain fish populations.
>
> ***Instream flow requirements***—Amount of water flowing through a stream course needed to sustain instream values.
>
> ***Peak flow***—Maximum instantaneous flow.

Fry—Life stage of fish between the egg and fingerling stages. For salmon this typically refers to fish less than 50 millimeters long.

General Plan—A comprehensive, long-term plan for the physical development of both a city and any land outside the city’s boundary. Under state planning law, each city in California must adopt a general plan. The plan must consist of a statement of development policies and include diagrams and text setting forth objectives, principles, standards, and land use plan proposals. The plan must consist of seven mandatory elements and an optional element that the city may choose to adopt. The seven mandatory elements include the following: land use, circulation, housing, conservation, open space, noise, and safety.

Groundwater—Water stored underground in pore spaces between rocks and in other alluvial materials and in fractures of hard rock occurring in the saturated zone.

Groundwater level—Refers to the water level in a well and is defined as a measure of the hydraulic head in the aquifer system.

Habitat—Area where a plant or animal lives.

Irrigation water—Water made available from the project, which is used primarily in the production of agricultural crops or livestock, including domestic use incidental thereto, and the watering of livestock.

Juvenile—Young fish that are no longer fry, but have not reached reproductive age.

Mitigation—One or all of the following: (1) avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments. National Environmental Policy Act requires agencies to identify feasible mitigation, whereas California Environmental Quality Act require agencies to implement feasible mitigation.

Preference power customers—Publicly owned systems and non-profit cooperatives that, by law, have preference over investor-owned systems for purchase of power from federal projects.

Project Use Power—is electrical power as defined by Reclamation law and / or that is used to operate the Central Valley Project or the Washoe Project facilities. PUP can also be provided to Reclamation-designated facilities that meet authorized purposes under Reclamation law, to meet statutory and contractual obligations, and in water rights settlements. Other PUP uses include station-service requirements at Reclamation dams, power plants, pumping plants, and designated loads directly associated with the Federal project. PUP is only available to those Reclamation project features in which the United States retains ownership.

Public involvement—Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any Environmental Impact Statement.

Riparian—The banks of a natural course of water. The soil moisture along such areas typically exceeds that found farther from the water course.

> ***Early-successional riparian community—***A group of plant recently established or beginning to establish in an area.

Recreation Visitor Day—A measure of the actual user day for a particular recreational activity.

Reservoir—Artificially impounded body of water.

Responsible agency—As defined by CEQA, a public agency, other than the lead agency, which has responsibility for carrying out or approving the project .

Riparian—The banks of a natural course of water (e.g., river, stream). The soil moisture along such areas typically exceeds that found farther from the water course.

Salmonids—Fish of the family *Salmonidae*, such as salmon and trout.

Smolt—A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spawning—The releasing and fertilizing of eggs by fish.

Special-status species—Species that are listed, proposed, or candidates for listing as endangered or threatened pursuant to federal or state endangered species acts, federal Species of Concern, Forest Service Sensitive Species, California Species of Special Concern, California Fully Protected Species, and plant species on list 1 through 4 maintained by the California Native Plant Society.

Spillway—Overflow structure of a dam.

Threatened species—Any species designated under the federal Endangered Species Act or California Endangered Species Act that is likely to become an endangered species within the foreseeable future throughout all, or a significant portion, of its range. Federally threatened species are under the jurisdiction of the U.S. Fish and Wildlife Service or National Marine Fisheries Service. State-threatened species are under the jurisdiction of the California Department of Fish and Game.

Tributary—A stream feeding into a larger stream or a lake.

Wetlands—An area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

Wildlife habitat—An area that provides a water supply and vegetative habitat for wildlife.

Appendix A
Alternatives, Fish Passage Benefit, and Agricultural Water Supply Benefit Analysis

Alternatives Analysis

Introduction

Several alternatives for the Environmental Impact Statement/Environmental Impact Report (EIS/EIR), including the No Action Alternative, were developed as part of the effort to improve fish passage and water reliability at Red Bluff Diversion Dam (RBDD). This report outlines the development and assessment of the project alternatives identified as part of the fish passage improvement project at RBDD. As a result of this effort, the following alternatives are being carried through a thorough analysis via the EIS/EIR process. Three gate operation scenarios generally describe alternatives: (1) a 4-month gates-in operation, (2) a 2-month gates-in operation, and (3) a 0-month gates-in operation. It is worth noting that this project uses a unique nomenclature for the alternatives. Gates-in refers to dam operations where the dam's gates are lowered into the Sacramento River, thus allowing gravity diversion of water into the Tehama-Colusa Canal (TC Canal). In contrast, gates-out refers to dam operations where the gates are in the raised position, precluding diversion of water by gravity except under extremely high flows.

- 1A: 4-month Improved Ladder Alternative. This alternative would continue the current 4-month gate operation (May 15 through September 14), improve the fish ladders (total fish passage flow approximately 1,600 cubic feet per second [cfs]), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 1,700 cfs.
- 1B: 4-month Bypass Alternative. This alternative would continue the current 4-month gate operation (May 15 through September 14). Fish passage would improve with construction of a 1,000-cfs bypass channel around the left abutment of the dam to provide passage for adult fish. The existing left bank ladder would remain in operation, but the right bank ladder would be improved to increase the amount of attraction flow. Total flow for fish passage would be 1,800 cfs. A conventional pump station would be constructed immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 1,700 cfs.
- 2A: 2-month Improved Ladder Alternative. This alternative would decrease the gates-in operation to 2 months (July 1 through August 31), improve fish ladders (total fish passage flow approximately 1,600 cfs), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,000 cfs.
- 2B: 2-month with Existing Ladders Alternative. This alternative would decrease the gates-in operation to 2 months (July 1 through August 31), improve the fish ladders (total fish passage flow approximately 1,600 cfs), and require a conventional pump station located immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,000 cfs.

- 3: Gates-out Alternative. Gates would remain out of the water year-round. Fish ladders would not be needed because there is no impedance of passage when the gates are out of the water. A conventional pump station would be constructed immediately north of Red Bank Creek with a flat-plate fish screen. Total pumping capacity would be 2,500 cfs.

These alternatives were developed from an existing knowledge base built from decades of study at RBDD. The fish passage project considered hundreds of alternatives previously proposed to address the conflicting uses of RBDD. The broad range of alternatives were considered against the purpose of the project and a set of secondary screening criteria which resulted in four of the five alternatives described above. The fifth alternative, Alternative 1B, was added following a number of public comments requesting its inclusion.

These alternatives were developed and considered in a manner consistent with National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA). Additionally, net benefits of the alternatives were calculated in an effort to determine cost-effectiveness. This economic analysis was based on the requirements of the Principles and Guidelines published by the U.S. Water Resources Council in 1983.

Primary Screening Criteria

During the initial phases of the project, a two-fold project purpose was carefully crafted to respond to the need for the project. The resultant purpose and need statement is a requirement of the NEPA process and served as an initial screen for previously developed alternatives. The purpose of the project is as follows:

- Substantially improve the long-term ability to reliably pass anadromous fish and other species of concern, both upstream and downstream, past RBDD.
- Substantially improve the long-term ability to reliably and cost-effectively provide water supplies into the Tehama-Colusa Canal Authority (TCCA) systems.

The need for the project is driven by the continued and well-documented fish passage and agricultural water diversion reliability problems associated with the operation of RBDD. Even with three separate fish ladders in operation, RBDD acts as an impediment to fish passage during the gates-in period each year. Impacts to fish passage have been eliminated during the 8-month gates-out period, but continue to occur during the 4-month gates-in period. The 4-month window of operation has constrained operation of the dam for diversion purposes to the point that TCCA cannot meet the water needs of its customers during certain periods of the year when the gates are out. Further shortening the window operation, even if only for a few days, will significantly exacerbate this water supply deficiency.

In order for proposed alternatives to be carried forward for further consideration, alternatives need to demonstrate the ability to meet the purposes of the project. Alternatives were carried forward if they could both permanently benefit fish passage by reducing fish passage impediments and permanently benefit TCCA by reducing or eliminating water delivery shortfalls that can occur outside the annual period of permitted RBDD operations.

Generic Projects

In February 1992, U.S. Bureau of Reclamation (USBR) issued an "Appraisal Report on the Red Bluff Diversion Dam Fish Passage Program" (referred to here as the Appraisal Report). USBR, with assistance from the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (CDFG), identified 22 alternatives for improvements to mitigate fish passage impediments at the dam.

Additionally, USFWS issued a supplemental Fish and Wildlife Coordination Act Report titled "Red Bluff Diversion Dam and the Tehama-Colusa Canal" in February 1998. This report provides a summary of the fish passage issues and a reference of the project background and history. Table A-1 presents a summary of alternatives identified in prior studies.

Initial Screening of Alternatives

The selection of feasible alternatives, which will ultimately lead to a preferred alternative, was driven by a number of factors. For an alternative to be considered feasible (and therefore subject to full NEPA and CEQA analysis) it must have the ability to address the purposes of the project. Alternatives that failed to address both purposes of the project were rejected.

A primary result of this initial screening exercise was the conclusion that alternatives requiring an increase in gates-in operations would not improve fish passage. Even with improvements to existing ladders, it was determined that maximum fish passage efficiency is achieved with gates out; therefore, an increase in gates-in operations would reduce fish passage by some degree and would not address the dual project purposes. Further, it is recognized that the current gate operating procedure was a direct result of the Biological Opinion for Winter-run Chinook Salmon, and an increase in the gates-in period would require a re-evaluation of the species under the Endangered Species Act (ESA). Administratively, this process would have the potential to make any such alternative infeasible. Likewise, alternatives that only address agricultural deliveries without improvements to fish passage were also eliminated. However, all of the specific components of previously developed alternatives were considered for their applicability to a 4-month-or-less gates-in alternative.

Alternatives considered in greater detail all required 4-month-or-less-gates-in operations. This resulted in alternatives that were largely similar in their gate operation assumptions, but covered a wide variety of facility options for pumping water for agricultural deliveries or providing improved fish passage. By limiting the gate operations, the number of feasible facility options was greatly reduced, although there were still a large number of potential options for facilities. The different combinations of potential facility options narrowed the number of potentially feasible alternatives to approximately 300. Many of these facility options could be sized to meet a range of requirements, resulting in even more possible alternatives.

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Pumping Plant Alternative 4A	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 2,720 cfs Gates-in Fish Ladder Operation: Gates-out year-round	0
Pumping Plant Alternative 4B	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 2,480 cfs Gates-in Fish Ladder Operation: Mid-May to mid-July	2
Fish Ladder and Gate Operation Alternative 3A4	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1	8
Fish Ladder and Gate Operation Alternative 3C4	Fish Ladders: Left Abutment: 3,000 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1.	8
Conveyance from Shasta Dam	Pipeline or canal from Shasta Dam to TC Canal.	0
Low Upstream Diversion and Conveyance	Structure placed upstream would divert flows and convey directly to TC Canal by pipeline or canal.	0
Artificial River Channel through Payne Slough	An artificial river channel would convey all Sacramento River flows except RBDD diversion flows around the east side of RBDD. Gates would be kept lowered to allow diversions. Channel would follow alignment of Payne Slough and would require low fish weirs. Would require new diversion structure with fish ladders to divert RBDD into the natural channel for later diversion at RBDD.	12
Terraced Artificial Channel on Left Abutment of RBDD	Would include a shorter channel than the Payne Slough alternative. Steeper longitudinal slope would require fish ladders instead of fish weirs. Gates at RBDD would still be lowered to allow gravity-flow diversion.	12
Iowa Vanes	Iowa vane flow deflectors would be installed to deflect water toward the downstream end of existing fish ladders. Iowa vanes about 9 feet long and 3 feet high.	12
Smaller Pumping Plant with Regulatory Storage	Continuously pump flow to a regulatory reservoir for later use.	0
Fish Passage Effectiveness Alternative 1	Modify right abutment fish ladder to 800 cfs. Retain existing 338-cfs left abutment fish ladder.	12
Fish Passage Effectiveness Alternative 2A	Add 1,000-cfs center fish ladder. Retain 338-cfs left and right abutment fish ladders.	12

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Fish Passage Effectiveness Alternative 2B	Modify right abutment fish ladder to 800 cfs and add 1,000-cfs center fish ladder. Retain existing 338-cfs left abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3A1	Modify left abutment fish ladder to 800-cfs capacity. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3A2	Modify left abutment fish ladder to 800 cfs and modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3B1	Add new 2,100-cfs fish ladder on left abutment to replace existing fish ladder.	12
Fish Passage Effectiveness Alternative 3B2	Add new 2,100-cfs fish ladder on left abutment to replace existing modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3C1	Add new 3,000-cfs fish ladder to replace existing fish ladder on the left abutment. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3C2	Add new 3,000-cfs fish ladder to replace existing; modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3D1	Add new 5,000-cfs fish ladder on left abutment to replace existing fish ladder. Retain 338-cfs right abutment fish ladder.	12
Fish Passage Effectiveness Alternative 3D2	Add new 5,000-cfs left abutment fish ladder; modify right abutment fish ladder to 800 cfs.	12
Fish Passage Effectiveness Alternative 3D3	Add new 5,000-cfs left abutment fish ladder; modify right abutment fish ladder to 800 cfs; add new 1,000-cfs center ladder.	12
Fish Ladder Alternative 3A3	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12
Fish Ladder Alternative 3B3	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12
Fish Ladder Alternative 3C3	Fish Ladders: Left Abutment: 3,000 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: All year	12

TABLE A-1
Alternatives Identified in Prior Studies

Alternative	Description	Gates-in Operating Period (months)
Pumping Plant Alternative 4C	Fish Ladders: Left Abutment: None Right Abutment: None Center: None Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to mid-October	6
Fish Ladder and Pumping Plant Alternative 4C1	Fish Ladders: Left Abutment: 800 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to October	5.5
Fish Ladder and Pumping Plant Alternative 4C2	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: 1,360 cfs Gates-in Fish Ladder Operation: Mid-April to October 1	5.5
Fish Ladder and Gate Operation Alternative 3B4	Fish Ladders: Left Abutment: 2,100 cfs Right Abutment: 800 cfs Center: 1,000 cfs Pumping Plant Size: None Gates-in Fish Ladder Operation: April 1 to December 1	8
Paynes Creek Slough Alignment	Provides a 2,500-cfs capacity bypass around RBDD. Underwater acoustic barriers would be used to guide fish into the bypass.	12
Connor's No Name Slough Alignment	8,900-foot-long, 20,000-cfs capacity single channel or 5,000- to 7,000-cfs multiple bypass channels. Would require gated headworks to maintain constant lake level while varying flow to bypass depending on the riverflow.	12
TCCA/Montgomery-Watson Alignment	2,000-foot-long rock-lined channel. A 200- to 500-foot intake sill would be constructed with a fixed crest elevation of 248 feet. Inflatable gates along the top of the sill would control water surface in the lake.	12
Weir Gates	Variable-flow gates would be installed in the existing gates to allow for flow over the gates rather than underneath the gates.	12

To organize the alternatives into a more manageable format, three primary alternatives were developed:

- Alternative 1 – Current 4-months gate operation with fish passage improvements and 1,700-cfs total pumping capacity.

- Alternative 2 – A reduction in gate operation to the 2 months correlating with peak agricultural demand (July and August), fish passage improvements, and 2,000-cfs total pumping capacity.
- Alternative 3 – Elimination of gates-in operation and need for fish ladders; 2,500-cfs total pumping capacity.

Fish Passage

Facility options for fish passage were considered separately from facility options for pump stations. Detailed hydraulic physical model studies conducted by USBR's Technical Services Center indicated that the flow in the existing right, center, and left fish ladders should be improved. A detailed field investigation of the right fish ladder was also conducted by the Technical Services Center, and it pointed to the need for improvements in the attraction water system (AWS). Past investigations and current technology being used in other fish passage projects were identified as potential facility options at RBDD. Details regarding specific improvements to fish ladders were a focus of the Technical Advisory Group (TAG) for the Fish Passage Improvement Project.

None of the alternatives with a gates-in operation greater than 4 months was carried forward for additional analysis. As noted previously, it was determined that increasing the gates-in period would reduce fish passage at the dam, and was therefore contrary to the purpose of the project relating to fish passage. However, many of the facility options from alternatives that were dropped were considered as part of alternatives with gates in 4 months or less. These facility options included ladders, bypass channels, locks/fish elevators, and flow deflectors (Iowa vanes and weir gates).

Specific designs for the improved fish ladders were developed and refined in conjunction with TAG. Through group deliberations, it was determined that alternatives with continued gates-in operation should include designs for three fish ladder facilities. The attraction water system for the left and right bank ladders would be increased, resulting in a total flow of 831 cfs and 800 cfs in the respective ladders. TAG determined that the combined 1,631 cfs of attraction flow would be adequate in the vast majority of flow conditions at the dam.

Following a public scoping meeting, numerous public comments were received regarding another method of improving fish passage at the dam, commonly referred to as the "Bypass Alternative." Bypass alternatives were generally a constructed channel that would divert river flow around the left abutment of the dam, thus providing fish passage and potentially allowing for increased gates-in operation. During previous studies of fish passage conditions at the dam, a series of bypass alternatives were developed as a means to increase the gates-in period while improving fish passage at the dam. Previous bypass alternatives were abandoned because of the uncertainty surrounding the effectiveness of bypass channels to effectively pass fish and the relatively high costs estimated for construction of such facilities. However, because of the intense public interest in bypass facilities as a method for passing fish, the general concept of a bypass channel was carried forward for additional evaluation.

Agricultural Water Delivery

Peak demand estimates were developed by TCCA to evaluate facility options for delivering water to the TC and Corning canals. Generally, agricultural demand increases as tempera ture and crop demands increase, reaching a maximum demand in July and August, then decreasing as temperatures fall and crops are harvested. Common practices and crop demands in spring can also cause a second, smaller peak to occur in early May. Average water deliveries are presented graphically on Figure A-1. In response to a request from USBR, TCCA prepared a second report documenting historical water orders. The report included calculations of potential demands that could occur if peak water orders occurred simultaneously. Peak water demands are summarized in Table A-2.

TABLE A-2
Actual and Potential TCCA Water Demands[a]

Period	Peak Historical Water Order[b]	Historical Potential Peak Water Order[c]	Maximum Potential Peak Water Order[d]	Facilities Design Assumptions[e]
May 1 to 15	1,901 cfs	1,901 cfs	2,151 cfs	1,700 cfs
May 16 to 31	1,231 cfs	1,292 cfs	2,137 cfs	2,000 cfs
June	1,545 cfs	1,596 cfs	2,386 cfs	2,000 cfs
July	2,209 cfs	2,838 cfs	2,838 cfs	2,500 cfs
August	1,125 cfs	2,282 cfs	2,282 cfs	2,500 cfs
September 1 to 15	1,049 cfs	1,540 cfs	1,865 cfs	2,000 cfs

[a]Derived from actual water deliveries between 1989 and 1999.

[b]Highest single day water order, comprised combined actual water order from TCCA member districts and Glenn-Colusa Irrigation District (GCID).

[c]Highest TCCA member district water order plus highest GCID water order in period (may not have occurred on same day, but could reasonably occur).

[d]Highest TCCA member district water order plus highest potential GCID water order (1,125 cfs).

[e]Assumptions used in developing project alternatives.

Facilities design assumptions were used to determine the capacity needed under various gate operation scenarios. For example, under the current 4-month gates-in scenario, it is assumed that 1,700 cfs of water supply capacity is needed. During gates-in operations, the dam can divert water in excess of the design capacity of the TC Canal headworks, which is 3,180 cfs. Thus, diversions from the river are not a limiting factor during gates-in operations. During gates-out operations, however, diversions from the Sacramento River are limited to 405 cfs of pumping capacity at RBDD.

Sacramento River diversions during the gates-out period are currently supplemented by diversions from Stony Creek. Stony Creek diversions are conveyed into the TC Canal through a constant head orifice (CHO) on the creek, which was originally intended to supply supplemental flows from the TC Canal to Stony Creek. By operating the CHO backwards, TCCA is able to divert approximately 600 cfs from Stony Creek into the canal when water is available from Black Butte Reservoir. Considering pumping capacity at RBDD in conjunction with Stony Creek diversions, total diversion capacity during the gates-out period is 1,005 cfs, leaving the TCCA approximately 700 cfs short in the early May

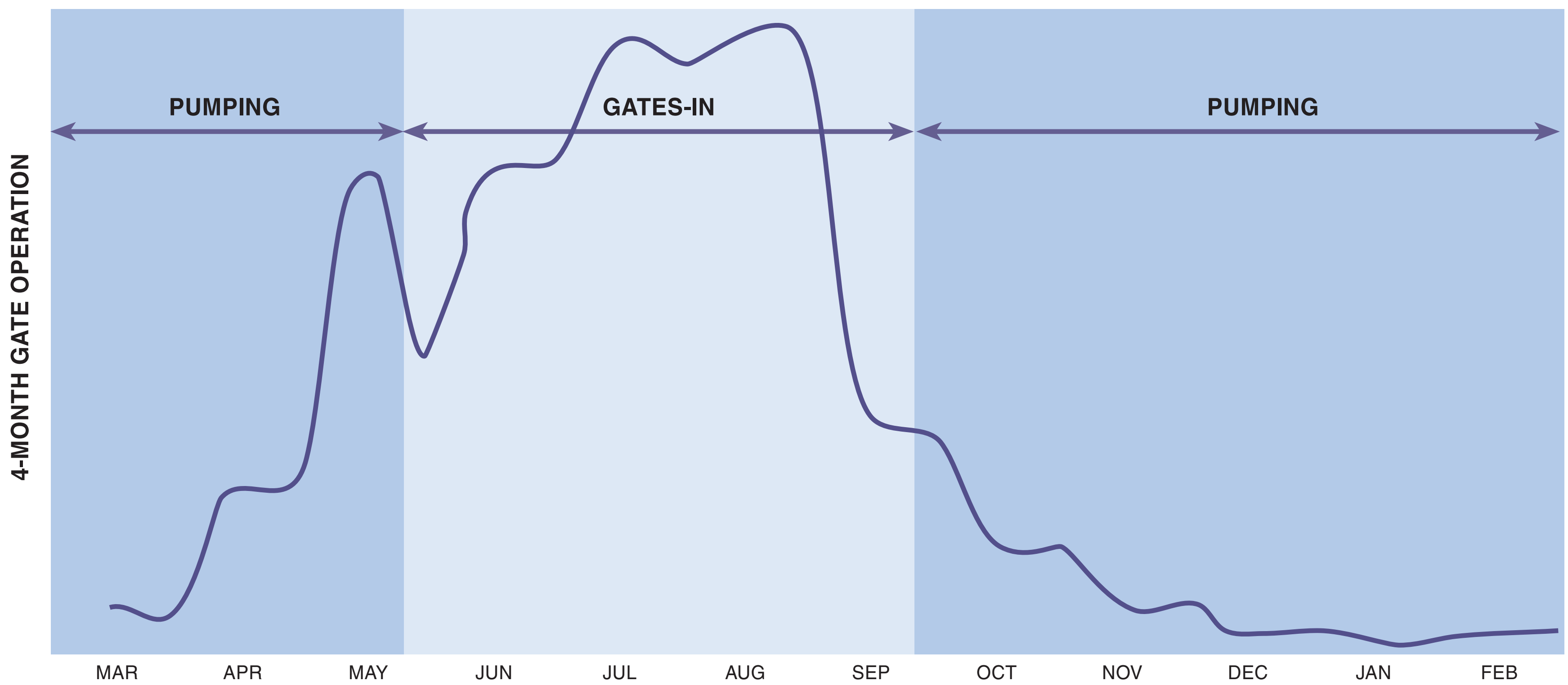

FIGURE A-1
AVERAGE WATER DELIVERIES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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period. However, it is important to note that diversions from Stony Creek are not considered to be a long-term sustainable resource because of concerns about fishery resources in Stony Creek and the unreliable nature of Stony Creek hydrology.

Facility options were considered according to their ability to meet the design assumptions listed in Table A-2 during gates-out operation. The review of offsite facility options for pump stations began with the identification of potential pump station locations. The locations identified are presented on Figure A-2 and in Table A-3. Additionally, the potential for building new onsite pumping plants was considered. The following three locations were considered: the Research Pumping Plant (RPP) (called the Tailwater Pump Station), the intake headworks, and the settling basin.

TABLE A-3
Offsite Intake Facility Locations

Site Number/Name	River Mile	Distance to TC Canal from Intake
11/Mill Site	242.7	0.5 mile to TC Canal
1/Existing Site	242.2	At canal
2/Orchard	240.7	0.8 mile to TC Canal; in orchard in floodplain; 15’ average water depth
3/Bow River	238.3	1.5 miles to TC Canal; 11’ average water depth
4/Coyote Creek	232.7	2.2 miles to TC Canal; 22’ average water depth
5/Upstream of Tehama	229.8	1.9 miles to TC Canal; 15’ average water depth
6/Downstream of Tehama	228.7	1.4 miles to TC Canal; 12’ average water depth
7/McClure Creek	226.5	1.1 miles to TC Canal; 14’ average water depth
8/Thomes Creek	223.8	2.1 miles to TC Canal; 11’ average water depth
9/Deer Creek	220.2	2.6 miles to TC Canal; 15’ average water depth
10/Woodson Bridge	218.5	2.4 miles to TC Canal; 17’ average water depth

The type of pumps proposed for the pump stations was also considered. Typically, pump stations as large as those being considered are outfitted with vertical turbine pumps. However, the existing RPP at the RBDD uses two types of non-standard pumps: helical and Archimedes pumps. These non-standard pumps are unique in that they do not use fish screens at the point of diversion. Instead, they pump water out of the river, then screen fish into a bypass for conveyance back into the river. Research conducted on these non-standard pumps indicates that there is minimal impact on fish pumped into the bypass facility. Accordingly, these pumps were considered in greater detail.

Secondary Screening Criteria

Additional screening criteria were developed to narrow the list of potentially feasible alternatives. The express purpose was to identify facility options that would create alternatives that have the greatest likelihood of success. Facility options were compared and evaluated against the following criteria:

- Effectiveness – technology, management of water delivery, and biological requirements that combine to provide a high likelihood of long-term success. Methods, processes, and equipment that have documented long-term successful performance were considered superior to those that were relatively untried.
- Implementation – practical execution, including potential public acceptance issues, permitting, and land use issues. Constructibility and complexity of maintaining effective fish passage and water delivery operations during the construction of new facilities were considered.
- Environmental – impact to environmental resources with emphasis on special-status species, including native fish species, and including both short-term (construction-related) and long-term impacts. Sites where construction can be limited in riparian zones, agricultural land, or other sensitive areas were considered superior to those where such areas would be disturbed.
- Cost – relative comparison of estimated life-cycle costs for each alternative, including initial capital costs and operation and maintenance (O&M) costs, including availability of project energy. At this level of consideration, costs were used to identify alternatives that were grossly out of proportion with other alternatives.

Results of Secondary Criteria

Fish Passage Facilities

Fish passage facilities were evaluated using the secondary criteria. Specific details about the facilities were developed in conjunction with TAG and built upon previous investigations conducted at the site. Fish passage facilities were originally considered as part of the 4-month gates-in and 2-month gates-in alternatives. The Gates-out Alternative would not lower gates into the water and would thus not require fish ladders. However, Alternative 2B was added to the alternatives that were considered following the detailed fish passage analysis, described in the next section.

Site conditions related to adult fish passage at RBDD are described in the following reports, which form the basis for the fish ladder designs considered as part of this project:

- *Prescoping Report: Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam* (CH2M HILL, 2000)
- *Hydraulic Field Evaluation of the Right Abutment Fish Ladder at RBDD* (USBR, 1997b)
- *Physical Model Study of Enlarged Fish Ladders for RBDD* (USBR, 1997a)

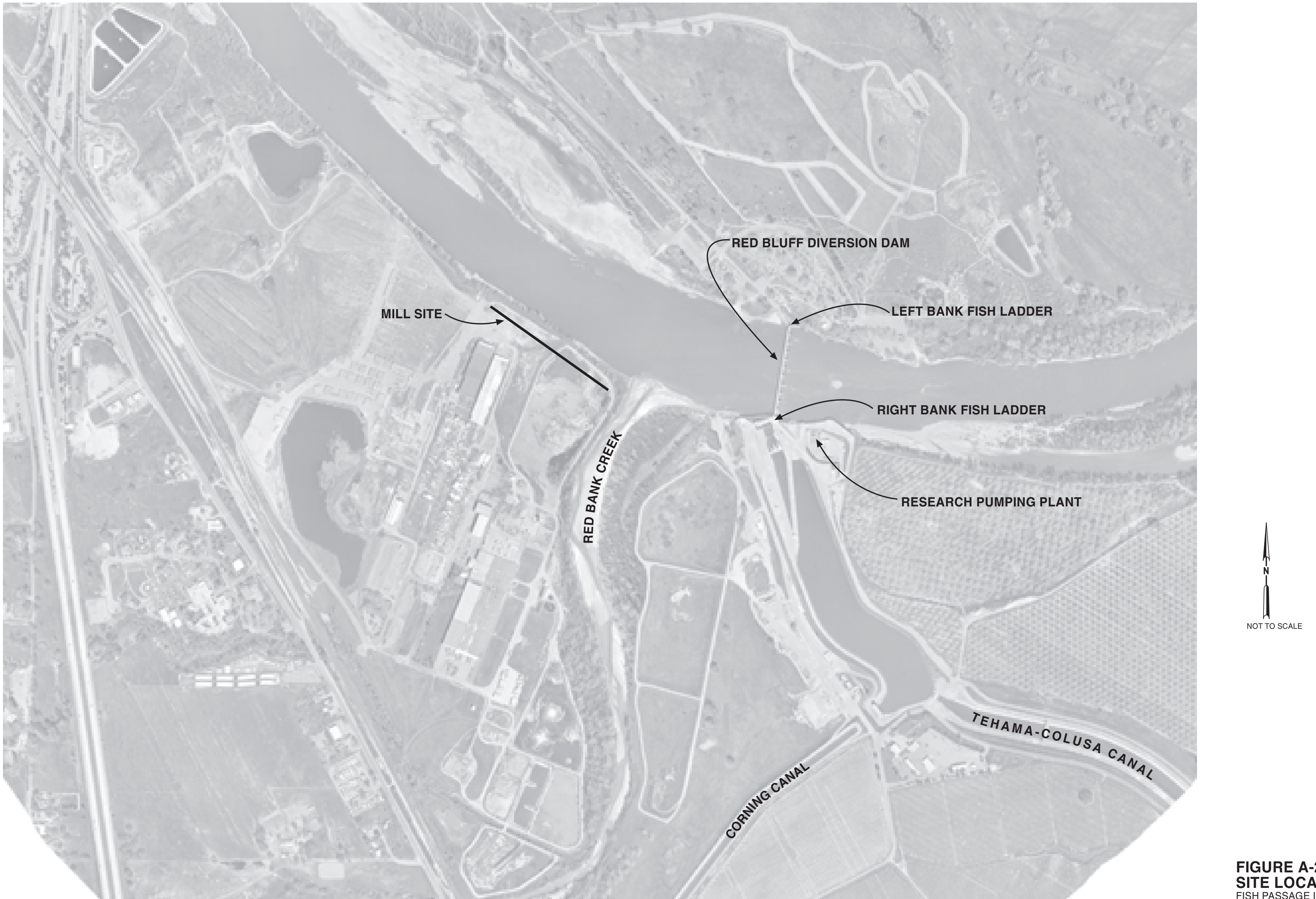

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FIGURE A-2
SITE LOCATION MAP
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

Right Bank Fish Ladder. The existing right bank fish ladder will be improved to provide improved adult fish passage. This will be accomplished by increasing the AWS flow from 265 cfs to 715 cfs. The fish ladder flow will remain at 85 cfs, although new Ice Harbor-type weirs will be installed. The total maximum fish ladder flow will be 800 cfs, including AWS flow. The fish ladder entrance bay will be reconfigured to enhance fish attraction and to accommodate the increased total flow. This main entrance will be fitted with a top-down slide gate to ensure proper entrance conditions at most flow levels. A low-flow entrance will also be included to provide a jet parallel to the dam just downstream of the spillway. The low-flow entrance will also have a top-down slide gate for closure or adjustment.

The lowest weir (Weir Number 1) of the existing fish ladder will be abandoned to provide for a larger entrance bay. At the design total flow of 800 cfs and the design maximum tailwater, the water velocity in the entrance bay just before the high-flow fish ladder entrance is 3.6 feet per second (fps), which is just below the design maximum water velocity criterion of 4.0 fps.

The existing AWS intake will be abandoned, and a new AWS intake will be constructed in the abandoned louver structure portion of the TC Canal. The AWS intake at the canal will need to be rebuilt to ensure proper flow conditions for the new AWS intake and the existing drum screens. The new AWS intake will have a trashrack, an automated trashrack cleaner, and a gross approach flow velocity of 1.0 fps.

The design criteria that will be used in the preliminary design of the right bank fish ladder are shown in Table A-4.

Advantages. The primary advantage of this ladder design is that the basic structures currently exist, which minimizes construction impacts. Other advantages are that the technology is widely accepted and has been implemented in other fish passage projects.

Disadvantages. A biological disadvantage of fish ladder improvements is that they might not address problems relating to delay at the dam. Additionally, ladders would not provide passage for sturgeon, and thus may pose a risk to future operations if sturgeon, or other fish with similar swimming characteristics, are listed under ESA or otherwise require changes in dam operations.

Screening Evaluation.

Effectiveness

- This type of fish ladder design has proven to be effective in other locations and would likely represent an improvement over the existing ladders.
- Improved passage for sturgeon would not be achieved with these facilities, unless they were implemented with a reduction in gates-in operation.
- It is possible that improved ladders would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

TABLE A-4
Design Criteria for the Right Bank Fish Ladder

River Design Flows	**cfs**
100-year Flood	206,000
Maximum River Flow for Fish Ladder Operations	20,000
Minimum River Flow for Fish Ladder Operations	2,200
River Elevations and Gross Heads (refer to tailwater rating curves)	**feet**
Forebay Level	252.5 ± 0.2
Maximum Tailwater Level (for fish ladder design)	242.0
Minimum Tailwater Level (for fish ladder design)	237.6
Maximum Gross Head	14.9
Minimum Gross Head	10.5
Fisheries Criteria	**each**
Type of Fish Ladder	Pool and weir
Weir Type	Ice Harbor with 9-inch sidewall slots
Number of Pools	14
Pool-to-Pool Differential	1.0 ft or less
Pool Turbulence Factor	4.0 ft-lb/sec/ft^3
Fish Ladder Entrance Velocity (average)	5.6 fps
Entrance Bay to Tailwater Differential	1.0 ft
Floor Diffuser V_n	0.5 fps
Wall Diffuser V_n	1.0 fps
AWS Trashrack V_n	1.0 fps
Transport Channel Maximum Velocity	4.0 fps
Transport Channel Minimum Velocity	2.0 fps
Monitoring and Evaluation Facilities	
Viewing Window	To be determined
Counting Facilities	To be determined
Adult Trap	To be determined
Fish Ladder Hydraulic Performance	**cfs**
Weir Flow	85
AWS Flow	715
Floor Diffuser Flow	650
Wall Diffuser Flow	65

ft-lb/sec/ft^3 = foot-pound per second per cubic foot.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the structures are already in place, there is no need for in-river construction; therefore, this option should have minimal impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Improved fish ladders would rely on accepted technologies used at other facilities to improve salmonid passage. However, the improvements to the ladders do not guarantee improvements to fish passage because delay caused by the dam may be caused by the operations of the gates. Further, fish ladders represent some degree of risk because they would not improve passage for sturgeon. It is recommended that the improved fish ladders be considered as part of the overall project alternatives.

Left Bank Fish Ladder. After modeling and evaluating various fish ladder flow rates ranging from 1,000 to 3,000 cfs, USBR (1997a) recommended enlarging the left bank fish ladder to a total flow of 1,000 cfs. To simplify the modifications to the left bank fish ladder in the context of the overall configurations for Alternatives 1 and 2, and reflecting the potential addition of a third (center) fish ladder among other conditions, an 831-cfs ladder is proposed. This size will allow for diffuser placement similar to that proposed for the right bank fish ladder and substantially simplify the required modifications to the existing ladder.

Improvements to the existing left abutment fish ladder will provide improved adult fish passage. This will be accomplished by increasing AWS flow from 265 cfs to 746 cfs. The fish ladder flow will remain at 85 cfs, although new Ice Harbor-type weirs will be installed. The fish ladder entrance bay will be reconfigured to enhance fish attraction and to accommodate the increased total flow. The existing AWS intake will be modified to include trashracks, an automated trashrack cleaner, and a gross approach velocity of 1.0 fps. The existing AWS intake will serve as a single 96-cfs wall diffuser in the entrance bay. A new AWS intake will be constructed on the left bank just upstream of the existing fish ladder exit. This intake will be similar to the one proposed for the right bank fish ladder and will be sized for the 650-cfs floor diffuser flow. The design criteria that will be used in the preliminary design of the left bank fish ladder are shown in Table A-5.

Advantages. The primary advantage of this ladder design is that the basic structures currently exist, which minimizes construction impacts. Other advantages are that the technology is widely accepted and has been implemented in other fish passage projects.

TABLE A-5
Design Criteria for the Left Bank Fish Ladder

River Design Flows	cfs
100-year Flood	206,000
Maximum River Flow for Fish Ladder Operations	20,000
Minimum River Flow for Fish Ladder Operations	2,200
River Elevations and Gross Heads (refer to tailwater rating curves)	**feet**
Forebay Level	252.5 ± 0.2
Maximum Tailwater Level (for fish ladder design)	242.0
Minimum Tailwater Level (for fish ladder design)	237.6
Maximum Gross Head	14.9
Minimum Gross Head	10.5
Fisheries Criteria	**each**
Type of Fish Ladder	Pool and weir
Weir Type	Ice Harbor with 9-inch sidewall slots
Number of Pools	14
Pool-to-Pool Differential	1.0 ft or less
Pool Turbulence Factor	4.0 $ft\text{-}lb/sec/ft^3$
Fish Ladder Entrance Velocity (average)	5.6 fps
Entrance Bay to Tailwater Differential	1.0 ft
Floor Diffuser V_n	0.5 fps
Wall Diffuser V_n	1.0 fps
AWS Trashrack V_n	1.0 fps
Transport Channel Maximum Velocity	4.0 fps
Transport Channel Minimum Velocity	2.0 fps
Monitoring and Evaluation Facilities	
Viewing Window	To be determined
Counting Facilities	To be determined
Adult Trap	To be determined
Fish Ladder Hydraulic Performance	**cfs**
Weir Flow	85
AWS Flow	746
Floor Diffuser Flow	650
Wall Diffuser Flow	96

Disadvantages. A biological disadvantage of fish ladder improvements is that they might not address problems relating to delay at the dam. Additionally, ladders would not provide passage for sturgeon, and thus may pose a risk to future operations if sturgeon, or other fish with similar swimming characteristics, are listed under ESA or otherwise require changes in dam operations.

Screening Evaluation.

Effectiveness

- This type of fish ladder design has proven to be effective in other locations and would likely represent an improvement over the existing ladders.
- Improved passage for sturgeon would not be achieved with these facilities, unless they were implemented with a reduction in gates-in operation.

- It is possible that improved ladders would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the structures are already in place, there is no need for in-river construction; therefore, this option should have minimum impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Improved fish ladders would rely on accepted technologies used at other facilities to improve salmonid passage. However, the improvements to the ladders do not guarantee improvements to fish passage because delay caused by the dam may be caused by the operations of the gates. Further, fish ladders represent some degree of risk because they would not improve passage for sturgeon. **It is recommended that the improved fish ladders be considered as part of the overall project alternatives.**

Bypass Channel. Over the years, there has been consistent interest in various bypass alternatives that could be used to improve fish passage while allowing the dam to function. Bypass alternatives typically include proposals to construct a channel through historical river meanders or sloughs along the eastern bank of the river channel. The basic concept is that a bypass channel approximating natural river conditions would be more efficient for passing fish than fish ladders. Additionally, some bypass proponents assert that the channels would be adequate to allow for a return to an 8-month or 12-month gates-in operation at RBDD. The greatest interest in bypass alternatives has been from citizens of Red Bluff, many of whom are concerned about the fate of Lake Red Bluff, which is formed during the gates-in period.

Bypass alternatives have been formally reviewed in at least three public documents: a 1992 Appraisal Report by USBR, a 1995 Bypass Evaluation Report by USBR, and a 2000 Prescoping Report by CH2M HILL. All three documents have resulted in recommendations that the bypass alternatives not be considered further. However, the general public has disputed all three recommendations.

The bypass channel concept that is being evaluated for this project has been configured to reduce costs, limit flood impacts and liability, and minimize adverse water quality changes to the Sacramento River near RBDD. Specifically, the objective has been to establish physical characteristics that allow for fish passage. The basic approach for the bypass channel has been to focus on non-salmonids, particularly sturgeon, which have more restrictive requirements than salmonids.

In order for the bypass channel to meet all of the concerns consistently expressed by the fishery agencies and engineers, it must meet the following criteria:

- Be passable by all species of concern.

Velocities in the channel should be considerably lower than in standard fish ladders. Literature review suggests that maximum velocities of 3 fps in the majority of the channel would be appropriate to pass non-salmonid species, with maximum velocities of 6 fps through very short reaches or slots.

The design includes concrete weirs about 2.5 feet high, placed at 150-foot intervals along the bypass channel. The weirs should be arch-shaped (in the horizontal direction) to provide more flow in the center of the channel and add complexity to the flow regime. The design also includes two full-depth slots in each weir, approximately 5 feet wide, to provide fish passage without requiring the fish to swim over the weirs.

- Avoid creation of slack waters and predator holding habitat either above or below the dam.

The bypass channel is configured to minimize the distance between the bypass entrance and exit and the dam itself. This configuration is intended to eliminate any additional slack water created by the bypass facility. Further, the location of the downstream end of the channel is intended to supplement attraction water to the left bank fish ladder, theoretically improving the performance of the ladder.

- Avoid areas or conditions of potential stranding.

Like other fish passage facilities, the bypass channel will be designed with flow depths to provide adequate fish passage and the requisite pool volume for energy dissipation. The channel configuration will also ensure complete drainage without pools where fish could be stranded.

The design includes a small, V-shaped concrete subchannel on each side to provide drainage of the facility. The bottom of the main channel will be sloped to drain toward each V-shaped subchannel from the center of the bypass channel. The arched weirs are assumed to be configured convex relative to the direction of the flow using the premise that this will reduce stranding and further enhance drainage. Additionally, it is assumed that the rock covering the bottom of the channel will be grouted to prevent juvenile fish from hiding in the voids between the rocks and becoming stranded.

- Provide enough attraction flow for the fish to readily find the bypass.

The bypass channel should re-enter the river as close as possible to the downstream side of RBDD to enhance the ability of migrating fish to find the channel.

- Avoid new facilities that recreate or move existing barriers.

To minimize cost, the bypass channel was located to minimize interference with the Sacramento River Discovery Center (SRDC), the existing road, the U.S. Forest Service (USFS) campground, and the existing fish ladder and its proposed improvements.

- Structurally stable at all flows (i.e., it must not trigger a shift in the river's channel).

When the RBDD gates are in, only minor fluctuations in the water surface elevation behind the dam are expected. Therefore, flow control with respect to the 1,000-cfs operational condition can be achieved with a simple weir concept. Another element of flow control is the ability to close off the bypass channel. A control structure will be constructed at the levee near the upstream entrance to the bypass channel to incorporate the weir and a set of large gates for closing the channel to reduce flood damage and maintenance.

- Able to accommodate the flow fluctuations that can be expected during the periods of use.

The flow control structure should be designed to close off the bypass channel from the Sacramento River when there is potential for flooding. The existing levee is high enough to protect against a 100-year flood in the river. However, it may still be possible for overland flow from other adjacent waterways to enter the bypass channel downstream of the levee. Rock slope protection will be used to provide bank stability and protection from erosion.

- Not be subject to constant or intensive maintenance efforts.

Current designs of the bypass channel include three features intended to keep maintenance efforts at a reasonable level. The channel includes gates at the upstream end that will minimize the amount of debris in the channel during periods of non-use, particularly during winter flood events. The channel will also be contoured to allow drainage via a subchannel along both sides of the channel floor. The channel floor will be grouted to avoid stranding juvenile fish during dewatering of the channel. The channel will be armored with rock to minimize scour and sloughing of the banks.

- Economically viable.

At 1,000 cfs, the channel will carry approximately the same amount of flow as an improved fish ladder, while at the same time, the capacity will be small enough to keep the size and the cost of the facility at a reasonable level. Final cost estimates will be available pending technical review of the design.

- Safe (i.e., not create a dangerous, attractive, public nuisance).

Most fish passage facilities, including this bypass channel, have inherent safety risks associated with high velocities, orifices and notches, submerged or exposed obstacles, and other elements of the facility. Accordingly, boating and other potential public uses of the bypass channel would carry serious safety and liability issues. Public use of this facility is viewed as incompatible with the fisheries use. The perimeter of the bypass channel should be securely fenced, and the flow control structure at the upstream end should be designed to prevent boats from entering from the Sacramento River.

The proposed layout of the bypass channel is presented on Figures A-3 and A-4.

Screening Evaluation.

Effectiveness

- This type of fish passage facility is considered experimental, with a significant risk of failure to achieve the intended improvements to fish passage.
- Improved passage for sturgeon might be achieved with these facilities because the flow conditions used as design criteria are considered to be compatible with sturgeon passage.
- It is possible that a bypass facility would not reduce delay at the dam, which is considered to be the major effect of the dam on migrating fish.

Environmental

- Because of the current dam operations, it is considered likely that this type of facility could be built without incurring impacts to fish passage during construction.
- Future listings of fish, particularly sturgeon, could require additional operational changes at the dam if this facility option is selected.
- This alternative would require replanting a portion of a mitigation area located east of the campground on the left bank of the river.

Implementability

- This structure would affect existing uses of the area near the left abutment of the dam. The SRDC, campground, and nearby facilities would require relocation. Finding a suitable replacement site might not be feasible.
- USFS is the land management agency for the proposed site. USFS has issued a preliminary opinion stating that the bypass channel would not be consistent with its land management plan. Building a facility that is inconsistent with the existing land management plan might not be feasible.

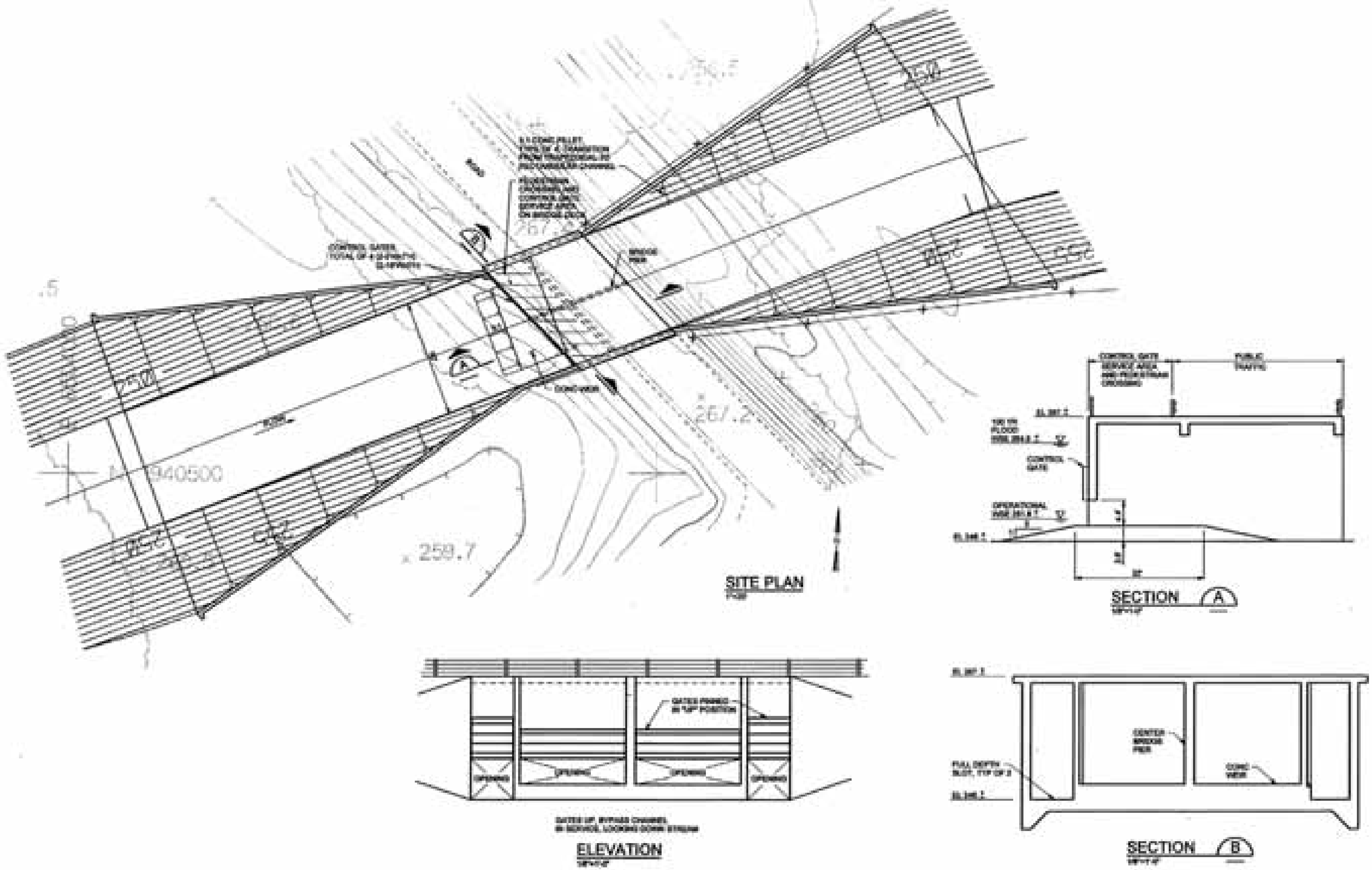

FIGURE A-3
RBDD BYPASS CHANNEL CONTROL STRUCTURE PLAN AND SECTIONS
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W042002002RDD_981 (8/15/02)

CH2MHILL

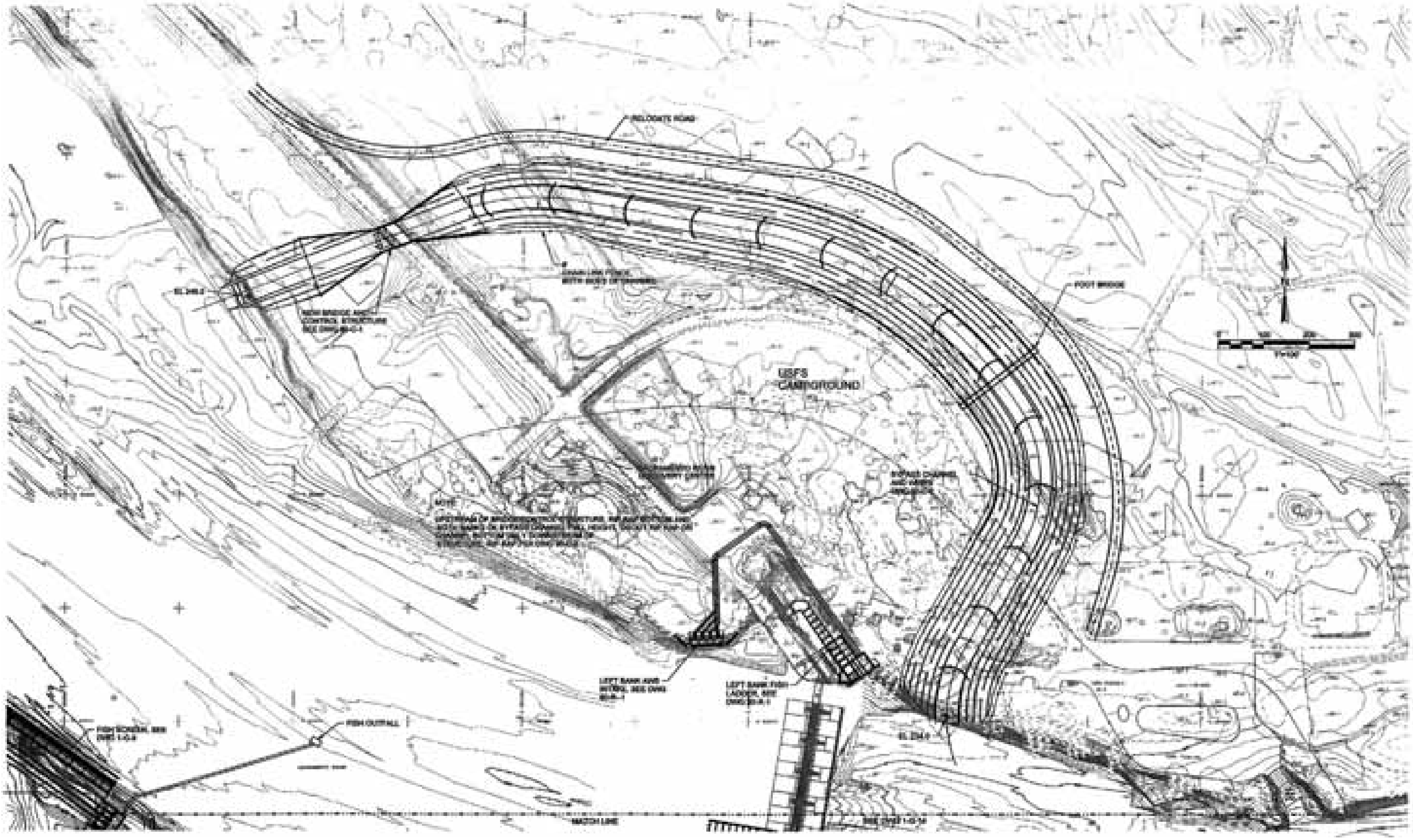

FIGURE A-4
RBDD SITE GRADING PLAN
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR
CH2MHILL

W042002002RDD_991 (8/15/02)

- Construction of this facility would not preclude land use near the proposed locations, and operation of the fish ladders is consistent with the management objectives of the proposed locations.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.

Cost

- The construction cost per unit of fish passage is greater than that for gates-out operation.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the existing fish ladders.

Conclusion. Decisions to reject the bypass alternatives have been presented in a number of public forums, most recently in August 2000 at a Public Scoping Meeting, and in September 2000 at a Public Stakeholder Meeting. At both of these meetings the public was overwhelmingly critical of the decisions to reject bypass alternatives as a viable solution to fish passage problems at RBDD. Public meetings that were held on the 1992 Appraisal Report and 1995 Bypass Evaluation Report also received negative reviews. Major concerns were voiced by members of the public regarding the process by which decisions were made, the cost of proposed alternatives, and the need for action at RBDD. Comments in support of bypass alternatives have primarily come from citizens of Red Bluff. Implementation of the bypass channel, as currently designed would be difficult because of the land use conflicts it would incur; however, in response to intense public interest, the facility is being carried forward. **Accordingly, it is recommended that a bypass alternative be added to the EIS/EIR as an alternative warranting full consideration.**

Pumping Facilities

Pumping options were evaluated using the secondary screening criteria for each potential facility. Three onsite and ten offsite locations for pumping facilities were identified and screened in the Prescoping Report (CH2M HILL, 2000). The potential onsite locations considered in the Prescoping Report were the headwater, tailwater, and sedimentation basin locations. The offsite locations considered were distributed along the Sacramento River from about ½ mile upstream of RBDD to Woodson Bridge, which is approximately 24 miles downstream of RBDD.

Each pump station site configuration consists of trashracks or fish screens, a forebay or intake piping, a pump station, and conveyance facilities. A fish bypass system may be needed, depending on the length of the fish screens and the type of pumping system. Many potential combinations of intake and pumping facilities options are associated with each alternative. Both Archimedes screw or helical pumps and vertical propeller pumps were considered.

Onsite Pump Station Facilities

Tailwater Pump Station – Screw/Helical Pumps. The Tailwater Pump Station (TPS) would be located immediately downstream of the right bank fish ladder at the current site of the RPP. TPS options fall into two categories: incorporating the existing RPP with modifications, and constructing a new TPS using conventional vertical propeller pumps in place of the screw and helical pumps in RPP.

The screw/helical pump option would use the existing RPP intake and discharge facilities and structures, and fish bypass system. The two existing Archimedes screw pumps and the helical pump would be retained, and one new helical pump would be installed in the currently unused fourth bay. The existing trashrack, intake and discharge piping, fish screen, and fish bypass system would remain in place with little or no modification. A fish screen would need to be installed in the new pump discharge channel.

Advantages. The primary advantage of this pumping option is that the basic structures and three of the pumps already exist, which minimizes construction impacts. Other advantages are that access and power are in place, a new fish screen facility would not be required in the river or RPP, and the capital investment that it represents would be used, minimizing new development cost. This pumping option is the easiest to implement and the least expensive means of achieving 320 cfs of installed capacity.

Disadvantages. A biological disadvantage of the screw pump option is that it removes more fish from the river via the bypass system than the options that include fish screens along the river. However, studies have documented low fish mortality rates, less than 5 percent, with the screw or helical pumps.

Unless the drum screen fish bypass is active, fish bypass flow velocities would not meet agency minimum velocity in bypass outfall criteria without modifying the outfall.

Another operating disadvantage of the screw/helical pump option is that water users are concerned about the long-term reliability and O&M costs of RPP technology. Because of limited operating experience for screw and helical pumps in this pump size, it is difficult to forecast the long-term reliability and O&M cost of the facility.

Additional pumping capacity would be needed at another location to satisfy peak water needs. Pumping from more than one location complicates operations. Another potential disadvantage is that RPP may not be available for research once it is dedicated to delivering irrigation water. These are not expected to be significant disadvantages.

Screening Evaluation.

Effectiveness

- This pumping option is not considered as biologically effective as options that leave the fish in the river.
- Because of the need to provide additional water to meet the minimum flow velocity criteria in the fish bypass piping system, this pumping option may not be as effective in delivering water as other pumping options.
- The long-term operating performance and O&M costs of the screw and helical pumps is unknown, so the operational effectiveness of using these pumps is considered less than TPS using the more conventional vertical propeller pumps.

- This pumping option would need to be used in combination with other facility options at another location or locations. The operational effectiveness is somewhat more complicated with the multiple locations for pumping.
- These pumps could be limited to delivering water during peak periods to minimize the operation time.
- Overall, this option is not considered to be as biologically or technically effective as other options (in terms of reliability of mechanical equipment).

Environmental

- Because the structure is already in place, the TPS RPP option is the least disruptive to the environment.
- If this option were used with an offsite pump station, the size of the offsite pump station would be reduced from a full-capacity pump station, which would decrease the impacts associated with developing a new site.
- No significant changes to the existing environmental setting are anticipated with this option.

Implementability

- Because the pumps and pump station structure are already in place, there is no need for in-river construction; therefore, this option should have minimal impact on continued uninterrupted water delivery and should not impact fish passage during construction.
- Since the site is already in use for water delivery, no new permits are expected, and no land acquisition is needed.
- This is the easiest option to implement; however, it is contingent upon NMFS acceptance.

Cost

- The construction cost per unit of water delivered is significantly lower for this option than for all other pumping options because the pump station structure and three of the four pumps are already in place.
- The power costs of operating screw/helical pumps at this location is comparable to operating vertical propeller pumps at the Mill Site and is less than the power costs at Site 2, Walnut Orchard Site, for a comparable amount of water delivered.
- This site is downstream from Red Bank Creek and therefore is expected to have a higher potential for sediment deposition and need for dredging.
- Overall, the O&M cost of this alternative is expected to be slightly, but not significantly, higher than the Mill Site vertical propeller pump option.

Conclusion. The screw and helical pumps in RPP have been characterized by poor past mechanical performance. The lack of long-term experience with the fish-friendly pumps in a full-scale application makes it difficult to assess long-term reliability and O&M

requirements in comparison to propeller pumps. The intake structure and three pumps are already in place making this the lowest construction cost per unit of water delivered pumping option. This option should have only limited environmental impacts because structures are already in place, and the site is already being used for water intake facilities. Construction should have little or no impact on operations of the existing facilities. It is the easiest option to implement since the structure is already in place. Using the pump station only during peaks could also allow further research on the screw/helical pump performances during off-peak periods. **It is recommended that RPP modifications be considered as part of the long-term pumping option.**

Tailwater Pump Station – Vertical Propeller Pumps. These TPS options would replace the screw pumps in the existing RPP structure with vertical propeller pumps. This would require that the trashracks along the river be replaced with fish screens. The pumping capacity is limited and depends on the length of the fish screen. The existing trashrack, intake and discharge piping, and fish bypass system would be demolished; and a new forebay and new discharge piping from the pumping station to the sedimentation basin would be constructed. A fish bypass system is not expected to be required for this option because of the relatively short fish screen length.

Two capacity variations were considered for the vertical propeller pump option: 600 cfs and 750 cfs. The water delivery capacity is limited by the length of the fish screen.

Advantages. Installing vertical propeller pumps in place of RPP overcomes most of the disadvantages associated with the screw/helical pumps. For the 600-cfs option, it is assumed that the fish are screened on the river, and no fish bypass would be required, which would eliminate increased predation or migration delays.

The vertical propeller pumps have an excellent long-term operating history. The length of the discharge piping is short compared to offsite pumping options. The existing RPP structure can be modified to accommodate the vertical propeller pumps, thereby taking advantage of the existing capital investment in the structure.

Disadvantages. The primary disadvantage of these options is that substantial demolition and reconstruction of the existing RPP structure would be required. Cofferdams would need to be built in the river and around the existing facilities for construction of the in-river fish screens and the pump station forebay. Modification of the internal structure of the existing pump station bays would be required to accommodate the different type of pumps.

Construction scheduling for the TPS vertical propeller pump station option would be more complicated than for the full-capacity pump station at an offsite location. The operation of the existing facilities could be impacted by construction of TPS.

Construction of new conventional vertical propeller pumps at the tailwater site would require new fish screens. The design of the fish screens would be subject to the criteria and approval of the fishery agencies.

This site is downstream from Red Bank Creek and could result in sediment deposits from Red Bank Creek in front of the screens or in the TPS forebay, requiring periodic dredging.

Another disadvantage is that the physical constraints of the site limit the pumping capacity; thus, a pump station would be required at one or two other offsite locations to satisfy the total peak water need, which could complicate operations.

Screening Evaluation.

Effectiveness

- The TPS with vertical propeller pumps would be effective in delivering water and, once construction is begun, should be biologically effective.
- Having an offsite pump station is considered to be less effective than operating one pump station.

Environmental

- Because of the need to construct a cofferdam in the river at the downstream end of the existing fish ladders, this option could have some temporary negative water quality and biological impacts associated with working in the water. The full impacts on fish passage from the construction in the river near the fish ladder are unknown.
- There would be no change in land use because this site is already used for intake and pumping.

Implementability

- Permits from the U.S. Army Corps of Engineers (USACE) and the Regional Water Quality Control Board (RWQCB) are required for construction activities in the river.
- The scheduling of this option is more complex than using the RPP or the offsite pumping options.
- The existing RPP would need to be removed from service at the start of the construction of the vertical propeller pump options; therefore, RPP capacity would not be available for water deliveries.
- During construction, the available peak pumping capacity would be less than the peak design pumping capacity.

Cost

- The construction cost per unit of water delivered is less for both the 600-cfs and 750-cfs vertical propeller pump options than for developing full pumping capacity offsite. However, in combination with an offsite pump station, there is an apparent cost disadvantage to converting RPP to a vertical propeller pump station. The combination of the expanded RPP and an offsite pump station is the least-cost option.
- The maintenance costs are expected to be somewhat higher at the TPS site because of the anticipated dredging needs and the operation of more than one pump station.

Conclusion. The TPS vertical propeller pump options do not have any apparent advantage compared to developing the total pumping capacity using a combination of RPP and a new pump station at an offsite location or a new full-capacity pump station at a single offsite location for the following reasons:

- Substantial demolition and potential interference with existing structures
- Complexity of scheduling
- Potential interference with current operations
- Reduced delivery capacity during construction
- Increased complexity in operating multiple pump stations

While the cost of this pump station option in combination with the Mill Site Pump Station is lower than developing full capacity at the Mill Site Pump Station alone, it is greater than the combination of the RPP and the Mill Site Pump Station. **Because of this, there is no apparent advantage to further considering the TPS option using a vertical propeller.**

Headwater Pump Station. The Headwater Pump Station (HPS) would be located in front of the existing RBDD headworks and right bank fish ladder exit just outboard of the existing sheet pile wall that directs flow and controls sediment. A new fish screen, forebay, and pumping station would be constructed; and a new discharge pipe would be installed to the existing gravity intake channels. The fish screen length is approximately 230 feet including a blowout panel. A fish bypass system is not anticipated for the HPS because of the short fish screen length.

HPS would be used only during gates-out operation. Fish screens installed in the river must be removable to allow the operation of the fish ladders during gates-in operation. When the gates are in and the right bank fish ladder is in service, the fish screens would be removed from the water to allow a free inlet for the headworks and a free exit for the fish ladder. This is similar to the current operation of the right bank fish ladder pump station.

Advantages. Many of the same advantages of TPS apply to HPS. The fish screen is short enough that it is assumed that NMFS would grant a variance to the 60-second exposure criterion. Because it is assumed that there would be no fish bypass, the fish would stay in the river, and the risks to fish associated with the bypass would be obviated. Also, HPS is onsite, and access and power to the site already exist. In addition, the length of discharge piping is short compared to offsite options because of the proximity to the TC and Corning canal forebay.

Disadvantages. The operation of a pump station at HPS would be more complicated than operation of a pump station at other locations. During the time that the gates are in, the screens would need to be removed from the river and panels placed in the forebay to guide upstream migrating fish to the river from the right bank fish ladder exit. The pumps and screens could be permanently installed for the gates-out option, but permanent screens would remove all flexibility for gates-in operations, even for short periods. The operation of the total pumping system also would be more complex if HPS was developed as a part of the total pumping system because of the need to pump from more than one pump station to achieve the required pumping capacity.

Because of its proximity to Red Bank Creek, the HPS option is the most vulnerable of the pump station locations to sedimentation deposits and the need for periodic dredging. Continuous sediment management, including periodic dredging, would be required.

Scheduling for the construction of the HPS would require careful sequencing with the operation of the existing system. The total available peak capacity would be reduced during construction.

Screening Evaluation.

Effectiveness

- This option should have a relatively high biological effectiveness because no fish bypass is anticipated.
- This option is considered the most complicated to operate. The fish screens would need to be removed at any time the gates are in to allow operation of the right bank fish ladder.
- The need for sediment removal in the forebay and area in front of the screens is expected to be more intensive at this location than at other pumping locations.

Environmental

- This option could have some temporary biological and water quality impacts associated with working in the water near the cofferdam location in relation to the fish ladder. The time period that the cofferdam would be in the water would be limited to the period when gates are out and the fish ladders are not operating. This could result in the need to construct the new facilities in the fall, winter, and spring when the risk of flooding and weather-related damage is greatest.
- The site is already used for intake and pumping, so there would be no new long-term site impacts, no land acquisition required, and no change in land use.

Implementability

- Permits from USACE, RWQCB, and CDFG would be required.
- The scheduling for this option would be one of the most complicated of all pumping options since the construction period would be limited to the time when gates are out and the fish ladders are not in use.
- The gravity-flow intake would not be operable when the cofferdam is in the water.

Cost

- The construction cost per unit of pumping capacity is higher than the other onsite options but is virtually the same as for the Mill Site vertical propeller pump option.
- Of all options presented, this pumping option is considered the most complicated to operate.
- The need for sediment removal in the forebay and area in front of the screens is expected to be more intensive at this location than at other pumping locations because of the location immediately downstream from the confluence of Red Bank Creek.

- The power costs would be similar to the TPS and Mill Site vertical propeller pump options.
- The overall O&M costs are expected to be higher.

Conclusion. The complexity of construction scheduling, the higher O&M cost because of the need to remove the screens during gates-in operation, and the higher potential for sediment deposition requiring dredging offset the apparent advantages of developing HPS. **There is no apparent construction cost advantage for developing this option compared to the offsite Mill Site vertical propeller pumping option; therefore, HPS will not be considered further.**

Sedimentation Basin Pump Station. The Sedimentation Basin Pump Station was identified as an option because all of the needed pumping capacity could be developed onsite. Access and power already exist at the site. The operation of the pump station would be simpler compared to options that include pump stations located at multiple sites or at on offsite location. The discharge conveyance system is short compared to offsite options.

For the Sedimentation Basin Pump Station option, TPS and HPS would not be used. All of the needed pumping capacity could be developed at the Sedimentation Basin Pump Station using conventional vertical propeller pumps or screw/helical pumps. For this option a new intake would be needed. The intake would be immediately downstream from the entrance to the right bank fish ladder. New trashracks would be required on the river to remove large debris and keep larger fish from entering the intake. A wall would be constructed across the sedimentation basin to isolate the existing drum screens and the southern end of the existing sedimentation basin. The wall would be necessary to optimize the balance of the flow rates through the fish screens.

For the Vertical Propeller Sedimentation Basin Pump Station option, a fish screen would be constructed in the basin, and a pump station would be constructed to lift the water to a new canal where it would then gravity flow to a discharge location just upstream from the TC and Corning canal intakes. The drum screens would be isolated and out of service during operation of the Sedimentation Basin Pump Station. A fish bypass system would be constructed to remove the fish from the front of the screens. Fish bypass pipelines would convey water and fish from the screens to fish-friendly screw or helical pumps. These fish bypass pumps would lift the water and fish to an elevation necessary to discharge into the existing fish bypass system.

For the Screw/Helical Pump Sedimentation Basin Pump Station option, a bank of screw or helical pumps would lift the water and fish to a discharge channel where the fish would be removed from the water by vertical fish screens similar to those at RPP. The fish and bypass water would enter a new fish bypass system that connects to the existing drum screen bypass system for conveyance to the existing bypass outlet in the Sacramento River.

Advantages. The sedimentation basin pump station was identified as an option because all of the needed pumping capacity could be developed onsite. Access and power already exist at the site, and the operation of the pump station would be simpler compared to options that include pump stations located at multiple sites or at one offsite location. The discharge conveyance system is short compared to offsite options.

Disadvantages. Biologically, this option appears to be the least desirable. A pumped fish bypass would have to be constructed. The biological risks are that fish would not find the bypass system and would be delayed in their pool area in front of the fish screen, or that predators would have an unnatural advantage over juvenile salmonids where the fish congregate in the slow-moving pools, particularly during minimum water delivery periods.

This is also the most complex construction scheduling pumping option. The schedule would need to be phased to consider and avoid impacts to existing operations. The water supply provided by the RPP screw pumps might not be available during construction of the Sedimentation Basin Pump Station because of the intake channel and fish screen structure.

Property acquisition would be required for this option. Part of an existing walnut orchard would be removed from production. A land use variance may be required to remove the land from existing agricultural use.

The sedimentation basin would be highly vulnerable to sediment deposition in front of the fish screens. This condition would warrant continuous sediment management and would require periodic dredging.

Screening Evaluation.

Effectiveness

- This option is considered the least biologically effective because of the “dead end” pool in front of the fish screens. Effective fish management depends on the ability of the fish to find and use the bypass entrance along the fish screens.
- This option is not considered as fish friendly as the options that screen the fish in the river.
- Sediment deposition could be a significant maintenance requirement to maintain the effective wetted fish screen areas.

Environmental

- There would be some impact associated with construction of the intake facilities. Cofferdams would be constructed in the river for the construction of the intake channel. The cofferdams could impact the effectiveness of the right bank fish ladder.
- The site in the intake channel is already used for water diversion, so there are no impacts on cultural resources or land uses.
- The proposed forebay, pump station, and discharge channel would be sited on land that is presently in agricultural use. Several mature walnut trees would be removed from production under the proposed facility layout.

Implementability

- A USACE permit would be required to perform construction in the Sacramento River.

Cost

- Land purchase would be required to implement this option, and a variance may be required to remove the land from agricultural use.
- The complexity of construction scheduling is high for this option; the existing facilities would need to remain in operation during the construction of the new Sedimentation Basin Pump Station facilities.
- Discharge piping from the existing RPP may need to be rerouted to permit the construction of the intake channel and the fish screen structures.

Conclusion. The disadvantages of the sedimentation basin pump station option, particularly the negative biological impacts to fish, the complexity of construction sequencing, and the high potential for sediment deposition far outweigh the advantage of developing a full-capacity pump station onsite. **Therefore, the Sedimentation Basin Pump Station will not be considered further**.

Offsite Pump Station Facilities

Ten potential pump station locations were identified in the Prescoping Report in addition to the existing location at RBDD. After preliminary screening during Phase I, one upstream site, the Mill Site, and one downstream site, Site 2, were judged to be superior to other site options and retained for further evaluation during Phase II.

A pumped fish bypass would be required for either of the offsite locations because there is not enough gradient in the river to drive a gravity bypass system. The river characteristics are similar at the Mill Site and Site 2, although Site 2 has a greater water depth, which reduces the required length of the fish screens. The entire peak pumping capacity could be developed at either of the offsite locations, thus eliminating the disadvantages of multiple pump station locations and the complexity associated with construction scheduling and sequencing at RBDD, potential interference from the existing structures, and the potential operating impacts.

Mill Site Pump Station – Screw/Helical Pumps. Fish-friendly pumps were identified as a potential option because the existing drum screens and fish bypass system could be used, and a new fish screen along the river would not be required. Trashracks would be similar to the existing trashracks used in front of RPP and would be installed along the river. The Outlet B screens would be used to screen fish. The fish bypass system would be over 4,000 feet long, including the discharge piping from the intake location to the sedimentation basin and the existing bypass piping from the drum screens in the sedimentation basin to the fish bypass outlet in the Sacramento River.

Advantages. The Mill Site screw/helical pump station option would use the existing drum screens and fish bypass system. New on-river fish screens would not be required, but trash-racks and louvers would be needed. The pump station could be constructed independently of the existing RBDD, so there would be no risk of interruptions to current water delivery operations during construction. The site is closest to the existing TC Canal forebay among the potential offsite locations. Power supply is nearby. The proposed use is more compatible with past and current land use on the site and in its vicinity. The potential for bank erosion does not appear to be as great for the Mill Site as for Site 2.

Disadvantages. A biological disadvantage of the screw/helical pump option is that it removes more fish from the river than the options with fish screens along the river. Because this option potentially removes more fish from the river than any other pump station option being considered, it would appear to be the least biologically desirable option.

Another disadvantage is the limited operating experience with the screw/helical pumps. There is no long-term operating experience with this type and size of pump in this configuration. Thus, it is considered the highest operational-risk pumping option and is the least acceptable to water users.

Furthermore, the drum screen mesh size does not meet the current agency fish screening criteria. NMFS has indicated that the mesh size will be acceptable until the mesh needs to be replaced.

At least three times the number of pumps would be required for the screw/helical pump option compared to the vertical propeller pump option because the upper capacity of the screw/helical pumps is limited to about 80 cfs, whereas a 250-cfs vertical propeller pump could be used. Consequently, the cost of a pump station that uses screw/helical pumps is about three times the cost of a pump station that uses vertical propeller pumps. Also, because this option would require more pumps, a larger structure is needed to generate an equivalent pumping capacity compared to a facility that uses propeller pumps.

In addition to a siphon under Red Bank Creek, access from the RBDD site would be provided by a new bridge crossing of the creek. Construction of both the siphon and bridge would result in construction-phase environmental impacts.

Screening Evaluation.

Effectiveness

- The full screw/helical pump option is considered the least biologically effective of the options being evaluated because it removes the most fish from the river.
- The operational effectiveness (long-term performance) of the screw/helical option is unknown because of the short operational history for these pump types in this application.

Environmental

- Because of the need to construct a siphon under Red Bank Creek and a bridge across the creek, this option would have some temporary negative environmental impacts associated with the need to remove riparian vegetation.
- A cofferdam would need to be constructed in the river to allow the construction of the trashracks and louvers. This would have some short-term biological and water quality impacts.
- The Mill Site is currently vacant. It was used in the past for industrial purposes. However, because of its previous uses, there is some concern about hazardous waste

contamination. Preliminary investigations suggest that any cleanup would be relatively minor, but further investigation is needed to confirm the preliminary findings. Because this site was previously in industrial use, no significant long-term site impacts are anticipated.

Implementability

Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.

- Construction of trashracks along the river would require a USACE permit.
- This option would require purchase of land.
- Compared to Site 2, the property at the Mill Site appears to be more available for purchase. It is currently being offered for sale.
- NMFS's acceptance of the screw/helical pumps for full-scale operation would be required to implement this option. If NMFS does not approve the use of screw/helical pumps, this option would not be implementable.

Cost

- The cost of developing the Mill Site using screw/helical pumps is higher than the cost of using vertical propeller pumps at this site. The cost of each screw or helical pump is much greater than the cost of each vertical propeller pump even though the capacity is about one-third. Although fish screens are not needed, an intake structure is still required along the river, which partially offsets the advantage of not having to install the in-river fish screens.
- The O&M costs are expected to be higher than those for the option of using vertical propeller pumps at this site because of the slightly less efficient pumps and the greater number of pumps to maintain.
- The long-term performance O&M costs are unknown because of the limited operating experience in this size, configuration, and application.

Conclusion. Because of the biological disadvantages associated with removing fish from the river and the long bypass, the lack of long-term operating experience, the limited mechanical performance history, and the higher cost and lower efficiency of screw pumps compared to vertical propeller pumps, **the pumping option of using screw/helical pumps for full capacity pumping at the Mill Site will not be considered further.**

Mill Site Pump Station – Vertical Propeller Pumps. For the vertical propeller pump option, the discharge piping would be routed to a new outlet structure at the sedimentation basin. It is assumed that the drum screens would be removed under this option. When the gates are in, water would be diverted by gravity through the fish screens into the new forebay and would then bypass the pump station into the conveyance system for delivery to the sedimentation basin.

Advantages. The Mill Site pump station could be constructed independently of the existing facilities and, therefore, would not interfere with the operation of, nor be impacted by, the existing structures. This site has several advantages compared to Site 2. The facility is near the existing RBDD, which requires a shorter conveyance pipeline than would be needed at Site 2. The land where the pump station would be constructed is adjacent to land owned by the federal government for RBDD and is currently available for purchase. Power supply is nearby, and access is in place. However, direct access to the site from the existing RBDD site would require a bridge across Red Bank Creek.

The conveyance system is shorter for the Mill Site Pump Station option compared to the Site 2 Pump Station option. The use of the Mill Site for a pump station is more compatible with current and past land uses.

The existing RBDD provides a hard point in the river that would help to protect bank stability. The potential for bank erosion is not as great for the Mill Site as for Site 2.

Disadvantages. A disadvantage with the Mill Site is that the conveyance system would need to cross under Red Bank Creek by means of a siphon. This could result in temporary environmental impacts during construction because of the need to remove riparian vegetation and disturb riparian habitat. Because the site was used for industrial purposes, there is a potential that hazardous wastes occupy the site, which would have to be cleaned up during construction. However, preliminary data searches and site observations have suggested that very little cleanup would be required. This option also would require a pumped fish bypass because of the long exposure time along the in-river fish screens.

Screening Evaluation.

Effectiveness

Internal fish bypasses would be required at this location. The number of bypasses depends on the pumping capacity that is developed at this location.

- Because of the longer screen length than at Site 2, this option could have one more bypass pipe and pump than required for the same capacity at Site 2.
- The use of in-river fish screens is considered more biologically effective than the options that remove fish from the river.
- Vertical propeller pumps are slightly more efficient than screw/helical pumps and have a longer-term operational history. Construction of offsite pumping facilities would have no impact on present water deliveries.

Environmental

- Like the screw/helical option, this option requires the construction of a siphon under Red Bank Creek and a bridge across the creek. This construction would result in some temporary negative environmental impacts associated with the need to remove riparian vegetation and disturb riparian habitat.
- There would be a need to construct a cofferdam in the river to allow the construction of the fish screens. This could have temporary biological and water quality impacts.
- The length of the fish screens is longer at this location compared to the Site 2 for the same amount of intake capacity because of the shallower depth at the Mill Site.

- Because of its previous industrial uses, there is some concern about hazardous waste contamination.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.
- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. It is currently offered for sale.
- NMFS's acceptance of the screw/helical pumps for the internal fish bypass system would be required.

Cost

- The construction cost per unit of water delivery capacity is less for the Mill Site vertical propeller pump station option than for Site 2. It is also less than for the screw/helical pump option at the Mill Site.

Conclusion. The Mill Site vertical propeller pump station has several advantages compared to the other options. It can be built without interfering with current operations at RBDD and has lower construction costs than the other offsite pump station location that is being considered. Land is currently available for purchase at this site. **Because of these positive benefits compared to other offsite pump station options, the Mill Site vertical propeller pump option will be carried forward into the preliminary design.**

Site 2 Pump Station – Vertical Propeller Pumps. Site 2, the Walnut Orchard Site, is located approximately 2 miles downstream from the existing RBDD. The site is currently used for a walnut orchard. The intake from the Sacramento River would be about 1 mile east of the TC Canal. A pump station using either Archimedes screw or helical pumps was identified as a possible option for this location. Because of the cost and capacity limitation of the screw/helical pumps, that option was disqualified from further consideration.

Site 2 facilities would include fish screens in the Sacramento River, a forebay, a structure for the pumps, an electrical building, conveyance pipelines, and discharge structures. Peak pumping capacity would vary from zero to 2,500 cfs, similar to the required capacities for the Mill Site, depending on the alternative and combination of onsite and offsite pump stations selected.

Advantages. The principal advantage of all offsite pump station options is that the pump station and related facilities can be constructed completely independently of the existing facilities. Therefore, construction would not impact current operations and would not be impacted by the existing facilities. The river at Site 2 is deeper than at the Mill Site. The greater water depth is more favorable for an intake, results in a shorter fish screen, and potentially requires one less fish bypass than at the Mill Site.

Disadvantages. A biological issue of concern at Site 2 is the potential for the presence of valley elderberry shrub. This shrub provides essential habitat for the valley elderberry longhorn beetle, which is listed as a threatened species under the federal ESA. This vegetation would need to be permanently removed for the construction of in-river fish screens at this location.

Site 2 is not as desirable as the Mill Site because it is more remote from RBDD, being about 2 miles downstream. The intake site is approximately 1 mile from the TC Canal, compared to about one-half mile for the Mill Site. Therefore, the conveyance system is about twice the length of that needed for the Mill Site.

The land uses at and adjacent to the Mill Site are more compatible with the pump station than at Site 2 because all of the facilities at Site 2 would be constructed on currently private lands. Site 2 is in agricultural production, whereas the Mill Site was previously used for industry. A substantial number of productive walnut trees would need to be removed for construction of the facilities. Site 2 would also require more land purchase than the Mill Site because of the greater length of the conveyance system. About one-half of the conveyance system required for delivering water to the TC Canal at the Mill Site is already on USBR-administered property.

Power is not available at Site 2; therefore, a power supply would have to be developed. Access to the site would also need to be developed. The access road would follow the route of the conveyance facilities from the TC Canal to the river. The access road would be approximately 1 mile long.

The land immediately downstream from Site 2 was recently purchased under SB 1086 as part of the program to restore the riparian wetland zones along the Sacramento River. The land where the pump station would be located could be purchased for riparian restoration, or at least development of the site could meet stiff opposition from groups interested in restoring that reach of the Sacramento River to a natural meandering river. Even if the site itself were not within the free and natural river restoration area, converted nearby lands that were restored to the natural and meandering state would significantly influence the stability of the river at that location.

The preliminary geotechnical engineering evaluation, which included site observations from the river and a review of the foundation drawings of the existing RBDD, indicated that H-piles could be required to support the pump station structure at Site 2. Preliminary geotechnical review also indicated that H-piles and their associated higher cost would not be necessary at the Mill Site. Exploratory test hole excavations and laboratory analysis of soil samples are needed to confirm foundation conditions.

Screening Evaluation.

Effectiveness

- Internal fish bypasses would be required at this location. The number of bypasses depends on the pumping capacity that is developed at this location, and could potentially have one less bypass pipe and pump than required for the same capacity at the Mill Site.
- Land downstream from this location was recently purchased under SB 1086 to restore the river to a natural meandering waterway. The land upstream from the site could also be purchased for the same purpose, and would make this location much more vulnerable to erosion than the Mill Site, which is protected by the existing RBDD structure.

- Of the two offsite locations being considered, Site 2 is the more remote from RBDD, which reduces the effectiveness of operations.

Environmental

- The length of the fish screens is shorter at Site 2 compared to the Mill Site for the same amount of intake capacity because of the deeper water at Site 2.
- More riparian vegetation would be removed at Site 2 compared to the Mill Site, resulting in permanent removal of existing riparian vegetation and wildlife habitat.
- There is a need to construct a cofferdam in the river to allow the construction of the fish screens. This could cause temporary biological and water quality impacts.
- Site 2 is currently a walnut orchard with mature producing walnut trees that would need to be removed. Since this pump station would be a change to the current agricultural land use, there would be long-term site impacts, such as increased noise and traffic in the local vicinity.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with the operation of the existing facilities.
- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. Land acquisition at this site is anticipated to be more difficult than at the Mill Site since the Mill Site is currently offered for sale.
- The acquisition of land at Site 2 may be opposed by river restoration enthusiasts who would like to see this stretch of the river restored to its natural and wild state and would oppose a hard point on the river at this location.
- NMFS's acceptance of the screw/helical pumps for the internal fish bypass system would be required.

Cost

- The construction cost of this pump station option is higher than the Mill Site vertical propeller pump station option primarily because of the longer conveyance pipeline and the anticipated need to support the structures on piles.
- The pumping cost would also be higher because of the higher lift requirements.

Conclusion. The Mill Site Pump Station has several apparent advantages over the Site 2 Pump Station. **Because of these advantages, the pump station option at the Mill Site is the preferred option and will be carried into preliminary design.**

However, **because only preliminary site investigations have been completed at the Mill Site, site constraints and development requirements are not fully known. With these unknown factors, Site 2 will be retained in abeyance but will not be carried into preliminary design.** If it becomes apparent as the design process and the NEPA/CEQA documentation proceed that the Mill Site is no longer feasible, then Site 2 will be reconsidered.

Bow River Pump Station. Site 3, the Bow River Site, is about two-thirds mile downstream of the confluence of the Bow River with the Sacramento River across from the Bow River trailer park. The project reach is about 1,600 feet long in water depths of 9 to 10 feet at low river flows along the outside of a very gradual bend. There is an approximate 0.5-mile bench area from the river's edge to another bank lined with trees. The length of the site would not limit the pump station capacity with the available water depths. The conveyance distance to the TC Canal would be approximately 1.5 miles using a combination of open channel and pipeline. There may be a conflict with existing refuge land associated with this site.

Advantages. The advantages include very sparse vegetation with an exposed steep, stable bank. It is a suitable site to divert the required peak flow of 2,500 cfs.

Disadvantages. A biological issue of concern at Bow River Site is the potential existence of California threatened bank swallow habitat in the area. In addition, there is a potential for the presence of valley elderberry shrub. This shrub provides essential habitat for the valley elderberry longhorn beetle, which is listed as a threatened species under the federal ESA. This vegetation would need to be permanently removed for the construction of in-river fish screens at this location.

Screening Evaluation.

Effectiveness

- Has over 1,000 feet of available shoreline and water depths at low riverflow of about 10 feet, thus presenting no restrictions on screen length.
- Location is on the outside of a gradual bend, and during low river flows would permit screens and diversion capacities to 2,500 cfs.

Environmental

- Requires removal of riparian tree and shrub vegetation along river bank, although vegetation is very sparse.
- California threatened bank swallows were observed in the area, as well as potential swallow habitat.
- Extensive riparian vegetation was found to be present upland of the slope and appeared to be a remnant riparian forest associated with the pre-dam Sacramento River floodplain.
- Elderberry shrubs are present, which are a host plant for federal-listed valley elderberry longhorn beetle.

Implementability

- Construction of pumping facilities at this offsite location would have very limited interference with operation of the existing facilities.

- Construction of fish screens along the river would require USACE, CDFG, and RWQCB permits.
- This option would require purchase of land. Land acquisition at this site is anticipated to be more difficult than at the Mill Site since the Mill Site is currently offered for sale.
- The acquisition of land at Site 3 may be opposed by river restoration enthusiasts who would like to see this stretch of the river restored to its natural and wild state and would oppose a hard point on the river at this location.

Cost

- The construction cost of this pump station option is higher than the Mill Site vertical propeller pump station option primarily because of the longer conveyance.

Conclusion. This site is similar to the orchard site. The shallower depths, longer distance to the TC Canal, and location in protected refuge lands makes this site undesirable. Because of these issues, **Bow River Site will not be considered further**.

Coyote Creek Pump Station. Coyote Creek Site is located just downstream of the confluence of Coyote Creek and the Sacramento River, near the high point of a bend. The bank has been experiencing significant erosion over the last several years, and may have migrated as much as 100 feet. There is evidence of significant bank sloughing, and exposed irrigation pipe remains hanging in the river. The property next to the river is planted in orchards that extend more than half the distance to the TC Canal. The conveyance length from the pump station to the TC Canal is approximately 2.2 miles. The existence of refuge lands is associated with Site 4.

Advantages. The principle advantage to this site is that it has the deepest river depths of all other sites. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The amount of erosion to the bank is of large concern for this site. Orchards exist approximately one-half the distance to the TC Canal. A biological issue of concern at Coyote River Site is the potential existence of California threatened bank swallow habitat in the area. There would be a restricted screen length of about 800 feet and a significant need for bank stabilization. Conveyance length would be more than 2 miles and would require significant operation costs.

Screening Evaluation.

Effectiveness

- Depths at this site were the deepest found.
- The location is on the outside of the apex of a substantial bend in the river. During low riverflows, the deep water at this site would permit screens and diversion capacities to 2,500 cfs.

Environmental

- Requires removal of riparian tree and shrub vegetation along river bank, although vegetation is very sparse and the bank has been severely eroded by recent river scouring.
- California threatened bank swallows were observed in the area, as well as a number of active nests in the exposed bank.
- Vegetation upslope of Coyote Creek Site is currently an orchard, and would need to be removed. Since this pump station would be a change to the current agricultural land use, there would be long-term site impacts, such as increased noise and more traffic in the local vicinity.

Implementability

- The overbank materials are composed of meander point bar scrolls. The river has meandered westward at this location over the past 100 years. There is a significant erosion problem at this location.
- The cutbank is near vertical, approximately 15 feet high, and composed almost entirely of fine silty sand. Riprap has been placed immediately downstream of this site but has appeared to be ineffective.
- The site would be restricted to about 800 feet long, indicated by the depth measurements and proximity to braided junctions of the river downstream.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has very unstable river conditions. It is located within protected refuge lands and has a conveyance length of over 2 miles. Because of these conditions, **Coyote Creek Site will not be considered further**.

Tehama Upstream Pump Station. Tehama Upstream Site at the Town of Tehama lies in a straight reach of the river with orchards on the nearby property. The site is more than 1,000 feet long and has signs of local erosion. According to the geomorphic review, the area upstream of Tehama has been a stable location. The conveyance length from the pump station to the TC Canal is approximately 1.9 miles.

Advantages. The bank is stable more than 1,000 feet along this site. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The primary disadvantage is the long conveyance system, approximately 2 miles, being located in orchards. Quite a bit of development is within a close proximity to the site.

Screening Evaluation.

Effectiveness

- Depths at this site are a minimum of 13 feet, making diversion capacities of up to 2,500 cfs achievable.

Environmental

- The bank is generally exposed, although a small number of elderberry shrubs exist directly adjacent to a large oak located toward the downstream portion of the site.
- Bank swallow habitat is very limited at this site, given the exposed portions of the bank. The soils are not suitable for nesting.
- Upslope vegetation is a combination of riparian forest and orchard. A large portion of it would have to be permanently removed upon construction.

Implementability

- The overbank materials are composed of undifferentiated stream alluvium. This site is immediately upstream of the Tehama Bridge, and the bank slope has had riprap placed for protection.
- According to the DWR geomorphic maps, there has been no meander of the river at this location over the past 100 years.

Cost

- The construction, and possibly the operational costs of this pump station option would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. The location of this site, being upstream of the Town of Tehama, is within close proximity to city development. The location of the 1.9-mile conveyance system is within orchards. The conveyance location would require railroad crossing at one point. Because of these conditions, **Tehama Upstream Site will not be considered further**.

Tehama Downstream Pump Station. Tehama Downstream Site is located just downstream of the Town of Tehama, and has similar characteristics as the upstream site. The site was located along a straight segment of the river and was identified as a stable site in the geomorphic review. The nearby property is open orchards containing grains and alfalfa. The conveyance distance from the pump station to the TC Canal is approximately 1.4 miles.

Advantages. No riparian tree or shrub species exist on the site. The site appears to be benign of environmental issues. The upstream riprap protects the site, and there are no screen length restrictions. The conveyance length from the pump station to the TC Canal is approximately 1.4 miles. It is also very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. Installing the conveyance system through farm land and orchards is a big disadvantage. There is also significant development within close proximity to the site.

Screening Evaluation.

Effectiveness

- The available bank frontage is more than 1,000 feet long with minimum water depths of 10 feet. Screen length and diversion capacity up to 2,500 feet would be achievable at this site.
- The local area around the Town of Tehama is known for overbank flooding during the winter high flows. Evaluation and documentation of the flood-prone areas and depths/elevation would be an important component for the development of the site to assure protection of the pump station and conveyance facilities.

Environmental

- Bank vegetation is limited to exotic grasses, as no riparian tree or shrub species are present within the vicinity of the site along the riverbank. Upslope vegetation is generally agricultural in nature, and Tehama Downstream Site appears to be a benign site in terms of environmental issues.

Implementability

- The bank materials are composed of undifferentiated stream alluvium.
- This site is immediately downstream of the Tehama Bridge, near significant development.
- The river has had very little westward meander over the past 75 to 100 years and is protected by riprap, which was put in place in 1975.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. The location of the site, being downstream from the Town of Tehama, is within an area that is prone to flooding. Extensive studies are anticipated to evaluate impacts of new intake facilities on upstream flooding. This site is a relatively long conveyance delivery system compared to other options. Because of these conditions, **Tehama Downstream Site will not be considered further**.

McClure Creek Pump Station. McClure Creek Site is located on the outside of a significant bend in the river and is currently experiencing a bend cutoff. The upland area is a combination of planted fields and riparian lands. The potential project site has a length of more than 1,000 feet with somewhat swift water velocity because of the restricted river width during low flow. The conveyance distance from the pump station to the TC Canal is approximately 1.1 miles; the river and TC Canal tend to converge at this location.

Advantages. The conveyance distance of 1.1 miles between the river and the canal is relatively short, compared to other locations. The location in the river makes it suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The river has had significant bank meander over the past 100 years. The bend dynamics pose significant problems and has begun to cut the site off. Extensive riparian vegetation exists.

Screening Evaluation.

Effectiveness

- The project at this site has a significant problem with bend dynamics and has begun to cut off.
- The river width along this branch is somewhat narrow, and the velocity was estimated at more than 3 fps.
- The water depth is 12 feet over a length of the site and should support a screen length of more than 1,000 feet. Screen length and diversion capacity up to 2,500 cfs would be achievable at the site.

Environmental

- Very little vegetation is present along the steep riverbank. The slope is dominated by riprap.
- Vegetation upslope from the site is generally mature riparian. Given the density of the trees, it was undetermined how far this vegetation extends beyond the upper point of the riverbank.

Implementability

- The overbank materials are composed of historical meander belt deposits.
- There has been significant meander at this location over the past 100 years.
- The slope is protected by riprap placed in 1978. The river has recently created cutoff upstream of this location.

Conclusion. Because of unstable river conditions, **McClure Creek Site will not be considered further**.

Thomes Creek Pump Station. Thomas Creek Site is along a relatively straight reach of the river just downstream of the confluence with Thomes Creek. The local overbank area is open farmland planted in grains and pasture. The project location is nearly 1.0 mile long with essentially unrestricted potential for screen length. Agricultural land use extends up to the riverbank along the entire reach with few, if any, buildings. The conveyance distance from the river to the TC Canal extends over 2.5 miles because of the eastern direction the river takes.

Advantages. Vegetation is limited at the site. The slope is protected by large riprap, which makes it quite stable. The river at this location is also very stable and has exhibited little meandering over a long period of time. This site is very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. A large, active osprey nest is located upslope on an artificial roost. The length of the conveyance system from the river to the TC Canal would be over 2 miles.

Screening Evaluation.

Effectiveness

- The site lies along an extremely long, straight reach of the river with continuous depths of 9 feet expected at low riverflows.
- The river has been very stable in this area, exhibiting little meander at this location over the past 100 years.

Environmental

- The banks contain a limited amount of riparian vegetation scattered within riprap areas, but ultimately contains little vegetation. Some pockets of vegetation are located downstream and upstream of the site, but overall such vegetation is very limited.
- A large, active nest was observed for the osprey which is on the federal ESA list as threatened. It was situated upslope from the site on an artificial roost directly adjacent to an electric distribution line and dirt road.
- Vegetation in the area is dominated by agriculture.

Implementability

- The overbank materials are composed of undifferentiated stream alluvium.
- The slope is protected by large riprap.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has considerably higher development costs because of the length of the conveyance facilities. The over 2-mile canal is subject to high energy use and annual O&M costs. Because of these constraints, **Thomes Creek Site will not be considered further.**

Deer Creek Pump Station. Deer Creek Site lies along the outside of a bend just upstream of the confluence with Deer Creek. The site is located within a significant bend in the river, which has caused a cutoff to form. Substantial evidence of high flows is noticeable, with large tree trunks embedded in the river bottom. The local overbank area is heavily forested in riparian growth with agriculture within 500 feet.

The project site has a length of over 1,200 feet and would provide unrestricted capacity for a pump station. The conveyance distance from the pump station to the TC Canal is approximately 2.6 miles as the river continues to move to the east at this location.

Advantages. This site is located on a stable bank and is very suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. This site would require the longest conveyance distance from the river to the TC Canal. Bend dynamics pose significant problems at this site because a cutoff has formed in recent time, and the river is now braided. This site is also located within a heavily forested riparian area.

Screening Evaluation.

Effectiveness

- The site is severely limited by the bend dynamics and has begun to cut off. The river width along this branch is narrow and sustains high velocities estimated in excess of 4 fps.
- The water depths are about 13 feet along the site and should support a screen length of more than 1,000 feet. Screen length and diversion capacity up to 2,500 cfs would be achievable at this site.

Environmental

- The 10-foot riverbank is dominated by riprap and rock. It contains limited riparian trees and shrubs. A dense riparian forest is upslope from the slope.
- Agricultural lands exist near the site.

Implementability

- The overbank materials are composed of stream channel, point bar, and floodplain deposits.
- There has been significant meander at this location over the past 100 years.
- The slope is protected by riprap, which was placed onsite in 1963.
- The river has recently created a cutoff upstream of this location. There has been significant erosion downstream of this site.

Cost

- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. Unstable river conditions and an excessively long conveyance delivery system create a high energy use and annual maintenance cost**.** Because of these constraints, **Deer Creek Site will not be considered further.**

Woodson Bridge Pump Station. Woodson Bridge Site at Woodson Bridge is both upstream and downstream of the bridge along a steep bluff, just below a 90-degree bend in the river. Substantial depths were noted for more than 1,500 feet; however, these depths were located entirely within the residential/commercial zone. Downstream of the developed area the water depths decreased to below desired levels. The conveyance distance from the pump station to the TC Canal is approximately 2.4 miles.

Advantages. The bank is very stable and suitable to divert the required peak flow of 2,500 cfs.

Disadvantages. The length of the conveyance system from the river to the TC Canal would be over 2 miles. The conveyance location would be in residential/commercial land use zones and would require costly utility relocations.

Screening Evaluation.

Effectiveness

- The project site includes a total length of more than 1,400 feet with water depths over 14 feet expected at low riverflow.
- About 600 feet upstream of the bridge and 800 feet downstream a project could be located without limiting diversion capacity.
- Although the site is just below a severe bend in the river, the Riverbank Formation was exposed along the bank and has exhibited stable conditions.
- Screen length and diversion capacity up to 2,500 cfs would be achievable at the site.

Environmental

- The project site is located within a developed residential and commercial area that would have significant environmental impacts associated with this location.
- Extensive mitigation requirements and right-of-way/easements would be needed for a project at this location.
- The area is heavily wooded along the banks throughout the residential area and is bisected by the Woodson Bridge.

Implementability

- The overbank materials are composed of Riverbank Formation as evidenced by the steep banks.
- There has been very little migration of the river at this location over the past 100 years.
- The site was identified as a stable location during the geomorphic review.

Cost

- Utility replacement and relocation would require a substantial project investment that would not appear to be outweighed by benefits of the site.
- The construction, and possibly the operational costs of this pump station option, would be significantly higher than other options, primarily because of the longer conveyance.

Conclusion. This site has considerably higher development costs because of the length of the conveyance facilities. This site also has the highest energy use and annual maintenance cost of any other site. Because of these constraints, **Woodson Bridge Site will not be considered further.**

Development of Final Alternatives

Following the full consideration of the facility options and gate operation restrictions engendered by ESA, the following alternatives are proposed for full environmental analysis. Additionally, these alternatives will be subjected to a maximum benefit analysis consistent with the requirements of the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies published by the U.S. Water Resources Council in 1983 (commonly referred to as the "Principles and Guidelines" or "P&G"). The final alternatives are summarized in Table A-6. Table A-6 also includes a summary of the existing condition presented by operation of RBDD and the likely condition that would exist under the No Action condition.

As initially proposed, the alternatives consisted of a range of gate operations from current 4-month gates-in operations to gates-out operation. Nomenclature for these alternatives initially consisted of the following:

Alternative 1: 4-month gates-in with improvements to agricultural water reliability and fish passage.

Alternative 2: 2-month gates-in with improvements to agricultural water reliability and fish passage.

Alternative 3: 0-month gates-in with improvements to agricultural water reliability and fish passage.

The final alternatives that will be carried forward consist of variations of these initial alternatives with specific details about the facilities associated with these alternatives.

1A: 4-month Improved Ladder Alternative

The 4-month Improved Ladder Alternative would continue the current operation of the dam with a 4-month gates-in (May 16 to Sept 15) period. Improved agricultural water deliveries would be achieved with operation of 1,700 cfs of pumping capacity (320 cfs at RPP; 1,380 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of new ladders (right 800 cfs, left 831 cfs, for a total of 1,631 cfs). If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring.

1B: 4-month Bypass Alternative

The 4-month Bypass Alternative would continue the current operation of the dam with a 4-month gates-in (May 16 to Sept 15) period. Improved agricultural water deliveries would be achieved with operation of 1,700 cfs of pumping capacity (320 cfs at RPP; 1,380 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of new ladders at the right abutment (800 cfs). A 1,000-cfs bypass channel for fish passage would be constructed at the left abutment near the existing SRDC. If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring with a bypass channel.

TABLE A-6

Summary of Final Alternatives

	Gates-in Operation		Fish Passage Facilities			Gates-out Water Supply				
Name	Duration	Timing	Right Bank (cfs)	Center (cfs)	Left Bank (cfs)	Research Pumping Plant (cfs)	Right Fish Ladder (cfs)	Mill Site (cfs)	Stony Creek (cfs)	Total (cfs)
Existing Conditions	4 months	May 15 through Sept 15	Existing 338	Existing 100	Existing 338	240	165		600	1,005
No Action Alternative	4 months	May 15 through Sept 15	Existing 338	Existing 100	Existing 338	320	165		600	485
1A: 4-month Improved Ladder Alternative	4 months	May 15 through Sept 15	New 800	Add if needed	New 831	320		1,380		1,700
1B: 4-month Bypass Alternative	4 months	May 15 through Sept 15	New 800	Add if needed	Bypass channel 1,000; existing 338	320		1,380		1,700
2A: 2-month Improved Ladder Alternative	2 months	July 1 through August 31	New 800	Add if needed	New 831	320		1,680		2,000
2B: 2-month with Existing Ladders Alternative	2 months	July 1 through August 31	Existing 338	Existing 100	Existing 338	320		1,680		2,000
3: Gates-out Alternative	0 months					320		2,180		2,500

2A: 2-month Improved Ladder Alternative

The 2-month Improved Ladder Alternative would reduce the current operation of the dam to a 2-month gates-in (July 1 to Aug 31) period. Improved agricultural water deliveries would be achieved with operation of 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Improvements to fish passage would be achieved with construction and operation of new ladders (right 800 cfs, left 831 cfs, for a total of 1,631 cfs) and the reduction in gates-in operation. If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring, although this is considered unlikely because of the absence of spring-run chinook salmon under this condition.

2B: 2-month with Existing Ladders Alternative

The 2-month with Existing Ladder Alternative would reduce the current operation of the dam to a 2-month gates-in (July 1 to Aug 31) period. Improved agricultural water deliveries would be achieved with operation of 2,000 cfs of pumping capacity (320 cfs at RPP; 1,680 cfs at Mill Site). Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would continue to be operated at the right and left abutments (right 338 cfs, left 338 cfs, for a total of 676 cfs). If deemed necessary, the center ladder would be constructed following a period of fish passage monitoring, although this is considered unlikely because of the absence of spring-run chinook salmon under this condition.

3: Gates-out Alternative

The Gates-out Alternative would reduce the current operation of the dam to a 0-month gates-in period, leaving the gates in the raised position year-round. Improved agricultural water deliveries would be achieved with operation of 2,500 cfs of pumping capacity (320 cfs at RPP; 2,180 cfs at Mill Site). Improvements to fish passage would be achieved through the reduction in gate operations. Existing ladders would no longer operate.

Fish Passage Benefits Analysis

A fish passage evaluation was conducted for final alternatives using a spreadsheet tool developed expressly for the Fish Passage Improvement Project at the Red Bluff Diversion Dam. The fish passage tool (informally referred to as "Fishtastic!") was used as a tool for evaluating RBDD Fish Passage Improvement Project alternatives against one another. Although the methodology is built upon biological data, it is not a biological evaluation of fish passage conditions at RBDD. It is intended solely to focus attention on aspects of the alternatives that have the greatest potential for improving fish passage at RBDD and to provide a means for conducting sensitivity analyses on different assumptions.

General Approach

Fishtastic! uses temporal species distribution to determine when different life stages of fish are expected to encounter RBDD. The "cost" or "effect" of encountering RBDD was assigned a score of zero to one (where zero is completely ineffective and one is totally effective) based on subjective assumptions about the relative effect of existing facilities compared to potential future facilities. The effects of the dam were separated into two distinct parts – upstream effect on adults and downstream effect on juveniles. A number of studies on the physical effects of the dam were reviewed and updated according to current investigations and professional judgement.

For adults, the primary effects are based on delay at the dam and ability to pass ladders or bypass facilities. For juveniles, the primary effects are the combined presence of predators below the dam and juveniles migrating downstream. Other factors considered included flow, size of the facilities, and physiology of different species of fish. The degree of effect for the various facilities was estimated using existing information and studies that have been conducted at the dam, peer-reviewed research at other facilities, and professional judgement. The results of the Fishtastic! analysis have been reviewed by the agency development team.

Fishtastic! results are characterized by the degree of effect each alternative has on the annual percentage of fish species, both adult and juvenile, that passes the dam. When the dam gates are raised, there is no effect. When the gates are lowered, there is a variable amount of effect that depends on the physical characteristics of the fish, facility assumptions, and flows. The maximum fish passage index is 100, which would be interpreted as 100 percent of either adult or juvenile fish passing the dam with no effect.

Fishtastic! initially evaluated impacts to all fish that migrate past the dam, but following a series of workshops, the analysis narrowed its scope to key focus species, which include the four runs of chinook salmon (winter, spring, fall, and late-fall runs), resident rainbow trout, anadromous steelhead, and green sturgeon. These fish were deemed to warrant a higher level of analysis than other fish because of their life cycle requirement to be upstream of the dam in combination with their commercial, recreational, and/or protected status. Results of the Fishtastic! focus species analysis are summarized in Tables A-7, A-8, A-9, and A-10.

Tables A-7 and A-8 show that operation of the dam gates has a variable effect on all adult focus species with the exception of late-fall-run salmon, which is unaffected by dam gates operation. Because there is no impediment to fish passage when the dam gates are raised, the Gates-out Alternative provides the greatest benefit to adult focus species, with a total fish passage score of 148. 2-month Improved Ladder and 2-month Existing Ladders alternatives also provide a significant benefit to adult focus species fish passage, with total scores of 119 and 114, respectively. 4-month Improved Ladder and 4-month Bypass Channel alternatives represent minimal benefit to adult focus species fish passage, with total scores of 20 and 16, respectively.

TABLE A-7
Summary of Fishtastic! Adult Focus Species

	Alternatives					
Adult Focus Species	**No Action**	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	90	91	91	98	98	100
Spring-run salmon	52	61	57	94	93	100
Fall-run salmon	83	86	85	91	89	100
Late-fall-run salmon	100	100	100	100	100	100
Rainbow trout	73	78	76	91	90	100
Steelhead	89	91	90	97	96	100
Green sturgeon	65	65	69	100	100	100

TABLE A-8
Comparison of Final Alternatives Adult Focus Species Analysis to No Action Alternative

	Alternatives Difference from No Action Alternative				
Adult Focus Species	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	1	1	8	8	10
Spring-run salmon	9	5	42	41	48
Fall-run salmon	3	2	8	6	17
Late-fall-run salmon	0	0	0	0	0
Rainbow trout	5	3	18	17	27
Steelhead	2	1	8	7	11
Green sturgeon	0	4	35	35	35
Total	**20**	**16**	**119**	**114**	**148**

TABLE A-9
Summary of Fishtastic! Juvenile Focus Species

	Alternatives					
Juvenile Focus Species	**No Action**	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	96	96	96	99	99	100
Spring-run salmon	99	99	99	100	100	100
Fall-run salmon	97	97	97	99	99	100
Late-fall-run salmon	94	94	94	98	98	100
Rainbow trout	92	92	92	98	98	100
Steelhead	92	92	92	99	99	100
Green sturgeon	73	73	73	88	88	100

TABLE A-10
Comparison of Final Alternative Juvenile Focus Species Analysis to No Action Alternative

	Alternatives Difference from No Action Alternatives				
Juvenile Focus Species	**4-month Improved Ladder**	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Winter-run salmon	0	0	3	3	4
Spring-run salmon	0	0	1	1	1
Fall-run salmon	0	0	2	2	3
Late-fall-run salmon	0	0	4	4	6
Rainbow trout	0	0	6	6	8
Steelhead	0	0	7	7	8
Green sturgeon	0	0	15	15	27
Total	**0**	**0**	**38**	**38**	**57**

Tables A-9 and A-10 show that operation of the dam gates has a minimal effect on all juvenile focus species. Again, the Gates-out Alternative represents no impediment to fish passage. Consequently, the Gates-out Alternative provides the greatest benefit to juvenile focus species, with a total fish passage score of 57. The 2-month Improved Ladder and 2-month Existing Ladders alternatives result in a fish passage score of 38, and both 4-month alternatives result in a fish passage score of 0.

Table A-11 illustrates the breakdown of capital and O&M costs into fish passage costs and agriculture costs. Column A, Fish Passage, shows the set costs for fish passage facilities (e.g., fish ladders, bypass channel) for each alternative. Column A, Pumping Facilities, shows the

TABLE A-11
Alternatives Cost Comparison Allocated to Fish Passage and Agriculture

	Capital Costs				O&M Costs			
	A	B	C	D	E	F	G	H
Alternative	Fish Passage	Fish Share of Pumping	Total Fish Capital Cost	Annualized Cost	Passage Facility Maintenance	Fish Share of Pumping Maintenance	Total Fish O&M	Total Fish Passage Annualized Cost
No Action								
4-month Improved Ladder	$15,400,000	$36,208,400	$51,608,400	$3,139,249		$244,425	$244,425	$3,383,674
4-month Bypass Channel	$21,100,000	$36,208,400	$57,308,400	$3,485,970		$244,425	$244,425	$3,730,395
2-month Improved Ladder	$15,400,000	$46,108,400	$61,508,400	$3,741,499		$212,843	$212,843	$3,954,292
2-month with Existing Ladders		$46,108,400	$46,108,400	$2,804,693		$212,843	$212,843	$3,017,536
Gates-out		$55,108,400	$55,108,400	$3,352,148		$188,575	$188,575	$3,540,722
	Pumping Facilities	Agriculture Share of Pumping Facilities	Total Agriculture Capital Cost	Annualized Cost	Pumping Facility Maintenance	Agriculture Share of Pumping Maintenance	Total Agriculture O&M	Total Agriculture Annualized Cost
No Action					$370,000	$370,000	$370,000	
4-month Improved Ladder	$69,100,000	$32,891,600	$32,891,600	$2,000,739	$466,460	$222,035	$222,035	$2,222,774
4-month Bypass Channel	$69,100,000	$32,891,600	$32,891,600	$2,000,739	$466,460	$222,035	$222,035	$2,222,774
2-month Improved Ladder	$79,000,000	$32,891,600	$32,891,600	$2,000,739	$406,189	$193,346	$193,346	$2,194,085
2-month with Existing Ladders	$79,000,000	$32,891,600	$32,891,600	$2,000,739	$406,189	$193,346	$193,346	$2,194,085
Gates-out	$88,000,000	$32,891,600	$32,891,600	$2,000,739	$359,875	$171,301	$171,301	$2,172,039

Note: Allocation of pumping costs to fish includes 600 cfs for Stony Creek, 165 cfs for fish ladder pumps, and the pumping difference between gate operations.

set costs for pumping facilities for each alternative. Column B shows the distribution of the costs for pumping facilities, as allocated to fish passage and agriculture[1]. The cost of pumping facilities allocated to agriculture is the same for all alternatives, but the cost difference among alternatives is allocated to fish passage. Column C shows the total capital costs for each alternative. Column C, Total Fish Capital Cost, totals the fish passage facility costs plus the fish passage share of pumping facilities. Column C, Total Agriculture Capital Cost, shows that the capital costs for agriculture are limited to the agriculture share of pumping facilities. Column D shows the total capital costs for fish passage and agriculture, annualized at 6.125 percent for 50 years.

Columns E, F, and G show O&M costs for each alternative, as allocated to fish passage and agriculture. Column H shows total annualized costs (capital and O&M) for each alternative as allocated to fish passage and agriculture.

Table A-12, uses the fish passage scores from Fishtastic! (shown in Tables A-7 through A-9) plus the total fish passage annualized costs (Column H in Table A-11) to achieve a cost-benefit analysis of fish passage for each alternative. Table A-12 shows the number of units of fish per million dollars for each alternative for adult and juvenile focus species.

As shown above, the alternative that provides the greatest cost benefit for fish passage is the Gates-out Alternative, with 57.91 units of fish per million dollars. The 2-month with Existing Ladders Alternative follows with 50.33 units of fish per million dollars, and the 2-month Improved Ladder Alternative is third with 39.85 units of fish per million dollars. The 4-month Improved Ladder and 4-month Bypass Channel alternatives provide the lowest cost benefit for fish passage, with 5.92 and 4.29 units of fish per million dollars, respectively.

There is some disagreement among parties about how pumping costs should be allocated. Because of this disagreement, the above analysis was repeated where only the cost of the pumping difference between gate operations is allocated to fish passage; all other pumping costs are allocated to agriculture. Table A-13 illustrates the breakdown of capital and O&M costs into fish passage costs and agriculture costs under this scenario. All other factors remain as described previously.

Table A-14 uses the fish passage scores from Fishtastic! (shown in Tables A-7 through A-9) plus the total fish passage annualized costs (Column H in Table A-13) to achieve a cost-benefit analysis of fish passage for each alternative under this revised cost allocation scenario. Table A-14 shows the number of units of fish per million dollars for each alternative for adult and juvenile focus species.

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[1] Under Existing Conditions, 240 cfs comes from RPP, 165 cfs from the right fish ladder, and 600 cfs from Stony Creek, for 1,005 cfs during the gates-out period. Under the No Action Alternative, the pumping capacity at RPP would be increased to 320 cfs, and the Stony Creek pumping would be eliminated, for 485 cfs during the gates-out period. Under the two 4-month gates-in alternatives, 320 cfs would come from RPP, and 1,380 cfs would come from the Mill Site, for a total of 1,700 cfs during the gates-out period. Under the two 2-month gates-in alternatives, 320 cfs would come from RPP, and 1,680 cfs would come from the Mill Site, for a total of 2,000 cfs during the gates-out period. Under the 0-month gates-in alternative, 320 cfs would come from RPP, and 2,180 would come from the Mill Site, for a total of 2,500 cfs during the gates-out period.

To allocate pumping facilities costs to fish passage and agriculture, fish passage was assigned the cost of 600 cfs from Stony Creek, 165 cfs from the right fish ladder, and the pumping difference between gate operations. Agriculture was assigned the cost of the difference between pumping 240 cfs at RPP under Existing Conditions and pumping 320 cfs at RPP under all alternatives plus the remainder of pumping capacity required. The allocation of costs is illustrated in Table A-13.

TABLE A-12
Unit Adult and Juvenile Focus Species per Million Dollars Annualized Cost

	Alternatives				
	4-month Improved Ladder	**4-month Bypass Channel**	**2-month Improved Ladder**	**2-month with Existing Ladders**	**Gates-out**
Adult Focus Species					
Winter-run salmon	0.30	0.27	2.03	2.65	2.82
Spring-run salmon	2.66	1.34	10.66	13.58	13.56
Fall-run salmon	0.89	0.54	2.03	1.99	4.80
Late-fall-run salmon	--	--	--	--	--
Rainbow trout	1.48	0.80	4.57	5.63	7.63
Steelhead	0.59	0.27	2.03	2.32	3.11
Green sturgeon	--	1.07	8.88	11.59	9.89
Total	**5.92**	**4.29**	**30.20**	**37.75**	**41.81**
Juvenile Focus Species					
Winter-run salmon	--	--	0.76	0.99	1.13
Spring-run salmon	--	--	0.25	0.33	0.28
Fall-run salmon	--	--	0.51	0.66	0.85
Late-fall-run salmon	--	--	1.02	1.32	1.69
Rainbow trout	--	--	1.52	1.99	2.26
Steelhead	--	--	1.78	2.32	2.26
Green sturgeon	--	--	3.81	4.97	7.64
Total	**--**	**--**	**9.64**	**14.67**	**16.10**
Combined Total	**5.92**	**4.29**	**39.85**	**50.33**	**57.91**

As shown above, the alternative that provides the greatest cost benefit for fish passage as indicated by the revised cost allocation scenario is the 2-month with Existing Ladders Alternative with 185.37 units of fish per million dollars. The Gates-out Alternative follows with 152.99 units of fish per million dollars, and the 2-month Improved Ladder Alternative is third with 89.71 units of fish per million dollars. The 4-month Improved Ladder and 4-month Bypass Channel alternatives provide the lowest cost benefit for fish passage, with 16.95 and 10.46 units of fish per million dollars, respectively.

TABLE A-13
Alternatives Cost Comparison Allocated to Fish Passage and Agriculture (Revised Cost Allocation Scenario)

	Capital Costs				O&M Costs			
	A	B	C	D	E	F	G	H
Alternative	Fish Passage	Fish Share of Pumping	Total Fish Capital Cost	Annualized Cost	Passage Facility Maintenance	Fish Share of Pumping Maintenance	Total Fish O&M	Total Fish Passage Annualized Cost
No Action								
4-month Improved Ladder	$15,400,000		$15,400,000	$936,755		$244,425	$244,425	$1,181,180
4-month Bypass Channel	$21,100,000		$21,100,000	$1,283,476		$244,425	$244,425	$1,527,901
2-month Improved Ladder	$15,400,000	$9,900,000	$25,300,000	$1,583,955		$212,843	$212,843	$1,751,798
2-month with Existing Ladders		$9,900,000	$9,900,000	$602,200		$212,843	$212,843	$815,043
Gates-out		$18,900,000	$18,900,000	$1,149,654		$188,575	$188,575	$1,338,228
	Pumping Facilities	**Agriculture Share of Pumping Facilities**	**Total Agriculture Capital Cost**	**Annualized Cost**	**Pumping Facility Maintenance**	**Agriculture Share of Pumping Maintenance**	**Total Agriculture O&M**	**Total Agriculture Annualized Cost**
No Action					$370,000	$370,000	$370,000	
4-month Improved Ladder	$69,100,000	$69,100,000	$69,100,000	$4,203,232	$466,460	$222,035	$222,035	$4,425,267
4-month Bypass Channel	$69,100,000	$69,100,000	$69,100,000	$4,203,232	$466,460	$222,035	$222,035	$4,425,267
2-month Improved Ladder	$79,000,000	$69,100,000	$69,100,000	$4,203,232	$406,189	$193,346	$193,346	$4,396,578
2-month with Existing Ladders	$79,000,000	$69,100,000	$69,100,000	$4,203,232	$406,189	$193,346	$193,346	$4,396,578
Gates-out	$88,000,000	$69,100,000	$69,100,000	$4,203,232	$359,875	$171,301	$171,301	$4,374,533

Note: Allocation of pumping costs to fish includes only the pumping difference between gate operations.

TABLE A-14
Unit Adult and Juvenile Focus Species per Million Dollars Annualized Cost (Revised Cost Allocation Scenario)

	Alternatives				
	4-Month Improved Ladder	4-Month Bypass Channel	2-Month Improved Ladder	2-Month with Existing Ladders	Gates-out
Adult Focus Species					
Winter-run salmon	0.85	0.65	4.57	9.76	7.46
Spring-run salmon	7.63	3.27	24.00	50.00	35.82
Fall-run salmon	2.54	1.31	4.57	7.32	12.69
Late-fall-run salmon	--	--	--	--	--
Rainbow trout	4.24	1.96	10.29	20.73	20.15
Steelhead	1.69	0.65	4.57	8.54	8.21
Green sturgeon	--	2.61	20.00	42.68	26.12
Total	**16.95**	**10.46**	**68.00**	**139.02**	**110.45**
Juvenile Focus Species					
Winter-run salmon	--	--	1.71	3.66	2.99
Spring-run salmon	--	--	0.57	1.22	0.75
Fall-run salmon	--	--	1.14	2.44	2.24
Late-fall-run salmon	--	--	2.29	4.88	4.48
Rainbow trout	--	--	3.43	7.32	5.97
Steelhead	--	--	4.00	8.54	5.97
Green sturgeon	--	--	4.00	8.54	5.97
Total	**--**	**--**	**21.71**	**46.34**	**42.54**
Combined Total	**16.95**	**10.46**	**89.71**	**185.37**	**152.99**

Conclusion

The two separate cost allocations described in Tables A-11 and A-13 cover a range of reasonable cost allocations between agricultural and fish “shares” of project cost. It is important to note that the two allocations arrive at different conclusions regarding the most efficient allocation of dollars. Using the allocation described in Table A-11 results in the Gates-out Alternative being the most economically efficient use of money (Table A-12). Using Table A-13 results in the 2-month with Existing Ladders Alternative as the most efficient (Table A-14). However, it is important to note that the other alternatives maintain the same order; that is, they are notably less efficient in the use of money than either the Gates-out or 2-month with Existing Ladders alternatives. Further, under both allocations, these two alternatives are within 20 percent of each other, indicating that the alternatives are certainly comparable under both analyses.

Therefore, because both cost allocation methods are reasonable, both the Gates-out and 2-month with Existing Ladders alternatives result in fairly similar outcomes. Assuming that the range of potential allocations is between those described above, the results should also vary between the results presented in Tables A-12 and A-14. In simple terms, the greater share of the project allocated toward fish, the more economical the Gates-out Alternative becomes. If agriculture bears the bulk of the project cost, then the 2-month with Existing Ladders Alternative is more economical.

Agricultural Water Supply Benefit Analysis

Similar to the analysis provided for fish passage, an analysis was conducted to compare the ability of the alternatives to provide water reliability in meeting agricultural water demand. For this portion of the analysis, only three action alternatives are considered: 4-month Gates-in, 2-month Gates-in, and 0-month Gates-in. Sub-alternatives relating to fish passage facilities do not affect the physical ability of various alternatives to supply water to TCCA. However, consideration of effects on fish is still an important parameter for agricultural supply as it relates to the risk that future conditions might require reductions in gates-in operations. An evaluation of such risk is considered beyond the scope of this analysis.

General Approach

For the years 1989 through 1999, records of actual daily water delivery, including deliveries to Glenn-Colusa Irrigation District (GCID), were reviewed. For the same time period, both the average and the maximum amount of water delivered on each day between May and September was also determined. These calculations help establish the historical range of deliveries accommodated by TCCA over the 1989 to 1999 period.

As a second step, reference evapotranspiration was calculated for the combined member districts of TCCA, excluding GCID. Reference evapotranspiration is used to calculate crop water consumption for both agricultural and natural vegetation. This analysis used the modified Pennman-Monteith method for calculating reference evapotranspiration. The modified Pennman-Monteith method is endorsed by the Food and Agriculture Organization of the United Nations as a preferred method for evaluating crop water requirements. The method uses a number of parameters, including solar radiation, air temperature, air humidity and wind speed, crop growth, and other factors in assessing the evaporation process. For the period of record, average monthly climatological data were used.

For the TCCA districts, excluding GCID, average crop mix as determined by USBR needs assessment was used as a representative crop variety over the period of record. The percentage of specific crops was pro-rated against the recorded acres irrigated in each year between 1989 and 1999. The acreage of each crop in each year in conjunction with average monthly climate data was used to derive a monthly water demand for the 1989 to 1999 period. Daily water demand was assumed to follow a pattern similar to the daily water deliveries. Using daily water deliveries, the monthly crop demands were disaggregated into daily demands to give a sense of variability within months. Average and maximum daily crop demand was then determined similar to those reported for water delivery. In most cases crop demand far outpaces actual water deliveries. Periods where water deliveries are in excess of crop demand are representative of large deliveries to GCID, which was not included in the crop demand analysis.

GCID was excluded from the crop demand analysis because its primary source of water is the GCID canal, not the TC Canal. Including crop demand within GCID would have yielded a much higher crop demand, but would not have been representative of the crop demands served by TCCA. However, it is important to note that water is regularly conveyed to GCID by TCCA. These GCID demands are episodic in nature and have been as high as 1,125 cfs, which is the maximum capacity of the intertie facilities between TCCA and GCID. Such demands are reflected in TCCA water deliveries, but not in the modeled crop demand.

Average daily water delivery is used to show the typical water delivery to TCCA member districts. Maximum water delivery is used to show the upper variability of water demand of TCCA member districts on any given day. Average modeled crop demand reflects the water needs of crops grown by TCCA member districts based on acres in production, water requirements of different crops, and weather conditions, averaged over the 11-year study period. The difference between crop demand and water delivery is likely accounted for by water reuse, groundwater pumping, and precipitation. Maximum modeled crop demand is simply the maximum calculated crop demand for each day of the period of record. These average and maximum water deliveries and average and maximum crop demands were then compared to the delivery capability from RBDD under each of the project alternatives.

Each of the alternatives includes various assumptions about the amount of capacity available to divert water into the TCCA system, and the time periods that capacity is available. For example, the gates-in period allows for maximum diversion from the Sacramento River; however, when gates are raised, capacity is limited to the facilities that are not dependent on gravity diversion from the Sacramento River. These facilities are primarily pumps, but also include diversions from Stony Creek. All of the alternatives, including the No Action Alternative, have the capacity to divert water far in excess of the contractual entitlements of TCCA member districts. None of the alternatives would change the total volume of water TCCA was contractually entitled to, although they would change the time periods under which TCCA districts could reasonably assume to call upon water deliveries.

Thus, the maximum potential diversion under each alternative is a measure of the water supply reliability of the alternative. The difference between the No Action Alternative and the various alternatives is a measure of the addition or reduction in total water supply reliability of the action alternatives. Further, by comparing the alternatives to the actual water deliveries and the modeled crop demand, it is possible to assess how the alternatives might constrain crop selection. Crops that are likely to require water during low capacity periods would be less desirable than crops that do not. Of course, other factors such as soil types, existing investment, and market conditions will also play important roles in future crop selection. Table A-15 outlines the maximum diversion capacity of the various alternatives over the May 1 through September 30 time period. Maximum diversion capacity is defined as the amount of water that could be diverted if the alternative operated at its maximum diversion rate every day of the period. Table A-16 presents the change in maximum diversion capacity compared to the No Action Alternative.

TABLE A-15
Comparison of Diversion Capacity and Maximum Diversion of Alternatives

	Alternatives							
	No Action		4-month Gates-in		2-month Gates-in		0-month Gates-in	
Time period	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)
May 1 through May 14	485	14,405	1,700	50,490	2,000	59,400	2,500	74,250
May 16 through May 31	2,500	79,200	2,500	79,200	2,000	63,360	2,500	79,200
June 1 through June 30	2,500	148,500	2,500	148,500	2,000	118,800	2,500	148,500
July 1 through August 31	2,500	306,900	2,500	306,900	2,500	306,900	2,500	306,900
September 1 through 15	2,500	74,250	2,500	74,250	2,000	59,400	2,500	74,250
September 16 through 30	485	14,405	1,700	50,490	2,000	59,400	2,500	74,250
Total		**637,659**		**709,830**		**667,260**		**757,350**

Note: Total maximum diversion would not change the cumulative CVP water service contract held by TCCA member districts

TABLE A-16
Action Alternatives Difference from No Action

	Alternatives					
	4-month Gates-in		2-month Gates-in		0-month Gates-in	
Time period	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)	Capacity (cfs)	Maximum Diversion (acre-feet)
May 1 through May 14	1,215	36,086	1,515	44,996	2,015	59,846
May 16 through May 31	0	0	(500)	(15,840)	0	0
June 1 through June 30	0	0	(500)	(29,700)	0	0
July 1 through August 31	0	0	0	0	0	0
September 1 through 15	0	0	(500)	(14,850)	0	0
September 16 through 30	1,215	36,086	1,515	44,996	2,015	59,846
Total		**72,171**		**29,601**		**119,691**

Figure A-5 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 4-month Gates-in alternatives. Figure A-5 shows that for the period of May 1 through May 14, average and maximum water deliveries and average and maximum crop demand exceed the ability of the No Action Alternative to deliver water. For the same time period, the maximum water delivery exceeds the ability of the 4-month Gates-in alternatives to deliver water. For the period of September 16 through September 30, average and maximum crop demand exceed the ability of the No Action Alternative to deliver water, but the ability of the 4-month Gates-in Alternatives to deliver water are not exceeded. For the majority of the irrigation season, May 15 through September 14, both the No Action and the 4-month Gates-in alternatives can meet the water needs defined by average and maximum water delivery and average and maximum crop demand. On whole, the 4-month Alternative increases the reliability of water diversion by increasing capacity in the May 1 to 15 and September 1 to 15 periods over the No Action Alternative.

Figure A-6 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 2-month Gates-in alternatives. For the period of May 15 through July 14, maximum modeled crop demand exceeds the ability of the 2-month Gates-in Alternatives, as does a portion of the maximum water delivery. For the remainder of the irrigation season, July 15 through September 30, the 2-month Gates-in Alternatives can meet average and maximum water delivery and average and maximum crop demand. The No Action Alternative is the same as described for Figure A-5. It is important to note that the 2-month Alternative reduces the reliability of water diversion during the May 15 through June 30 and September 1 through 15 periods compared to the No Action Alternative. On whole, however, because of increased capacity in the May 1 through 14 and September 16 through 30 periods, this alternative would increase the reliability of water diversion over the No Action Alternative.

Figure A-7 illustrates the average and maximum water delivery and average and maximum modeled crop demand compared to the No Action and 0-month Gates-in alternatives. Figure A-7 shows that the water delivery ability of the 0-month Gates-in Alternative satisfies the average and maximum water deliveries and average and maximum crop demand for the entire irrigation season, with the exception of a single day where maximum modeled crop demand is not met. The No Action Alternative is the same as described for Figure A-5. On whole, the 0-month Alternative increases the reliability of water diversion by increasing capacity in the May 1 through 14 and September 1 through 15 periods over the No Action Alternative.

Conclusion

Although the alternatives were designed to be similar in terms of water supply reliability, there are important differences to note. The 0-month Alternative provides the greatest water supply reliability because it can divert a full 2,500 cfs at any time during the irrigation season. The 4-month Alternative does not provide as much water supply reliability as the 0-month alternative because of reduction in capacity from 2,500 cfs during the gates-in period, to 1,700 cfs during the gates-out period. The 2-month Alternative provides the least water supply reliability because of the reduction in capacity during the May 15 through June 30 and September 1 through 15 periods compared to No Action. The comparative reliability is summarized in Table A-16.

As noted in the Fish Passage Benefit Analysis (specifically Tables A-11 and A-13), there is currently some debate regarding the proper allocation of costs between fish and agriculture. However, under all potential allocations, the costs assigned to agriculture are static across alternatives. Therefore, it is possible to rank the action alternatives in terms of economic efficiency because the relative costs are all the same. Using that approach, the 0-month

Alternative provides the most economically efficient benefits, followed in order by the 4-month Alternative and the 2-month Alternative.

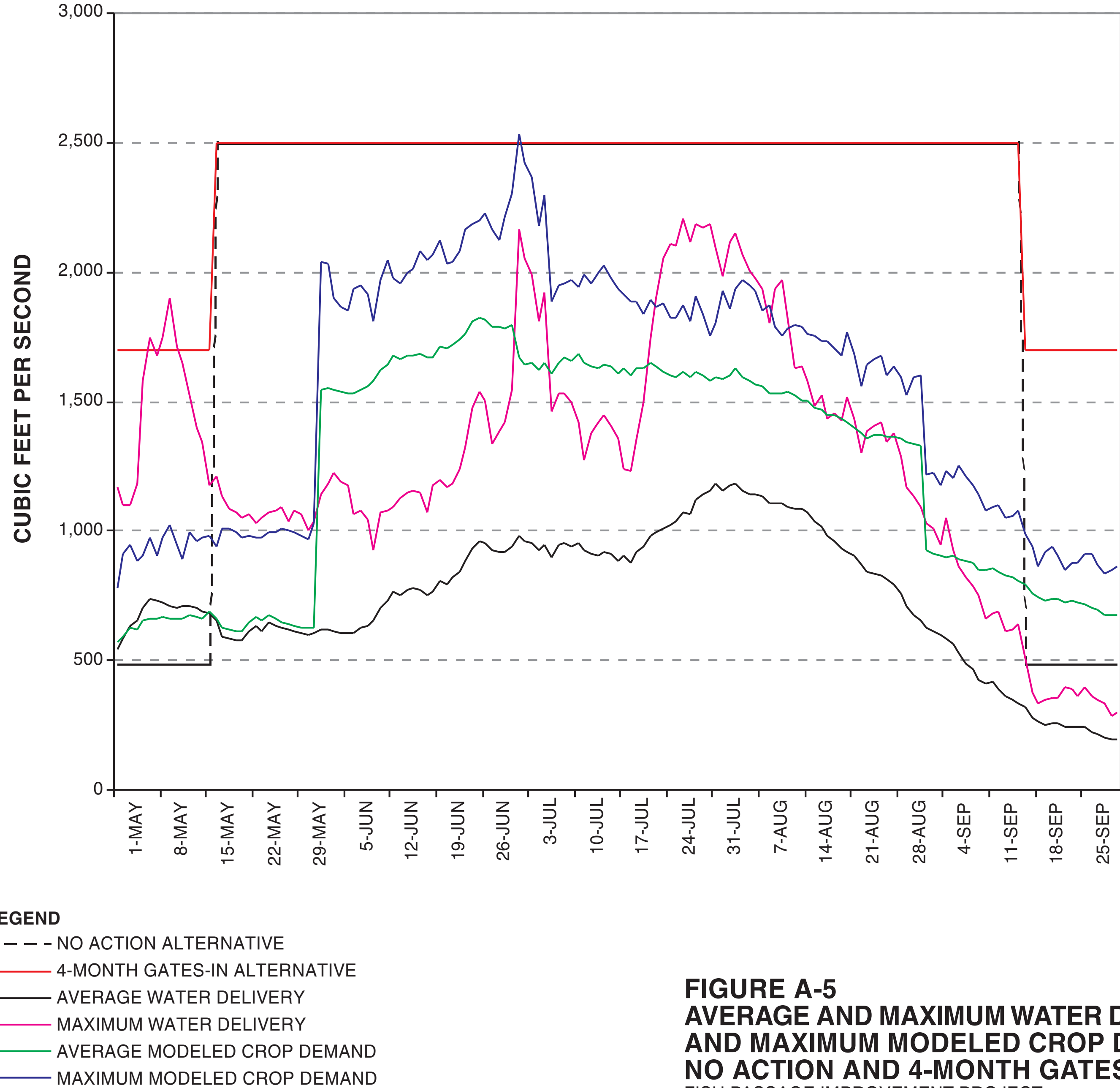

FIGURE A-5
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED CROP DEMAND COMPARED TO NO ACTION AND 4-MONTH GATES-IN ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W042002002RDD_93 (8/12/02)

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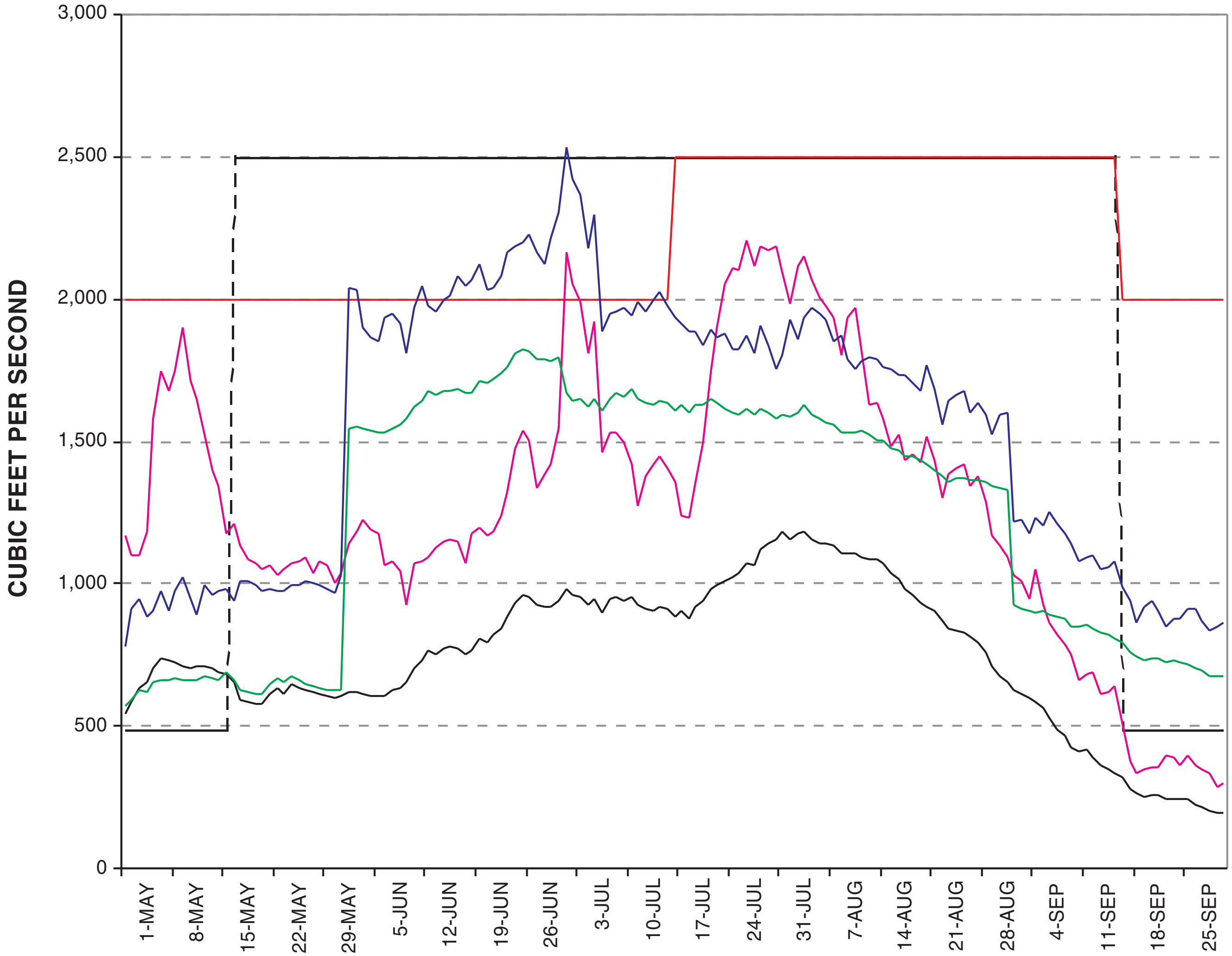

LEGEND

- NO ACTION ALTERNATIVE
- 4-MONTH GATES-IN ALTERNATIVE
- AVERAGE WATER DELIVERY
- MAXIMUM WATER DELIVERY
- AVERAGE MODELED CROP DEMAND
- MAXIMUM MODELED CROP DEMAND

FIGURE A-6
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED CROP DEMAND COMPARED TO NO ACTION AND 2-MONTH GATES-IN ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

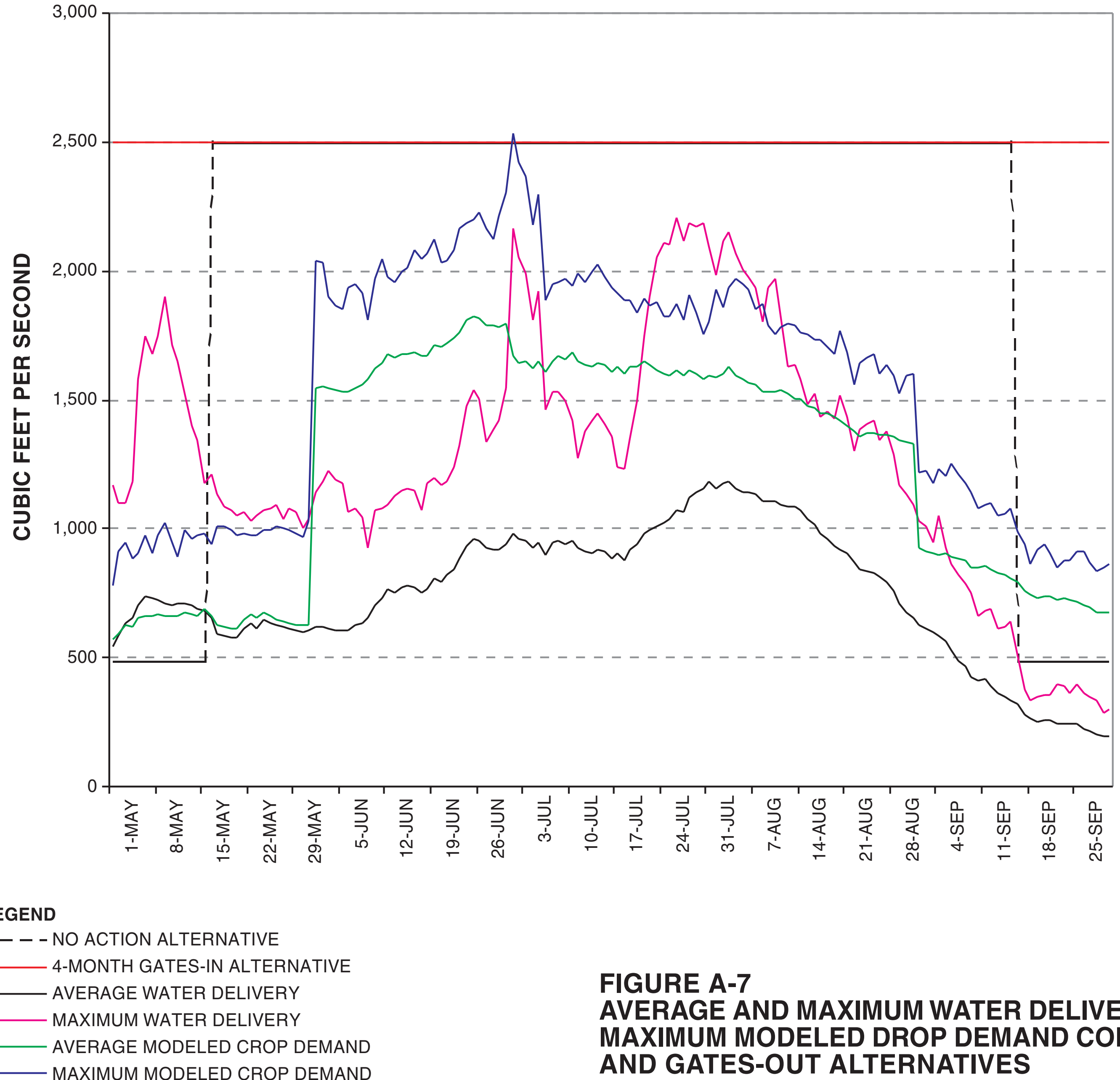

FIGURE A-7
AVERAGE AND MAXIMUM WATER DELIVERY AND AVERAGE AND MAXIMUM MODELED DROP DEMAND COMPARED TO NO ACTION AND GATES-OUT ALTERNATIVES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

Appendix B
Fishery Resources

APPENDIX B

Fishery Resources

Affected Environment

The fishery resources in the Sacramento River near the Red Bluff Diversion Dam (RBDD) consist of a diverse assemblage of fish species including native and non-native (introduced species). Table B-1 provides a species list of those fish that may likely be found at or near RBDD at some time during their life history. Of those species shown in Table B-1, four groups of fish species will be discussed together in this section because of their family relationship, life history characteristics, legal status, and occurrence within the project area. These groups include:

- Native anadromous salmonids (NAS)
- Other native anadromous fish (NAO)
- Non-native anadromous fish (NNA)
- Resident native and non-native fish (RN and RNN)

TABLE B-1
Fish Found in the Sacramento River near RBDD

Common Name	Scientific Name	Group	Native	Introduced
Chinook salmon[a]	*Oncorhynchus tshawytscha*	NAS[b]	X	
Steelhead[c]	*Oncorhynchus mykiss irideus*	NAS	X	
Sockeye salmon	*Oncorhynchus nerka*	NNAS[d]		X[e]
Pink salmon	*Oncorhynchus gorbuscha*	NNAS		X[f]
Pacific lamprey	*Lampetra tridentata*	NAO[g]	X	
River lamprey	*Lampetra ayresi*	NAO	X	
Green sturgeon	*Acipenser medirostris*	NAO	X	
White sturgeon	*Acipenser transmontanus*	NAO	X	
Striped bass	*Morone saxatilis*	NNA[h]		X
American shad	*Alosa sapidissima*	NNA		X
Rainbow trout[i]	*Oncorhynchus mykiss*	RN[j]	X	
Hitch	*Lavinia exilicauda*	RN	X	
Sacramento splittail	*Pogonichthys macrolepidotus*	RN	X	
Hardhead	*Mylopharodon conocephalus*	RN	X	
Sacramento pikeminnow	*Ptychocheilus grandis*	RN	X	
Speckled dace	*Rhinichthys osculus*	RN	X	
California roach	*Hesperoleucus symmetricus*	RN	X	
Sacramento sucker	*Catostomus occidentalis*	RN	X	
Tule perch	*Hysterocarpus traski*	RN	X	
Prickly sculpin	*Cottus asper*	RN	X	

TABLE B-1
Fish Found in the Sacramento River near RBDD

Common Name	Scientific Name	Group	Native	Introduced
Riffle sculpin	*Cottus gulosus*	RN	X	
Sacramento blackfish	*Orthodon microlepidotus*	RN	X	
Threespine stickleback	*Gasterosteus aculeatus*	RN	X	
Brown trout	*Salmo trutta*	RNN[k]		X
Threadfin shad	*Dorosoma petenense*	RNN		X
Largemouth bass	*Micropterus salmoides*	RNN		X
Spotted bass	*Microterus punctulatus*	RNN		X
Smallmouth bass	*Micropterus dolomieui*	RNN		X
Green sunfish	*Lepomis cyanellus*	RNN		X
Bluegill	*Lepomis macrochirus*	RNN		X
Redear sunfish	*Lepomis microlophus*	RNN		X
Pumkinseed	*Lepomis gibbosus*	RNN		X
Black crappie	*Pomoxis nigromaculatus*	RNN		X
White crappie	*Pomoxis annularis*	RNN		X
Channel catfish	*Ictalurus punctatus*	RNN		X
White catfish	*Ictaurus catus*	RNN		X
Black bullhead	*Ictalurus melas*	RNN		X
Yellow bullhead	*Ictalurus nalalis*	RNN		X
Golden shiner	*Notemigonus crysoleucas*	RNN		X
Fathead minnow	*Pimephales promelas*	RNN		X
Goldfish	*Carassius auratus*	RNN		X
Carp	*Cyprinus carpio*	RNN		X
Mosquitofish	*Gambusia affinis*	RNN		X

a Fall, late-fall, spring, and winter chinook salmon runs

b Native anadromous salmonid

c Anadromous form of *O. mykiss*

d Non-native anadromous salmonid

e Likely non-native kokannee salmon

f Non-native to the Sacramento River

g Native anadromous other

h Non-native anadromous

i Resident form of *O. mykiss*

j Resident native

k Resident non-native

Sources: Moyle, 1976; Lee et al., 1980; and K. Brown and D. Killam, pers. comm.

Native Anadromous Salmonid Species

The Sacramento River near RBDD provides essential habitat for the freshwater life stages of chinook salmon as well as steelhead. Within California's Central Valley, the Sacramento River provides a corridor for the anadromous salmonid resources between upstream reaches and the tributaries to the Sacramento River and the Pacific Ocean. The Sacramento River is the largest river system in California with more than 90 percent of the Central Valley salmon spawning and rearing within the Sacramento River system. The Sacramento River supports four runs (races) of chinook salmon: fall, late-fall, winter, and spring run. The fall-run chinook salmon is the predominant salmon in the Central Valley. Fall-run steelhead are also found in the Central Valley with almost the entire population restricted to the Sacramento River watershed. The Sacramento River does not contain native coho or other salmon species or native coastal cutthroat trout. The number of chinook salmon and steelhead spawners estimated passing upstream of RBDD from 1970 through 1999 are summarized in Table B-2.

TABLE B-2
Estimated Chinook Salmon Spawning Escapement Upstream of RBDD (1970 to 2000)

Species	Average	Low (year)	High (year)
Fall	75,017	29,898 (1977)	205,487 (1997)
Late-fall	10,131	291 (1994)	19,261 (1975)
Winter	10,783	189 (1994)	53,089 (1971)
Spring	6,960	163 (1998)	25,095 (1976)
Steelhead	4,189	104 (1998)	13,240 (1970)

Fall-run chinook salmon are the dominate run in the watershed, and on the average over the 30-year period, escapement upstream of RBDD exceeded all other chinook runs by greater than 7-fold (Table B-2). However, as shown on Figure B-1, the annual escapement of fall chinook salmon upstream of RBDD has varied greatly over the last 30 years. (All figures are located at the end of this appendix.) The annual fall chinook escapement upstream of RBDD has ranged from over 205,000 (1997) to less than 30,000 (1977) with an increasing trend in escapement over that period (Figure B-2). Since 1970, late-fall-run chinook salmon escapement upstream of RBDD has averaged approximately 10,000 adults and has ranged from greater than 53,000 (1971) to less than 300 (1994) (Table B-2). The trend for late-fall chinook escapement upstream of RBDD has been a gradual decline since 1970 (Figure B-3).

Annual winter-run chinook salmon escapement has also averaged approximately 10,000 adults upstream of RBDD. The annual escapement of winter-run upstream of RBDD has declined significantly over the 30 years since 1970 (Figure B-4). As shown in Table B-2, winter chinook salmon escapement upstream of RBDD in 1971 was greater than 53,000 adults. Also as shown on Figure B-4, except for the year 1981, annual estimates of winter-run chinook passing RBDD since 1977 have never exceed 5,000 adults, a decrease greater than 10-fold over the last 30 years.

Spawning escapement of Central Valley spring-run chinook salmon has also varied since 1970 (Table B-2). The annual spring-run chinook salmon escapement upstream of RBDD in the last 30 years has averaged less than 7,000 spawners and has ranged from greater than 25,000 in 1975 to less than 200 adults in 1998. Since 1990, spring-run chinook salmon spawning escapement upstream of RBDD has not exceeded 1,000 adults (Figure B-5).

The annual spawning escapement upstream of RBDD since 1970 is summarized in Table B-2. As shown in Table B-2, the annual number of steelhead spawners has averaged approximately 4,000 adults. The trend over the last 30 years has indicated a steady decline in the annual numbers of spawners (Figure B-6) from over 10,00 in the early 1970s to less than a thousand by the later 1990s (Figure B-6). Furthermore, it is estimated that, currently, approximately 10 percent to 30 percent of adult steelhead in the Sacramento River are of natural (non-hatchery) origin (McEwan and Jackson, 1996).

Life History Characteristics and Habitat Requirements

Specific life history timing for the anadromous salmonids near the project area is provided in Table B-3.

TABLE B-3
Life History Timing for Native Anadromous Salmonids in the Sacramento River in the Vicinity of RBDD

Name	Adult Immigration	Spawning	Incubation	Rearing	Juvenile Emigration
Fall Chinook	July-December	October-December	October-March	December-June	December-July
Late-fall Chinook	October-April	January-April	January-June	April-November	April-December
Spring Chinook	April-July	August-October	August-December	October-April	October-May
Winter Chinook	December-July	April-August	April-October	July-March	July-March
Steelhead	August-March	December-April	December-June	Year-round (1-2 years)	January-October

As shown on Figure B-7, each of the five salmonid species have distinct periods when the adults are actively immigrating upstream through the project area. Factors that may affect the timing adult passage include water-year type, river flows, weather events, and RBDD operations.

Habitat needs of the four runs of salmon and steelhead are similar, but each species differs somewhat in its freshwater habitat requirements. These differences are important and have implications from a resource management standpoint. The habitat needs of salmon and steelhead include physical habitat for adult migration and holding, spawning and egg incubation, fry and juvenile rearing, and smolt emigration. Adequate flows, water temperatures, water depths and velocities, appropriate spawning and rearing substrates, and the availability of in-stream cover and food are critical for the propagation and survival of all salmonids in the Sacramento River.

Each of the life stages of these species has its own specific habitat requirements. Adult spawning and egg incubation requires suitable water velocity, temperature, depth, and substrate (gravel) size. Adult spring-run chinook salmon and steelhead have additional habitat needs for longer-term holding habitat, in which pool size and depth, temperature, cover, and proximity to cover and spawning areas are important requirements. Newly emerged fry and juvenile salmonids require rearing habitat where low velocities, open cobble substrate for predator refuge, cool water temperatures, and adequate food production are critical features. Emigration of smolts to the ocean and the immigration of spawning adults require adequate barrier-free passage, adequate transport flows, and adequate water depths and temperatures to complete those migrations.

In the vicinity of RBDD the Sacramento River acts primarily as a transport corridor for adults immigrating upstream, juvenile fry rearing and dispersing, and smolts emigrating downstream. In addition, fall-run chinook salmon and, to a lessor degree, the winter-run and other salmon species are known to spawn in the vicinity of RBDD both immediately upstream and, to a lessor degree, downstream of RBDD. Inundation of Lake Red Bluff may act to discourage these fish from spawning in the reach of the Sacramento River immediately upstream of RBDD because of inadequate velocities and excessive water depths during RBDD gates–in operations.

The periods when juveniles (fry, pre-smolt, and smolt salmon and fry, sub-yearling, and yearling steelhead) are migrating downstream past RBDD are shown on Figure B-8. In addition to passage, fry, pre-smolt salmon, and sub-yearling, and yearling steelhead may rear or reside near RBDD. These life stages are particularly vulnerable to predation by either fish or avian predators as they pass through or reside in the project locale. Timing of smolt emigration is dependent on species, flow conditions, and water year.

Impacts of Current Operations on Native Anadromous Salmonid Fish

Current operation of RBDD includes a 4-month period of time (mid-May through mid-September) when the dam gates are placed in the river, creating a velocity barrier and whitewater turbulence that prevents or impedes adult fish passage. Placement of the dam gates into the river results in blockage and delay of migrating adult salmon and steelhead (Vogel et al., 1988; Hallock et al., 1982; Hallock, 1987). Vogel et al., (1988) determined from salmon tagging studies conducted from 1983 through 1998 that between 8 percent and 44 percent of adult chinook salmon, depending on run, were blocked from passing upstream of RBDD. Similarly, Hallock et al., (1982) determined that passage of 15 percent to 43 percent of adult chinook salmon, depending on run, were blocked by RBDD. Fish ladders are currently operational on the east and west ends and at the center of RBDD. These currently operate during the gates-in period to provide upstream passage of adult salmonids. Vogel et al., (1988) determined that the mean time of delay in passage of adult chinook salmon at RBDD was greater than 3 to greater than 13 days, depending on the run. Radio telemetry investigations conducted from 1999 to 2001, using adult fall-run chinook salmon, indicate that delay in passage, under existing conditions at RBDD, may average approximately 21 days (USFWS, unpublished data). However, the existing fish ladders at RBDD may be inefficient in passing spring-run chinook salmon at RBDD (CDFG, 1998). Currently adult late-fall chinook salmon pass unimpeded at RBDD because they immigrate during months (October through March) when the RBDD gates are out of the water and, therefore, no barrier exists. The passage timing for adult salmonids was obtained from data collected from fish ladder counts conducted at RBDD from 1982 to 1986 for fall, late-fall, and winter chinook salmon and steelhead (USFWS/CDFG, unpublished data). For spring chinook salmon, some of which may pass RBDD prior to installation of the RBDD dam gates, the current (1995 though 2000) ladder counts were used to estimate passage timing (USFWS/CDFG, unpublished data). For ladder counts made during 1995 and 2000, the average monthly percent (44) of spring chinook passing RBDD during May were distributed equally between the before gates-in (<May 15) and after gates-in (>May 15) periods. For the following discussion, refer to Figure B-7 for timing of adult salmonids near RBDD.

Under current operations, approximately 15 percent of winter chinook adult spawners passing through the project area may be blocked or delayed by the current 4 months of gates-in operation (CDFG, 1998; USFWS/CDFG, unpublished data). The approximate average percentages of entire adult population of winter-run chinook that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—5 percent of annual total
- June—7 percent of annual total
- July—3 percent of annual total

For migrating adult steelhead, approximately 17 percent of the annual adult steelhead run may be affected by the current gates-in operation. The approximate average percentages of the annual run of adult steelhead passing RBDD that may be affected are listed by month as follows:

- June—1 percent
- July—1 percent
- August—5 percent
- Early September—10 percent

Up to 25 percent of the annual run of fall chinook salmon may be affected by the current gates-in operation. The approximate average percentages of the annual population passing RBDD that may be impacted are listed by month as follows:

- July—2 percent
- August—13 percent
- Early September—10 percent

By far, the greatest effect on adult anadromous salmonids is to spring-run chinook salmon. Approximately 72 percent of the annual adult spring chinook spawners passing through the project area must do so during the current gates-in operation (Figure B-7). The approximate average percentages of the annual population passing RBDD are listed by month as follows:

- Late May—22 percent
- June—38 percent
- July—9 percent
- August—2 percent

Impedance of these adult spring chinook by RBDD operations may adversely affect their ability to successfully pass upstream into and through the Sacramento River and into tributary streams and headwater reaches (CDFG, 1998). It is in these headwater reaches in the tributaries and the most upstream portion of the mainstem Sacramento River that the majority of spring-run chinook salmon must hold throughout the summer months before spawning in the early fall. The biological consequences of blockage or passage delay at RBDD results in changes in spawning distribution (Hallock, 1987), hybridization with fall chinook (CDFG, 1998), increased adult pre-spawning mortality (USBR, 1985), and decreased egg viability (Vogel et al., 1988), all of which result in the reduction of annual recruitment of this species.

Currently, it is difficult to precisely characterize the temporal distribution of spring-run chinook salmon as they pass RBDD. This is because prior to mid-May the gates-out operations at RBDD preclude the use of the fish ladders and therefore the enumeration of adults as they pass RBDD. However, once the RBDD gates go in during in May, spring run chinook are identified as they pass. The exact effect of lowering the gates during this species peak immigration period is unknown but as this species is threatened, it cannot be desirable to interrupt their migration.

During gates-in periods at RBDD, juvenile life stages of all anadromous salmonids migrate downstream (emigrate) through the project facilities. During gates-in operation, existing pathways for juvenile salmonids at RBDD include passage under the dam gates or through the fish ladders and their auxiliary water systems; or they are subjected to impingement, entrainment, and passage through diversion bypass systems at the Research Pumping Plant (RPP) and Tehama-Colusa Canal (TC Canal) headworks. An additional effect of the existing operations of RBDD on juvenile salmonids, especially on steelhead smolts, includes predation by avian species while passing through Lake Red Bluff and downstream of the dam (Vogel et al., 1988; USFWS/USBR, 1998).

Vondracek and Moyle (1983) reported that the cause of mortality of juvenile salmonids at RBDD was the result of a dysfunctional predator-prey relationship created by RBDD and Sacramento pikeminnow (formerly squawfish). Through investigations conducted at RBDD, USFWS (1981) concluded that mortalities of up to 42 percent of downstream-migrant steelhead and greater than 50 percent of chinook salmon occurred, likely as a result of predation of those juveniles by pikeminnow downstream of the dam. Using divers, surface observations, and stomach contents analysis, Vogel et al., (1988) determined that adult Sacramento pikeminnow were the principal predator on juvenile salmon passing RBDD. Hallock (1987) reported that stomach content analysis confirmed that adult striped bass were also preying on juvenile salmon passing through RBDD. Furthermore, Tucker et al., (1998) determined that during summer months (gates-in operations), approximately 66 percent (by weight) of the stomach contents of Sacramento pikeminnow consisted of juvenile salmonids.

Recently, Tucker et al., (1998) found that nearly four times as many pikeminnow passed the RBDD ladders in May and June of 1981 as compared to May and June of 1996. This is an indication that the densities of these predators are now much lower since the RBDD gates are in only from mid-May through mid-September.

The following discussion refers to Figure B-8, which depicts juvenile salmonid passage at RBDD. The passage timing for juvenile salmonids was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). The following discussion is based on the timing information obtained from those investigations. With the current gates-in operations, on average approximately 8 percent of annual juvenile fall-run chinook salmon passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities.

The annual percentage of juvenile fall-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—2 percent
- June—3 percent
- July—2 percent
- August—1 percent

For spring-run chinook, on average approximately less than 1 percent of the annual number of juveniles passing RBDD are vulnerable to operations and facilities at RBDD. However, a potentially large number of late-fall and winter chinook salmon and steelhead juveniles are subject to operations and facilities of RBDD and its associated diversion facilities (Figure B-8). For winter chinook salmon, the earliest dispersing and outmigrating juveniles may be subjected to adverse effects from RBDD operations. Approximately 39 percent of juvenile winter chinook salmon, on average, are subjected to the operational effects of RBDD and its associated diversion facilities. The passage timing for juvenile salmonids was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). The following discussion is based on the timing information obtained from those investigations. The approximate annual percentage of the annual juvenile winter-run chinook salmon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- July—1 percent
- August—12 percent
- Early September—26 percent

On average, approximately 35 percent of the juvenile late-fall run chinook salmon passing RBDD presently subject to operational impacts are listed by month as follows:

- Late-May—4 percent
- June—4 percent
- July—7 percent
- August—14 percent
- Early September—6 percent

On average, approximately 36 percent of juvenile steelhead passing RBDD during the gates-in period subject to operational impacts are listed by month as follows:

- Late May—6 percent
- June—4 percent
- July—4 percent
- August—12 percent
- Early September—10 percent

Anadromous Salmonid Species Listed or Candidates for Listing under Federal Endangered Species Act and California Endangered Species Act

All five of the anadromous salmonids that are present at RBDD during some period in their life history are either listed by the California Endangered Species Act (CESA) and/or the federal Endangered Species Act (ESA), or are listed as candidates under ESA.

The following list includes each species' status, date of listing, and their date of Critical Habitat Designation (if applicable):

- Winter-run chinook salmon: California Endangered (9/22/89); Federal Endangered (1/4/94); Habitat Designated (3/32/99)
- Spring-run chinook salmon: California Threatened (2/5/99); Federal Threatened (9/16/99); Habitat Designated (2/16/00)
- Steelhead—Central Valley chinook salmon evolutionary significant unit (ESU): Federal Threatened (3/19/98); Habitat Designated (2/16/00)
- Central Valley fall/late-fall chinook salmon ESUs: Federal Candidate/Not Warranted for listing (9/16/99)

For Sacramento River winter-run chinook salmon, ESU critical habitat is designated to include the following: Sacramento River from Keswick Dam in Shasta County (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins: Butte, Colusa, Contra Costa, Glenn, Napa, Nevada, Placer, Plumas, Sacramento, Shasta, Solano, Sutter, Tehama, Trinity, Yolo, and Yuba.

Critical habitat for federal Central Valley spring-run chinook salmon ESU is designated to include all river reaches accessible to listed chinook salmon in the Sacramento River and its tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge (see Table B-4).

Excluded are tribal lands and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 9,329 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Butte, Colusa, Contra Costa, Glenn, Marin, Napa, Nevada, Placer, Sacramento, San Francisco, San Mateo, Shasta, Solano, Sonoma, Sutter, Tehama, Yolo, and Yuba.

TABLE B-4
Hydrologic Units and Counties Containing Critical Habitat for Central Valley California Spring-run Chinook Salmon and Dams/Reservoirs Representing the Upstream Extent of Critical Habitat

Hydrologic Unit Name	Hydrologic Unit	Counties[a] within Hydrologic Unit and within Range of ESU	Dams/Reservoirs
Sacramento-Lower Cow-Lower Clear	18020101	Shasta, Tehama	
Lower Cottonwood	18020102	Shasta, Tehama	
Sacramento-Lower Thomes	18020103	Butte, Glenn, Tehama	Black Butte Dam
Sacramento-Stone Corral	18020104	Butte, Colusa, Glenn, Sutter, Yolo	
Lower Butte	18020105	Butte, Colusa, Glenn, Sutter	Centerville Dam
Lower Feather	18020106	Butte, Sutter, Yuba	Oroville Dam
Lower Yuba	18020107	Yuba	
Lower Bear	18020108	Placer, Sutter, Yuba	Camp Far West Dam
Lower Sacramento	18020109	Sacramento, Solano, Sutter, Placer, Yolo	
Sacramento-Upper Clear	18020112	Shasta	Keswick Dam, Whiskeytown Dam
Upper Elder-Upper Thomes	18020114	Tehama	
Upper Cow-Battle	18020118	Shasta, Tehama	
Mill-Big Chico	18020119	Butte, Shasta, Tehama	
Upper Butte	18020120	Butte, Tehama	
Upper Yuba	18020125	Nevada, Yuba	Englebright Dam
Suisun Bay	18050001	Contra Costa, Napa, Solano	
San Pablo Bay	18050002	Alameda, Contra Costa, Marin, Napa, San Mateo, Solano, Sonoma	
San Francisco Bay	18050004	Alameda, Contra Costa, Marin, San Francisco, San Mateo	

[a]Some counties have very limited overlap with estuarine, riverine, and riparian habitats identified as critical habitat for this ESU.

Critical habitat for Central Valley steelhead ESU is designated to include all river reaches accessible to listed steelhead in the Sacramento and San Joaquin Rivers and their tributaries in California. Also included are adjacent riparian zones, as well as river reaches and estuarine areas of the Sacramento-San Joaquin Delta; all waters from Chipps Island westward to Carquinez Bridge including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are areas of the San Joaquin River upstream of the Merced River confluence, tribal lands, and areas above specific dams or above longstanding, naturally impassable barriers (i.e., natural waterfalls in existence for at least several hundred years). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,096 square miles in California. The following counties lie partially or wholly within these basins (or contain migration habitat for the species): Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Glenn, Marin, Merced, Nevada, Placer, Sacramento, San Francisco, San Joaquin, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tuolumne, Yolo, and Yuba.

On September 16, 1999, National Marine Fisheries Service (NMFS) determined that listing was not warranted for the Central Valley fall and late-fall-run chinook salmon ESU. However, the ESU is designated as a candidate for listing because of concerns over specific risk factors. The ESU includes all naturally spawned populations of fall-run chinook salmon in the Sacramento and San Joaquin River Basins and their tributaries east of Carquinez Strait, California. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 13,760 square miles in California. The following California counties lie partially or wholly within these basins: Alameda, Butte, Calaveras, Colusa, Contra Costa, Glenn, Mariposa, Merced, Napa, Nevada, Placer, Plumas, Sacramento, San Joaquin, Santa Clara, Shasta, Solano, Stanislaus, Sutter, Tehama, Trinity, Tuolumne, Yolo, and Yuba.

Other Native Anadromous Species (Sturgeon, Pacific Lamprey, River Lamprey)

In addition to the native anadromous salmonid species found in the vicinity of the project area, several other native anadromous species occupy or have the potential to occupy the Sacramento River at various stages of their life history and during seasonal intervals. These include:

- White sturgeon (*Acipenser transmontanus*)
- Green sturgeon (*Acipenser medirostris*)
- Pacific lamprey (*Lampetra tridentata*)
- River lamprey (*Lampetra ayresi*)

Sturgeon are a highly specialized group of large, primitive, bony fish. Of the 24 species worldwide, all are found in the temperate waters of the northern hemisphere. Seven species are found in the United States, with two occurring in California. The white sturgeon are the largest freshwater fish in North America, with the largest documented record at 1,300 pounds (Moyle, 1976). Of the two sturgeon species in the Sacramento River, green sturgeon are known to commonly pass into Sacramento River reaches upstream of RBDD, and white sturgeon are not generally recognized to occur at locations upstream of RBDD (K. Brown, USFWS, pers. comm.). Both lamprey species are recognized to pass into Sacramento reaches upstream of RBDD. Detailed information on these lamprey species is much less than that for anadromous salmonids and sturgeon in the Sacramento River. Of the two lamprey, the Pacific lamprey is physically larger in size and are more common than river lamprey.

Populations of these species in the Sacramento River are generally unknown. However, white sturgeon populations in California seem to be abundant. CDFG population estimates based on their trawling surveys range from 11,000 to 128,000 white sturgeon in the San Francisco Bay estuary (Kohlhorst, 1991 as cited by Moyle et. al, 1995). The Sacramento River population has rebounded after many years of over fishing, and recently the sport catch has nearly equaled the commercial catch of the late 1800s. Because of the importance of the white sturgeon fishery in the Sacramento delta, the number and size of the annual catch of white and green sturgeon is closely monitored. While there is no direct evidence that populations of green sturgeon are declining in the Sacramento River, the small size of the population increases the risk that a decline in numbers would be difficult to detect until a collapse in the population occurs (Moyle et al., 1995).

Green sturgeon populations have been reduced throughout their entire range. In North America, only three known spawning populations still exist (Sacramento, Klamath, and Rogue rivers), with several historically important populations expirated (Eel River and South Fork Trinity River) (Moyle et al., 1995). The primary causes for this decline include: (1) loss of access to spawning habitat by dam construction, (2) degraded spawning habitat, and (3) overfishing by commercial, sport, Native American, and illegal fisheries. In studies conducted by CDFG between 1954 and 1991, a ratio of green sturgeon to white sturgeon for fish <101 centimeter (cm) fork length (approximately 40 inches) of 1:9 and fish >101 cm fork length of 1:76 has been determined (Moyle et. al., 1995). Assuming that green and white sturgeon are equally vulnerable to CDFG's capture gear, and using those ratios, green sturgeon populations (fish greater than 101 cm) in the San Francisco Bay estuary are approximately 200 to 1,800 fish (Moyle et. al., 1995).

Pacific lamprey are still common in most watersheds in California and throughout the Pacific northwest. In California, dams on several major watersheds have decreased the spawning distribution of Pacific lamprey. Population numbers in the Sacramento River are not known. Population trends of river lamprey are not known in California, but are assumed to have declined along with losses in habitat quantity and quality, especially within the Sacramento-San Joaquin River system (Moyle et al., 1995).

Life History Characteristics and Habitat Requirements

White and Green Sturgeon. White sturgeon has been caught in salt water from Ensanada, Mexico, to the Gulf of Alaska (Miller and Lea, 1972). In California, large populations occur only in the Sacramento and Feather rivers, but small numbers of white sturgeon have been noted in the San Joaquin River, Russian River, and Klamath River (Moyle, 1976). In California, spawning has been confirmed only in the Sacramento and Feather rivers (Moyle, 1976) and the San Joaquin River (Kohlhorst, 1991 as cited by PSMFC, 1992). A spawning population was trapped upstream of Shasta Dam following its completion in 1944, reproducing successfully until the early 1960s (Fisk, 1963 as cited by PSMFC, 1992). Following the construction of Keswick Dam and water storage in 1948, white sturgeon probably spawned in the Sacramento River downstream of Keswick Dam to Grimes (RM 125) (Kohlhorst pers. comm., as cited by USFWS, 1998). In the Sacramento River, most spawning seems to occur upstream of the Feather River confluence (Moyle, 1976). Under existing conditions, white sturgeon spawning is likely restricted in the Sacramento River to reaches downstream of RBDD (K. Brown, USFWS, pers. comm.).

A summary of white sturgeon life history characteristics is presented in Table B-5. Spawning in California occurs between March and early June, is dependent on water temperature, and takes place in swift, deep water where eggs are broadcast over cobble substrate (Moyle, 1976). Peak spawning in the Sacramento River in 1973 occurred at 58 degrees Celsius (°C) (Kohlhorst, 1976). The timing of white sturgeon spawning in the Sacramento River, based on the recovery of larvae and back calculation of spawning, is shown on Figure B-9. During 1973, it was estimated that white sturgeon in the Sacramento

River downstream of Colusa (RM 145) spawned from mid-February through late May, with 93 percent spawning between March 3 and May 5 (Kohlhorst, 1976). During this investigation, all larvae were captured downstream of RBDD with the majority of larval white sturgeon captured at Colusa (RM 145) and downstream at RM 112.

TABLE B-4
Life History Timing for Native Anadromous Fish in the Sacramento River in the Vicinity of RBDD

Name	Adult Immigration	Spawning	Incubation	Larval/Juvenile Rearing	Juvenile Emigration
White sturgeon	February-May	February-June	Embryos planktonic drifting downstream	Larvae in river, juveniles in Delta	N/A
Green sturgeon	February-June	March-July	Embryos planktonic drifting downstream	Larvae in river, juveniles in Delta	June-August
Pacific lamprey	February-June	Spring-Summer	Brief followed by ammocoete larval stage	Up to 7 years	September-April
River lamprey	February-June	Spring-Summer	Brief followed by ammocoete larval stage	Up to 5 years	March-June

N/A = White sturgeon are not known to spawn upstream of RBDD.

Female sturgeon spawn only about once every 5 years, but may produce nearly 5 million eggs (Moyle, 1976). Larval white sturgeon are flushed downstream and rear in the upper reaches of the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary. Transport into the Suisun-San Pablo Bay estuary is greater in years with high river flows (Kohlhorst, 1976). Except during spawning runs, adult white sturgeon are primarily found in the lower reaches of the Delta and in Suisun/San Pablo and San Francisco bays. White sturgeon are less marine-oriented than green sturgeon and tend to spend most of their lives in the estuaries of large rivers. Little is known about the age and growth of white sturgeon except that they are long lived and reach a maximum size of 4 meters fork length and 590 kilograms.

Green sturgeon have been caught in saltwater from Ensanada, Mexico, to the Bering Sea (Miller and Lea, 1972). In California, green sturgeon have been recorded in lower reaches of the Sacramento-San Joaquin River system, the Eel River, Mad River, Klamath River, and Smith River (Moyle, 1976). In California, spawning has been confirmed only in the Sacramento River and the Klamath River (Moyle et al., 1995). After the construction of Keswick Dam and storage of the reservoir in 1948, the primary spawning areas were from Keswick Dam to Hamilton City (U.S. Fish and Wildlife Service [USFWS], 1998).

USFWS routinely observes adult sturgeon in the vicinity and downstream of RBDD when the dam gates are in (K. Brown, pers. comm.). It is unclear if these are all adult green sturgeon or not. However, to date, all sturgeon larvae that have been captured at RBDD and grown out to determine species have been green sturgeon (D. Killam, pers. comm.). Green sturgeon have been observed downstream of RBDD at Dairyville, Tehama County (RM 234), in the 10-mile reach of the Sacramento River downstream of RBDD, and near Hamilton City, Glenn County (RM 197) (Moyle et al., 1995). Green sturgeon life history characteristics are summarized in Table B-5. The presumed timing of spawning green sturgeon passing in the vicinity of RBDD is shown on Figure B-10. Adult green sturgeon generally pass RBDD during March though June (K. Brown, pers. comm.).

The habitat requirements for green sturgeon are poorly known, but spawning and larval ecology is likely similar to that of white sturgeon (Moyle et al., 1995). Green sturgeon are thought to require colder and cleaner water than do white sturgeon (Moyle et al., 1995). Spawning occurs between March and July when water temperatures reach between 46°C and 57°C (Moyle et al., 1995). Spawning takes place in swift, deep water (>10 feet) where eggs are broadcast over clean sand to large cobble substrates.

Following egg hatching, larvae drift passively downstream and reach juvenile stages beginning at about 2 cm in length. Juvenile sturgeon are routinely captured in traps at RBDD during the summer months (K. Brown, pers. comm.). The presence of juvenile green sturgeon near RBDD as indicated by trapping data is shown on Figure B-11. The passage timing for juvenile green sturgeon was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). The majority of juveniles pass through the vicinity of RBDD from June through August (Figure B-11). Juvenile green sturgeon are transported and rear in the Sacramento-San Joaquin Delta and Suisun-San Pablo Bay estuary for one or more years before entering the deeper San Francisco Bay and exiting into the ocean primarily during the summer and fall before they are 2 years old (Moyle et al., 1995). Individual green sturgeon have been tagged in San Pablo Bay and recovered from Santo Cruz, California, to Gray’s Harbor, Washington (Chadwick, 1959 and Miller, 1972 as cited by Moyle, 1995). Little is known about the age and growth of green sturgeon except that they are long lived and reach a maximum size of 2.3 meters fork length and 159 kilograms (Skinner, 1962).

Pacific Lamprey. Pacific lamprey (*Lampetra tridentata*) are distributed along the Pacific coast from Unalaska, Alaska, south to California’s Santa Ana River, with populations occurring in most coastal watersheds. In the ocean, Pacific lampreys have been collected off the Japan coastline as well as off Baja, California. In California, large spawning populations are rare south of Monterey Bay (Moyle, 1976). The adults are predatory during the 1- to 2-year period spent in the ocean. It is unlikely that during this oceanic phase adults of this species migrate very far from the mouths of their native spawning streams (Moyle, 1976). Spawning adults range from 12 to 27 inches in total length. Spawning runs into freshwater generally occurs from April to late July. Trapping information at RBDD indicates that adult Pacific lamprey are found to be migrating upstream past RBDD primarily in the spring and summer months (D. Killam, pers. comm.). According to the observations by CDFG and USFWS at RBDD, the presumed timing of adult Pacific lamprey immigration at RBDD occurs as shown on Figure B-12.

Lamprey form a simple nest by dislodging larger stones from a gravel area in moderate current (Moyle, 1976). The nest is a depression with the loosened stones piled at the bottom. Eggs are then released into the pit and eventually buried with more gravels. Depending on size, the fecundity of female Pacific lamprey is from 20,000 to 200,000 eggs (Moyle, 1976). All adult lamprey die after spawning. After hatching, the young lamprey (ammocoetes) stay in the nest gravel for a short period before emerging and disbursing downstream. Following their initial disbursal, ammocoetes locate areas of silt and mud in the river bottom where they burrow tail first and exist from 3 to 7 years as filter feeders (Moyle, 1976). At a length of approximately 14 to 16 cm the ammocoetes begin to undergo a metamorphosis transformation life stage (termed “transformer”) during which they develop into adults. During this phase they develop large eyes, a sucking disc, and change color to silver on sides with a dark back (McPhail and Lindsey, 1970 as cited by Moyle, 1976). The timing of lamprey transformer life stages passing RBDD was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001). From trapping studies conducted at RBDD, the downstream passage of emigrating Pacific lamprey transformers in the Sacramento River is shown on Figure B-13. The transformers of this species occur at RBDD during the fall through early spring (September through April). Following their migration downstream, little is known about the movement or distribution of adults within the lower Sacramento River, Delta, or into the ocean.

River Lamprey. River lamprey are an anadromous species which have been collected in coastal watersheds from Juneau, Alaska to San Francisco Bay, California (Moyle, 1976). In California they appear to be most common in the Sacramento and San Joaquin rivers and their tributaries. They have also been found in the Russian River, and a land-locked population may exist in Sonoma Creek, California (Wang, 1986 as cited by Moyle et al., 1995). The abundance of this species is unknown in California. The biology of river lamprey has not been studied in California; therefore, the following discussion is based on life history information from studies from British Columbia, Canada (Moyle et al., 1995). Unlike Pacific lamprey, adults of river lamprey are parasitic during both freshwater and saltwater phases. This species is much smaller than Pacific lamprey, with adults reaching approximately 10 to 12 inches in length (Moyle et al, 1995). As adults, they prey on a variety of small- to intermediate-sized (4 to 12 inch) fish including salmon and herring (Moyle et al., 1995).

Adult migration is thought to take place in winter months with spawning taking place in clean gravelly riffles and pool tails of small tributaries usually during April and May (Moyle, 1976). The fecundity of female river lamprey is between 11,000 and 37,000 eggs. All adults die after spawning. Similar to Pacific lamprey, the ammocoetes of river lamprey remain buried in silty bottoms of river backwaters and eddies feeding on algae and micro-organisms for 3 to 5 years (Moyle et al., 1995). The silty habitat utilized by river lamprey ammocetes requires high water quality with summer temperatures that do not exceed 25°C (Moyle et al., 1995). Metamorphosis into adults begins when the ammocoetes are approximately 4 inches long during summer months and may take up to 10 months to complete this transformation. According to trapping conducted at RBDD (Gaines and Martin, 2001), the passage/presence of river lamprey transformers at RBDD occurs during the spring and early summer months (March through June) as shown on Figure B-13.

Impacts of Current Operations on Other Native Anadromous Fish

When the dam gates are placed in the river, a physical barrier is created that prevents passage of adult sturgeon. Placement of the dam gates into the river results in complete blockage of migrating adult green sturgeon. Because of their preference for spawning in the lower portions of the Sacramento River, white sturgeon are generally not blocked by RBDD on their spawning migrations (K. Brown, pers. comm.). Currently, a large portion of the green sturgeon spawning run successfully passes RBDD unimpeded because they are immigrating during months prior to May 15 when the RBDD gates go in (Figure B-10).

However, because sturgeon prefer lower water velocity and do not readily jump fish ladder weirs like salmonids, the existing fish ladders that operate during gates-in operations prevents any upstream passage of adult green sturgeon.

Under current operations, approximately 35 percent of adult green sturgeon spawners passing through the project area may be blocked by RBDD. The percentages of entire adult population of green sturgeon that are attempting to pass RBDD and may be impacted are listed by month as follows:

- Late May—approximately 15 percent
- June—approximately 20 percent of the annual upstream of RBDD

In addition, some adult green sturgeon are delayed in their down-river migration by RBDD if these fish arrive at RBDD on or after May 16 when the dam gates go in.

During gates-in periods at RBDD, nearly 100 percent of the larval or juvenile life stages of anadromous green sturgeon migrate downstream (emigrate) through the project facilities. During gates-in operation, existing pathways for these life stages includes passage under the dam gates or through the fish ladders and their auxiliary water systems, or they are subjected to impingement, entrainment, and passage through diversion bypass systems at RPP and TC Canal headworks. An additional effect of the existing operations of RBDD on larvae or juvenile green sturgeon includes predation by both fish and avian species while passing through Lake Red Bluff and downstream of the dam.

The following discussion refers to Figure B-11, which depicts the timing of larval and juvenile green sturgeon passage at RBDD. With the current gates-in operations, a total of approximately 99 percent of annual juvenile green sturgeon passing RBDD are subjected to the operational effects of the dam and it's associated diversion facilities. The annual percentage of juvenile green sturgeon passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—less than 1 percent
- June—37 percent
- July—50 percent
- August—11 percent

A majority of the adults of the two lamprey species are believed to pass RBDD during the months of February through August. Of these, approximately 25 percent of the annual lamprey spawning run may be affected by the gates-in operation (Figure B-12).

The percentages of the entire annual adult migrating population of Pacific and river lamprey passing RBDD that may be affected each month by operation of RBDD are estimated as follows:

- Late May—approximately 10 percent
- June—approximately 5 percent
- July—approximately 3 percent
- August—approximately 2 percent
- Early September—approximately 5 percent

While there may be some impedance of migration during gates-in operation, adult lamprey are known to actively pass through fish ladders at RBDD (D. Killam, pers. comm.) and fish ladders and obstacles at locations throughout the world (Kimsey and Fisk, 1964 as cited by Moyle, 1976). Their ability to attach on to the walls of the ladders allows for their passage through these structures. The potential biological consequences of delay at RBDD results in changes in adult spawning distribution (temporal and spatial), an increase in adult pre-spawning mortality, and decreased egg viability, all of which may result in the reduction of annual recruitment for these species.

During gates-in periods at RBDD, transformer life stages of Pacific lamprey migrate downstream (emigrate) through the project facilities. During gate-in operation, existing pathways for these lamprey life stages at RBDD includes passage under the dam gates or through the fish ladders and their auxiliary water systems, or they are subjected to impingement, entrainment, and passage through diversion bypass systems at RPP and TC Canal headworks. An additional effect of the existing operations of RBDD on lamprey transformers includes predation by both fish and avian species while passing through Lake Red Bluff and downstream of the dam.

The following discussion refers to Figure B-12, which depicts lamprey transformer passage at RBDD. With the current gates-in operations, approximately 6 to 7 percent of the annual run of Pacific lamprey transformers passing RBDD are subjected to the operational effects of the dam and its associated diversion facilities. The annual percentage of Pacific lamprey transformers passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—<2 percent
- June—1 percent
- July—<1 percent
- August—<1 percent
- Early September—less than 5 percent of the annual run at RBDD

The current gates-in operations affect approximately 30 percent of the annual run of river lamprey transformers passing RBDD. The annual percentage of this species passing RBDD that are presently subject to operational impacts are listed by month as follows:

- Late May—<15 percent
- June—>11 percent
- July—none
- August—none
- Early September—<6 percent of the annual run at RBDD

The greatest threat to any of the larval, juvenile, or transformer life stages of these non-salmonid anadromous fish passing through the project area are the direct losses related to passing under the RBDD gates and subsequent predation by Sacramento River pikeminnows and striped bass congregated immediately below the dam. Additionally, predation by avian and fish species within Lake Red Bluff may also be a significant threat to all larval, juvenile, or transformer life stages in the vicinity of RBDD.

Species Listed or Proposed for Listing under ESA or CESA

None of the four species discussed above is currently listed as endangered or threatened or a candidate for listing as endangered or threatened under ESA or CESA. Green sturgeon was petitioned for listing under ESA (June 11, 2001), but NMFS has not yet issued findings of the review of the Petition. However, green sturgeon is a California State Species of Special Concern (SSC), Class 1 (Moyle et al., 1995). River lamprey is a California SSC, Class 3 (Moyle et al., 1995). Anadromous Pacific lamprey is a California SSC, Class 4 (Moyle et al., 1995).

Non-native Anadromous Species (American Shad, Striped Bass)

The two non-native anadromous fish species found in the Sacramento River in the vicinity of the RBDD are: striped bass (stripers) (*Morone saxatilis*) and American shad (*Alosa sapidissima*). Both of these species were introduced into California from the eastern United States between 1871 and 1882 (Moyle, 1976). Striped bass populations were established from a total of 432 fish released into the San Francisco-San Pablo Bay estuary from two shipments delivered in 1879 and 1982. By 1888 a commercial fishery had been established, harvesting in excess of 1.2 million pounds by 1899 (Moyle, 1976). American shad were derived from approximately 830,000 fry collected in New York State and released into the Sacramento River between 1871 and 1881. A commercial fishery for American shad was developed in California by 1879, and over 1 million mature shad were captured in the commercial fishery by 1886, soon glutting the market (Skinner, 1962).

The commercial gill net fishery for striped bass ended in California in 1935 because sport angling took over the fishery (Skinner, 1962). From the 1930s and after, the striped bass fishery was one of the most successful recreational fisheries in California with over 1 to 2 million fish caught by sport fishers every year through at least 1957 (Skinner, 1962). By the 1940s, however, a decline in striped bass populations was noted by CDFG, and populations were severely depleted by 1970. CDFG records indicated that populations declined from an average of 3 million fish in the early 1960s to less than an average of 1.7 million adults by the late 1960s (U.S. Bureau of Reclamation [USBR], 1997). The average adult striped bass population during the period from 1967 to 1991 was approximately 1.25 million fish. By 1990, the annual population of adult striped bass had declined to approximately 680,000 adults. Sport catches of striped bass declined from an average annual catch of more than 300,000 fish in the early 1970s to less than 150,000 by the late 1980s (USBR, 1997). Beginning in 1981, juvenile striped bass were raised in hatcheries and released into the Delta and Bay to supplement the wild populations (USBR, 1997).

The commercial catch for shad in California peaked with over 5.6 million pounds landed in 1917 with an annual average of 1 to 2 million fish landed commercially until 1945. The California Legislature banned the use of gill nets for shad in 1957, virtually eliminating the commercial fishery for shad (Skinner, 1962). Shad was never popular among consumers in the Western United States because it is a bony species, and there were shortages of skilled boners/filleters. Additionally, the flesh of this fish is delicate and does not ship well. The primary use of shad was for its roe, which in the 1950 to 1960s brought 6 to 8 cents a pound (Skinner, 1962). A sport fishery was born for shad in the 1950s following the closure of commercial gill netting. Fly anglers and fishermen using “bump netting” methods caught over 30,00 fish in 1954. It remains a viable sport fishery in the lower Sacramento River to Red Bluff and in the Feather and American rivers. CDFG estimated that population of adult shad in 1976 and 1977 were approximately 3.04 million and 2.79 million adults, respectively (USBR, 1997).

Habitat Characteristics and Requirements

Striped Bass. Stripers are an anadromous species with adults spawning in freshwater, larvae and juveniles rearing in the Delta, and then migrating between the Delta, San Francisco Bay estuary, and Pacific Ocean as adults. Definite adult spawning migrations occur when mature adults enter the Carquinez Strait from San Francisco Bay in the fall months where they over-winter in Suisun Bay and the Delta (Mitchell, 1987 as cited by USBR, 1997). During the spring months, adults move into the upper Delta and its tributary rivers to spawn. Spawning occurs beginning in April in the Delta and May in the Sacramento River continuing through June. Spawning is dependent on water temperature, and begins when temperatures exceed approximately 58°C. It intensifies when water temperatures are between 63 to 68°C (Mitchell, 1987 as cited by USBR, 1997). Approximately 40 percent of stripers spawn in the Delta and the lower San Joaquin River, and 60 percent spawn in the Sacramento River and its tributaries (USBR, 1997). Spawning occurs during brief “peak” periods when most eggs are released within one or a few days. Moyle (1976) states that two major spawning areas are in the Central Valley: the San Joaquin River from Venice Island downstream to Antioch and the Sacramento River from Isleton upstream to Butte City (approximately RM 165). The habitat requirements for striped bass are presented in Table B-6.

Striped bass are mass spawner, broadcasting eggs and sperm into the water column, in a group of 5 to 30 fish near the surface of the main current, usually in the late afternoon or early evening. Fertilized egg are slightly denser that fresh water, and they slowly sink to the bottom in slow currents (Moyle, 1976) and are transported greater distances in swifter currents. Eggs hatch within approximately 2 days and have absorbed their yolk sac within approximately 7 to 9 days depending on the water temperature. Larvae begin feeding on zooplankton and increase in size and swimming ability. Early larval striped bass are poor swimmers. Eggs and larvae are transported by river currents within the Sacramento River into the Delta before larvae begin external feeding. The location of their geographic delivery into the Delta is a function of the volume of flows in the Sacramento River during egg and larval transport. Larval stages last 4 to 5 weeks before obtaining all the characteristics of juvenile fish. By July they will have grown to approximately 38 millimeters (mm) (USBR, 1997). The juveniles remain in the Delta or Suisun Bay depending on outlfows through the Delta where they forage and grow. Young-of-the-year striped bass move downstream into the Suisun or San Pablo bays during the late fall and winter . Their movements as juveniles following their first winter is similar to adults, migrating downstream into San Francisco Bay and Pacific Ocean in the summer and into Suisun Bay/Delta in the winter.

TABLE B-6
Habitat Requirements for Common Native and Non-native Resident and Anadromous Fish in the Vicinity of RBDD (Moyle, 1976)

Common Name	Scientific Name	Temperature Requirements	Preferred Spawning Habitat; Substrate	Adult Food Preference	Preferred Habitat Types	Notes or Comments
Striped Bass	*Morone saxatilis*	Spawning at 58-70°F (63-68 F optimal)	Broadcast spawns in moving water; n/a	Highly predatory of fish	Open water-pelagic predators	Extensive migratory patterns in the rivers, Delta, San Francisco Bay and ocean
American Shad	*Alosa sapidissima*	Spawning at 59-68°F	Broadcast spawns in moving water over sand, gravel, cobble	Large zooplankton, insects, crustaceans, molluscs	Prefers open water, but young will feed in dead-ended sloughs	Primarily found in saltwater except to spawn and early life stages
Sacramento Splittail	*Pogonichthys marcrolepidotus*	Optimal abundance in Delta: 59-73°F	Spawning over flooded vegetation in dead-ended sloughs	Bottom feeders: benthic invertebrates, insects, zooplankton, worms, and molluscs	Slow moving sections of main channel in rivers and sloughs	Tolerant of salinities up to 10-18 ppt; presently found in very restricted portions of their historical range
Hardhead	*Mylopharodon conocephalus*	Warm water conditions typical of low- to mid-elevation streams	Low-velocity riffles with gravel, (thought to be mass spawners)	Filamentous algae, small invertebrates, aquatic plants	Clear warm streams with large deep, rock and sandy bottom pools	Found in undisturbed sections of larger streams; move into smaller tributaries to spawn
Sacramento Pikeminnow	*Ptychocheilus grandis*	Do not flourish in waters less than 59°F; spawn above 57°F	Gravel riffles, congregate to spawn over rocky-gravely areas	Highly predatory on fish and crayfish	Clear well-shaded sand-rock bottomed pools with rocks/logs	Sedentary habits, often remaining in one pool for long intervals; also known to migrate up-, downstream to spawn and forage
Sacramento Sucker	*Catostomus occidentalis*	Wide temperature range, most abundant in cool streams-pools	Congregate over clean gravel	Filamentous algae, detritus, invertebrates associated with the bottom	Feed in small groups at head of pools or edge beds of aquatic vegetation; deep pools	Typically spend 2-3 years in natal stream before migrating into larger rivers with high water (in the fall)

ppt = parts per thousand.
°F = degrees Fahrenheit.

Near the project area, adult striped bass are known to begin congregating in the late spring/early summer month in the vicinity of RBDD. These fish move into the project area after spawning in downstream areas of the Sacramento River (M. Tucker, pers. comm.). From investigations conducted to determine predatory habits of Sacramento pikeminnow and striped bass, Tucker et. al., (1998) determined that the average catch per hour for striped bass captured near RBDD peaked in July during the years 1994 to 1996 (Figure B-14). As shown on Figure B-14, striped bass are present near RBDD from May through October.

During this period, adult striped bass congregate downstream of RBDD to prey on any appropriately sized juvenile fish, including salmonids that pass through the diversion complex (under the dam gates, through the fish ladders, or through the diversion bypasses). Striped bass are generally not known to pass through the fish ladder at RBDD (M. Tucker, pers. comm.).

American Shad. American shad are anadromous fish that are found in freshwater only when they move inland to spawn. Young shad migrate into saltwater almost immediately after hatching, and spend the majority of their lives (3 to 5 years) in saltwater (Moyle, 1976). Adult shad move into the lower San Francisco Bay estuary in the fall but do not move into freshwater until temperatures exceed 50-52°C, usually in late March or April. Spawning runs begin in late May or June when water temperatures reach 59°C or greater. Some evidence has indicated that increased flows initiate spawning runs, not just temperature (Painter et al., 1980 as cited by USBR, 1997). Spawning runs will continue until water temperatures exceed 68°C, usually in July. Spawning is done in mass in the main channels of the San Joaquin and Sacramento rivers and their tributaries. In the mainstem Sacramento River, shad spawning runs reach as far as unimpeded passage allows. Presently, passage of shad is generally blocked at RBDD. American shad do not pass above RBDD when the gates are in (D. Killam, pers. comm.) and generally do not use ladders to any appreciable extent (Skinner, 1962). Most shad die following spawning, but some return to the ocean following their spawning run. The estimated seasonal distributions of adult and larval American shad in the Sacramento River near Red Bluff are shown on Figure B-15. Shad eggs are slightly heavier that water and drift near the bottom of the currents they are spawned in. Hatching is completed in 6 days or more, depending on water temperature. Shad larvae and juveniles remain in the Delta until late summer when the juveniles are approximately 8 to 18 mm and they enter saltwater (Moyle, 1976). As previously stated, shad remain in the ocean for up to 5 years and are believed to undergo wide migrations along the Pacific Coast of California before returning to spawn in the Sacramento/San Joaquin rivers.

Impacts of Current Operations on Non-native Anadromous Fish

As stated previously, gates-in operations at RBDD results in restricting adult striped bass to reaches downstream of the dam following their spawning in the lower reaches of the Sacramento River. Because of either their inability or desire to distribute upstream of RBDD, stripers congregate downstream of and feed on juvenile fish passing the facilities at RBDD (Tucker et al., 1998). Therefore, predatory striped bass near RBDD are benefited by the creation of a “feeding station” when juvenile fish migrate through the vicinity. Striped bass are not recognized as spawning or rearing in the Sacramento River upstream of RBDD. Therefore, there are no adverse impacts to these life stages as result of RBDD operations.

American shad generally do not use the existing fish ladders at RBDD. Therefore, this species are prevented from migrating upstream of RBDD to spawn by the gates-in operations. This restriction however, does not likely adversely affect their population because this reach of the Sacramento River is at the northernmost extent of their geographic range in the Sacramento River watershed. Optimal spawning temperature for American shad is 62 to 70°F (Skinnner, 1962), and these water temperatures are unlikely to occur in the Sacramento River during the period when American shad are in the vicinity of RBDD. Consequently, American shad are only occasionally observed upstream of RBDD (USBR, 1997).

Resident Native and Resident Non-native Species (Pikeminnow, Rainbow Trout, and Others)

Habitat Characteristics and Requirements

As shown in Table B-1, large number of native and non-native resident species are found in the Sacramento River near RBDD. Principal species include: Sacramento pikeminnow, hardhead, hitch, Sacramento splittail (all *Cyprinid* species), resident rainbow trout, and Sacramento suckers. Life history characteristics for many of these species are shown in Table B-6. A large number of non-native sportfish species including large and smallmouth bass, various sunfish, catfish, and crappie, as well as brown trout, are commonly found near RBDD. Non-game species such as carp, shiners, minnows, and mosquito fish are also commonly found at RBDD. Many of these species have life histories that requires them to move up and downstream of the dam seasonally for spawning, rearing, or foraging life stages.

Sacramento Pikeminnow. In the case of the highly predatory Sacramento pikeminnow (formerly referred to as squawfish), current RBDD gates-in operations result in large congregations of adults that are known to prey heavily on chinook salmon smolts as they pass through RBDD. Several investigators have conducted predation assessments on pikeminnows and have concluded that predation is a serious threat to juvenile salmonids passing RBDD. In studies conducted by USFWS it was determined that predation is the primary cause of downstream migrant salmon mortalities at RBDD (Vogel et al., 1988). This investigation estimated that losses from predation, primarily by pikeminnows, are substantial and may range up to 55 percent of smolts passing RBDD. Tucker et al., (1998) found that in their investigations, the relative abundance of predatory pikeminnows at RBDD was lower than previous estimates. However, from their studies, Tucker et al., (1998) determined that the highest densities of pikeminnows occurred in the spring and early summer months when RBDD gates are in and when pikeminnows were attempting to migrate upstream to spawn. The stomach contents of pikeminnows captured near RBDD consisted predominately of juvenile salmonids but only during months when the RBDD gates were in (Tucker et al., 1998).

Populations of this species are generally not known. Some recent investigations however have determined the seasonal changes in the relative abundance of Sacramento pikeminnow near RBDD (Tucker et al., 1998). Pikeminnows are known to use the existing fish ladders at RBDD to migrate upstream during their spawning season. A summary of the current pattern of Sacramento pikeminnow presence near RBDD is shown on Figure B-16. This figure depicts the current relative abundance of predatory pikeminnows near RBDD.

Rainbow Trout. Resident native rainbow trout also are found in the Sacramento River near RBDD. The adults of this species migrate seasonally within the Sacramento River, but unlike steelhead, do not return to the ocean. Adult fish are known to use the existing ladders at RBDD to pass upstream, and juveniles are commonly observed at RBDD (D. Killam, pers. comm.) (Figure B-17). Adult rainbow trout migrate through RBDD as shown on Figure B-17. These fish are seeking upstream or tributary locations for spawning and/or are re-distributing within the Sacramento River to forage. It is difficult to differentiate between juvenile rainbow trout and steelhead as they're captured passing through RBDD. For the purposes of the analysis of impacts to juveniles of this species, it was assumed that rainbow trout and steelhead pass through RBDD as shown on Figure B-17. The timing of juvenile rainbow trout passing RBDD was obtained from data collected from rotary screw trapping investigations conducted downstream of RBDD during 1994 through 2000 (Gaines and Martin, 2001).

Other Resident Species. Population of other resident native species including hitch, hardhead, and Sacramento suckers have life histories that include seasonal migrations and re-distributions that, for the most part, are largely unaffected by operations of RBDD. Adults of some of these species are known to seasonally pass through the ladders at RBDD (e.g., hardheads and Sacramento suckers) (D. Killam, pers. comm.). Juveniles of these species are found at RBDD and are less preferred as forage species by the large predators that seasonally congregate at RBDD. The presumed presence and passage of adult hardheads and Sacramento suckers are shown on Figure B-18. Trapping investigations conducted by USFWS have determined the presence and the passage of juvenile hardheads and Sacramento suckers as shown on Figure B-19 (Gaines and Martin, 2001). The operations of RBDD may largely be inconsequential to populations of non-native resident species such as bass, sunfish, and others. Furthermore, the status of these species populations is generally unknown.

Impacts of Current Operations on Resident Native and Non-native Fish

Operation of the gates at RBDD may not directly adversely affect populations of most of the resident species, but operations may seasonally limit their access into optimal habitats. Rates of predation on juveniles of species such as rainbow trout and other native species near RBDD may be affected by the operations of the RBDD because of the congregation of adult pikeminnows and striped bass. Except for juvenile rainbow trout, predation on juvenile resident native and non-native fish may be inconsequential, as these species are less-preferred prey.

Species Listed or Proposed for Listing under ESA or CESA

Sacramento splittail (*Pogonichthys macrolepidotus*) was first listed by the USFWS as federal threatened on February 8, 1999. This listing applies to this species throughout its entire range within California. Splittail are native to California’s Central Valley, where they were once widely distributed (Moyle, 1976). Historically, splittail were found as far north as Redding on the Sacramento River. In recent times, dams and diversions have increasingly prevented splittail from upstream access to the large rivers, and the species is now restricted to a small portion of its former range (Moyle and Yoshiyama, 1992). However, during wet years, they migrate up the Sacramento River as far as RBDD (Federal Register 64:25, February 8, 1999).

Splittail abundance varies widely in response to environmental conditions, but the general population numbers are declining. The splittail is primarily threatened by the altered hydraulics and reduced Delta outflow caused by the export of freshwater from the Sacramento and San Joaquin rivers through operation of the state and federal water projects (Federal Register 64:25, February 8, 1999). Additional threats to this species include:

1. Direct and indirect mortality at power plants and in-Delta water diversion sites

2. Reduced river flows and changes in the seasonal patterns of flows in the Sacramento and San Joaquin rivers and their tributaries
3. Loss of spawning and nursery habitat as a consequence of draining and diking for agriculture
4. Loss of shallow-water habitat from levee slope protection, marina construction, and other bank oriented construction activities
5. Reduction in the availability of highly productive brackish-water habitat
6. Presence of toxic substances, especially agricultural and industrial chemicals and heavy metals in their aquatic habitat
7. Human and natural disturbance of the food web through altered hydrology and introduction of exotic species
8. Flood control operations that strand eggs, larvae, juveniles, and adults
9. Increase in severity of these effects by 6 years of drought
10. Entrainment of fish through unscreened or inadequately screened municipal and agricultural diversions

Environmental Consequences

Methodology

The analysis of the environmental consequences was conducted by comparing each of the proposed alternatives with the No Action Alternative (NAA). Each fish species' adult and juvenile monthly and annual passage indices calculated and obtained as output from the Fishtastic! analysis tool were used to compare the effects of each alternative. See Attachment B1 of this appendix for a description and discussion of the development of Fishtastic!, its methodology, and assumptions.

The analyses of the environmental consequences to fisheries resources through the use of the Fishtastic! tool was conducted for a large number of fish species that were identified by various resources agency participants. However, the available information and knowledge of life history characteristics at RBDD for many of these species (e.g., Sacramento sucker) limited the usefulness of this analysis tool. Therefore, the bulk of the analysis output from Fishtastic! was directed at those species for which a large amount of life history information is available. These species, termed the "focus species" in this analysis, included:

- Winter-run Chinook Salmon
- Spring-run Chinook Salmon
- Fall-run Chinook Salmon
- Late-fall-run Chinook Salmon
- Steelhead
- Rainbow Trout
- Green Sturgeon
- Pacific Lamprey
- River Lamprey

Compared to many of the salmonid species, less is known of the river lamprey's life history characteristics. However, this species is a California Species of Special Concern (SSC) and a native anadromous species known to transit RBDD. Therefore, this species was analyzed using the Fishtastic! impact analysis tool. Finally, because it is a native anadromous species, has similar morphology and somewhat similar life history characteristics, and is commonly known to transit RBDD, the Pacific lamprey was also analyzed using the Fishtastic! impact analysis tool.

For the remaining fish species, a qualitative evaluation was conducted to determine the environmental consequences of project alternatives.

Significance Criteria

Significance criteria represent the thresholds that were used to identify whether an impact or benefit would be potentially measurable. Under the California Environmental Quality Act (CEQA), any adverse impact to State Listed Species would be considered significant, and mitigation would be required to reduce impacts to less than significant levels.

For the purposes of distinguishing project alternatives from No Action, the following significance criteria for evaluating passage improvements were used in the analyses of impacts and benefits:

- No Difference in Passage Indices = No change
- <10-percent Difference in Passage Indices = No measurable impact (-) or benefit (+)
- ≥10-percent <25-percent Difference in Passage Indices = Measurable impact (-) or benefit (+)
- ≥25-percent Difference in Passage Indices = Large measurable impact (-) or benefit (+)

Analyses of the Environmental Consequences of Project Alternatives to Fishery Resources

This section provides a discussion of the consequences of the project alternatives on fishery resources as compared to NAA. Additional analyses of the consequences of project alternatives on fishery resources are provided in Attachment B2 of this appendix. The impact analysis is conducted for four groups of fish commonly found at RBDD: NAS, NAO, NNA, and RN and RNN.

The results of the analysis of the project alternatives are summarized and discussed in the sections below. In the case of adult life stages of the four fish groups listed above, a discussion of the consequences of all of the alternatives listed below are provided in the Summary Results section and Alternatives Discussion sections that follow. For analysis purposes, it was assumed that there would be no impacts or benefits to juvenile life stages from the ladder and/or bypass elements of the alternatives. Therefore, the summary and discussion of the consequences for juveniles are presented in the summary discussion sections as noted below. The project alternatives analyzed include:

- No Action Alternative (NAA)—(presented for adults and juveniles)
- 1A: 4-month Improved Ladder Alternative—(presented for adults)
- 1B: 4-month Bypass Alternative—(presented for adults)

- 4-month Gates-in—(presented for juveniles)
- 2A: 2-month Improved Ladder Alternative—(presented for adults)
- 2B: 2-month with Existing Ladders Alternatives—(presented for adults)
- 2-month Gates-in—(presented for juveniles)
- 3: Gates-out Alternative—(presented for adults and juveniles)

Summary of Consequences

The results of the Fishtastic! analyses are present in Tables B-7 through B-12. These tables provide the summary of the passage index scores (scaled to 100 as a maximum value). The index values represent the approximate portion of the species and lifestage that is un-affected by operations of the RBDD facilities for the entire calendar year. For example, an adult passage index of 89 means that approximately 89 percent of the entire annual population would pass RBDD and Lake Red Bluff without blockage, delay or some loss or injury.

Additionally, these tables present the percent difference between existing conditions and the No Action Alternative; the percent difference between an alternative and NAA; the percentage improvement over the NAA, and a measure of effect based on the significance criteria provided above.

Summary tables for adult fish passage are as follows:

- Table B-7—NAS species
- Table B-9—NAO species
- Table B-11—RN (rainbow trout)

Summary tables for juvenile fish passage are as follows:

- Table B-8—NAS species
- Table B-10—NAO species
- Table B-12—RN (rainbow trout)

The analysis of the consequences of changes in passage indices for adult native anadromous salmonid species (NAS) is summarized in Table B-7. In this table, the calculated adult passage indices are presented for each of the five species and the differences from those for the NAA. Also summarized in Table B-7, for each species, are the percentage improvement from NAA and the effect of each alternative compared to NAA.

The analysis reveled that, in all cases, for all species and all alternatives, the adult passage indices were equal to or greater than those for NAA. Therefore, no alternative resulted in measurable adverse impacts to adults of any of the five NAS species.

TABLE B-7
Index Value, Relative Difference, and Improvement in Passage Index for Adult Anadromous Salmonids between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect	Index Value	Difference	Percent Improved	Effect
	Winter-run Chinook Salmon				**Spring-run Chinook Salmon**			
NAA	89	n/a	n/a	*No Change*	52	n/a	n/a	*No Change*
1A	91	2	2	*No Measurable Benefit*	61	8	16	*No Measurable Benefit*
1B	91	1	1	*No Measurable Benefit*	57	5	9	*No Measurable Benefit*
2A	98	8	9	*No Measurable Benefit*	94	41	79	*Large Measurable Benefit*
2B	98	8	9	*No Measurable Benefit*	93	40	77	*Large Measurable Benefit*
3	100	10	12	*Measurable Benefit*	100	48	91	*Large Measurable Benefit*
	Fall-run Chinook Salmon				**Late-fall-run Chinook Salmon**			
NAA	83	n/a	n/a	*No Change*	100	n/a	n/a	*No Change*
1A	86	3	4	*No Measurable Benefit*	100	0	0	*No Change*
1B	85	2	2	*No Measurable Benefit*	100	0	0	*No Change*
2A	91	8	8	*No Measurable Benefit*	100	0	0	*No Change*
2B	89	6	8	*No Measurable Benefit*	100	0	0	*No Change*
3	100	17	20	*Measurable Benefit*	100	0	0	*No Change*
	Steelhead							
NAA	89	n/a	n/a	*No Change*				
1A	91	2	2	*No Measurable Benefit*				
1B	90	1	1	*No Measurable Benefit*				
2A	97	8	9	*No Measurable Benefit*				
2B	96	7	8	*No Measurable Benefit*				
3	100	11	12	*Measurable Benefit*				

The results of the analyses of changes in juvenile native anadromous salmonid passage indices are summarized in Table B-8. In this table, the calculated juvenile passage indices are presented for each of the five species and their differences from those for the NAA. Also summarized in Table B-8, for each species, are the percentage improvement from NAA and the effect of each alternative compared to NAA.

In all cases, for all species and all alternatives, the juvenile passage indices were equal to or greater than those for NAA. Therefore, no alternative resulted in measurable adverse impacts to juveniles of any of the five NAS species.

The principal NAO fish species occurring at RBDD are green and white sturgeons and Pacific and river lampreys. Of these, the Fishtastic! analyses focused on the green sturgeon, because this species is known to congregate downstream of RBDD during periods when the dam gates are in place (K. Brown, pers. comm.). An additional non-native anadromous species, white sturgeon, are believed to migrate into lower segments of the Sacramento River to approximately Colusa (River Kilometer 231) to spawn (Schaffter, 1997). However, this species are generally not known to spawn upstream of RBDD. For this reason, it was assumed for the analysis that white sturgeon are not presently affected by operations at RBDD, and further impacts analysis was not conduced.

The timing and passage of both of the lamprey species are less precisely known than the anadromous native salmonid species. Therefore, conclusions concerning these species are based on their general life history characteristics, their physical morphology, and their observed passage at RBDD. The summary of the passage indices for all alternatives for adult NAO species is shown in Table B-9. Juvenile passage indices for all project alternatives and NAA for juvenile green sturgeon and transformer life stages of the lamprey species are shown in Table B-10.

The adult passage index values for rainbow trout for all alternatives are summarized in Table B-11. The juvenile passage indices for rainbow trout for all alternatives are shown in Table B-12.

No Action Alternative

Under NAA, there would be no impacts or benefits to adult or juvenile fishery resources from the construction/expansion of RPP. The expansion of the existing RPP would be built within the existing off-channel footprint of RPP and not within the Sacramento River proper.

Operations under NAA would result in no adverse impacts or benefits to fishery resources compared to existing conditions. Under NAA, the RPP's capacity would be expanded to 320 cubic feet per second (cfs) from 240 cfs (existing conditions). There would be no measurable adverse impacts or benefits from this operational increase in pumping capacity because the fundamental assumption for all new screened diversion elements, including those for the expansion of the RPP, was that all screens and bypasses would meet all requirements and criteria for the protection of juvenile fish.

TABLE B-8
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile Anadromous Salmonids between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect	Index Value	Difference	Percent Improved	Effect
	Winter-run Chinook Salmon				**Spring-run Chinook Salmon**			
NAA	96	n/a	n/a	*No Change*	100	n/a	n/a	*No Change*
4-Month Gates-in	96	0	0	*No Change*	100	0	0	*No Change*
2-Month Gates-in	99	3	3	*No Measurable Benefit*	100	0	0	*No Change*
Gates-out	100	4	4	*No Measurable Benefit*	100	0	0	*No Change*
	Fall-run Chinook Salmon				**Late-fall-run Chinook Salmon**			
NAA	97	n/a	n/a	*No Change*	93	n/a	n/a	*No Change*
4-Month Gates-in	97	0	0	*No Change*	93	0	0	*No Change*
2-Month Gates-in	100	2	2	*No Measurable Benefit*	98	4	5	*No Measurable Benefit*
Gates-out	100	3	3	*No Measurable Benefit*	100	7	7	*No Measurable Benefit*
	Steelhead							
NAA	92	n/a	n/a	*No Change*				
4-Month Gates In	92	0	0	*No Change*				
2-Month Gates In	99	6	7	*No Measurable Benefit*				
Gates-out	100	8	8	*No Measurable Benefit*				

TABLE B-9
Index Value, Relative Difference, and Improvement in Passage Index for Adult Other Native Anadromous Species between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect	Index Value	Difference	Percent Improved	Effect
	Green Sturgeon				**Pacific Lamprey**			
NAA	65	n/a	n/a	*No Change*	83	n/a	n/a	*No Change*
1A	65	0	0	*No Change*	86	3	4	*No Measurable Benefit*
1B	69	4	6	*No Measurable Benefit*	85	2	2	*No Measurable Benefit*
2A	100	35	54	*Large Measurable Benefit*	97	14	17	*Measurable Benefit*
2B	100	35	54	*Large Measurable Benefit*	96	13	16	*Measurable Benefit*
3	100	35	54	*Large Measurable Benefit*	100	17	20	*Measurable Benefit*
	River Lamprey							
NAA	83	n/a	n/a	*No Change*				
1A	86	3	4	*No Measurable Benefit*				
1B	85	2	2	*No Measurable Benefit*				
2A	97	14	17	*Measurable Benefit*				
2B	96	13	16	*Measurable Benefit*				
3	100	17	20	*Measurable Benefit*				

TABLE B-10
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile (and transformers) for Other Native Anadromous Species between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect	Index Value	Difference	Percent Improved	Effect
	Green Sturgeon Juveniles				**Pacific Lamprey Transformers**			
0	73	n/a	n/a	*No Change*	99	n/a	n/a	*No Change*
4-Month Gates-in	73	0	0	*No Change*	99	0	0	*No Change*
2-Month Gates-in	88	15	21	*Measurable Benefit*	100	1	1	*No Measurable Benefit*
Gates-out	100	27	38	*Large Measurable Benefit*	100	1	1	*No Measurable Benefit*
	River Lamprey Transformers							
NAA	87	n/a	n/a	*No Change*				
4-Month Gates-in	87	0	0	*No Change*				
2-Month Gates-in	100	13	15	*Measurable Benefit*				
Gates-Out	100	13	15	*Measurable Benefit*				

TABLE B-11
Index Value, Relative Difference, and Improvement in Passage Index for Adult Rainbow Trout between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect
NAA	73	n/a	n/a	*No Change*
1A	78	5	7	*No Measurable Benefit*
1B	76	3	4	*No Measurable Benefit*
2A	91	18	25	*Measurable Benefit*
2B	90	17	23	*Measurable Benefit*
3	100	27	37	*Large Measurable Benefit*

TABLE B-12
Index Value, Relative Difference, and Improvement in Passage Index for Juvenile Rainbow Trout between Existing Conditions and NAA, and NAA and Project Alternatives

Alternative	Index Value	Difference	Percent Improved	Effect
NAA	92	n/a	n/a	*No Change*
4-Month Gates-in	92	0	0	*No Change*
2-Month Gates-in	99	7	7	*No Measurable Benefit*
Gates-out	100	8	8	*No Measurable Benefit*

1A: 4-month Improved Ladder Alternative

Construction. Impacts from constructing fish ladder and pump stations, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing east and west bank fish ladders and the new pump station location at the "Mill Site." At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. Construction of the left bank fish ladder would require installation of a 166-LF sheet pile cofferdam.

In addition, impacts could also occur at these locations because of de-watering active channel areas following sheet pile installation. Acoustic shock from pile driving activities could destroy any incubating embryos within 200 feet of any sheet pile installation. Both adults and juveniles could be physically crushed during earth movement or sheet pile installation. Both adults and juveniles may be stranded and lost during de-watering actions following the installation of sheet piling.

These activities would adversely affect migrating adults, rearing stages of fry and juveniles, and migrating smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults, embryos, and juvenile life stages would occur as a result of sediment disturbances and turbidity that would result from construction of project fish ladders and pump stations. These impacts would be significant and would require mitigation to reduce them to less than significant.

Operations. No significant adverse impact to fishery resources would occur with operations of this alternative. Therefore, no mitigation is required.

Native Anadromous Salmonids (NAS)

Adults. As previously discussed and shown in Table B-7, the adult passage index values for the 4-month Improved Ladder Alternative for NAS are equal to or greater than those for the NAA. The index values for these species are shown on Figure B-20. There is no change in the adult passage index for late-fall chinook salmon from implementing this alternative (Table B-7). This is because this species does not immigrate through RBDD during the gates-in operational period (mid-May through mid-September). There are small improvements (2 to 4 percent) in passage indices for adult winter-run and fall-run chinook salmon and steelhead . There is a measurable improvement for adult spring-run chinook salmon (16 percent). While the percent improvement in the passage index for adult spring-run chinook salmon seems relatively large (16 percent), the overall annual passage index for this species remains a rather low 61 out of a possible 100 (Table B-7).

These small improvements in adult passage are a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative. Except for spring-run chinook, the magnitude of these improvements however, is generally not sufficiently beneficial to be considered a measurable improvement for adult passage of NAS species. Rather large components (approximately 39 percent) of threatened adult spring-run salmon would continue to be blocked or impeded under this alternative. In addition, approximately 9 percent of endangered winter-run chinook salmon and threatened adult steelhead would also continue to be blocked or impeded by the gates at RBDD under this alternative (Figure B-20.

Juveniles. The juvenile passage indices for the NAS species are rather large (greater than 92 on a scale of 100) (Table B-8). For the 4-month Improved Ladder Alternative, there are no differences in the juvenile passage indices for the NAS species as compared to NAA. This result is because of the lack of operational changes (Gates In/Out) for this alternative that affects the principal impact mechanism for juvenile anadromous salmonids at RBDD, namely, predation. The juvenile passage indices for the NAS, NAO, and RN/RNN species analyzed using the Fishtastic! tool are presented on Figure B-22.

Other Native Anadromous Species (NAO)

Adults. The adult passage indices for the three NAO species for the 4-month Improved Ladder Alternative are equal to or greater than those for NAA (Table B-9). These indices are also shown on Figure B-21. There is no improvement in the adult passage index for green sturgeon from implementing this alternative (Table B-9). This is because this species does not generally successfully use fish ladders constructed for salmonid species, and even with improvement in the fish ladders, this species would not benefit.

The small (4 percent) improvements in adult Pacific and river lamprey passage indices are a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative. However, the magnitude of these improvements are not sufficiently beneficial nor a measurable improvement for adult passage. For all project alternatives and NAA, the passage indices for the lamprey species are great (>83 on a scale of 100) because of these species' passage timing and their efficiency in passing ladders (Table 9). Lamprey are known to transit fish ladders by physically attaching to the ladder structures with their oral disc (sucker) (Killam, pers. comm.), thereby resting between bursts of swimming activity while passing through the ladder.

Juveniles. For this alternative, there are no differences in the juvenile passage indices for green sturgeon and the transformer lifestages for the lamprey species as compared to NAA (Table B-10). This result is because of the lack of operational changes for this alternative that affects the principal impact mechanism for juveniles or transformers of these species at RBDD, namely, predation. Juvenile/transformer passage indices are shown on Figure B-22.

Non-native Anadromous Species (NNA)

Adults. Non native anadromous species that may occur periodically at RBDD include American shad (shad), and striped bass (stripers). These species more commonly occur in the lower portions of the Sacramento River and Delta but seasonally occur at RBDD. In is not necessary for either of these introduced species to migrate to areas upstream of RBDD to spawn or rear their young. Adult shad would be expected to arrive at RBDD during their spawning run primarily from May through July. However, this species does not generally use fish ladders successfully that are primarily designed to pass salmon, steelhead, or trout. For this species, little if any benefit would be expected to occur from the implementation of the 4-month Improved Ladder Alternative. Furthermore, the continued impedance of shad from passing RBDD is not likely to adversely affect the continued success of this species.

New ladders on the east and west banks would provide additional flow and passage improvement for salmonids but would likely not measurably improve adult passage of striped bass. It has been observed that striped bass arrive at RBDD in the spring/early summer months after spawning in the lower reaches of the Sacramento and Feather Rivers. After arriving at RBDD stripers seem prefer to remain immediately downstream of the dam.

These highly predatory fish continue to forage on juvenile fishes passing through the dam (Tucker, pers. comm.). It is unlikely that this alternative would measurably alter their behavior and therefore this alternative would not alter passage of adult of either American shad or striped bass.

Juveniles. Juvenile striped bass are not likely to be present in the project area as they are typically spawned in the lower reaches of the Feather and Sacramento rivers and rear in the Sacramento-San Joaquin River Delta. There would be no change from NAA in operations that would affect juvenile American Shad. Therefor this alternative would provide neither any benefit nor adverse impact to juveniles of either shad or striped bass.

Resident Native and Resident Non-native Species (RN/RNN)

Adults. Rainbow trout are a species of native resident fish that were analyzed using the Fishtastic! tool. For the 4-month Improved Ladder Alternative, the adult rainbow trout passage index is approximately 7 percent greater than that for NAA (Table B-10). The small improvement in adult rainbow trout passage for this alternative is a result of increased efficiencies in attraction to and passage within the new fish ladders featured in this alternative. However, the change in adult passage index for this species is small and not considered a measurable improvement for rainbow trout. A rather large component (22 percent) of adult rainbow trout remains blocked or impeded by the gates at RBDD with this alternative Figure B-20.

Other than rainbow trout, the principal resident native species found near RBDD include Sacramento pikeminnow, splittail, hardhead, and Sacramento sucker. These species have evolved within the Sacramento River and have distinct life history characteristics and requirements. All of these species maintain residency within the freshwater portion of the Sacramento River watershed. However, these species do migrate upstream and downstream throughout the river system to meet their spawning, rearing, and foraging needs. In that way, the operations of RBDD can hinder these species to a greater or lessor degree depending on time of year and the species needs.

Adult Sacramento pikeminnow (formerly squawfish) are known to migrate upstream in the spring months spawn and therefore when the RBDD gates go in these fish tend to congregate below the dam. Operation of RBDD under the Reasonable and Prudent Alternatives specified in the Winter-run Chinook Salmon Biological Opinion (NMFS, 1993) which specified that the gates may not go in prior to May 15th, have greatly reduced the impacts of predation on salmonids from pikeminnows. This species can and does readily pass through the existing fish ladders at RBDD. However, there continues to be a congregation of predators, including pikeminnows, downstream of RBDD under existing conditions and the NAA. Tucker (1998) found that during sampling during 1994-1996, the largest catch/per/unit effort (26 percent of annual total) of Sacramento pikeminnows occurred at RBDD during June when the gates are in.

Under the 4-month Improved Ladder Alternative there may be additional passage opportunity provided for adult pikeminnow through the new fish ladders proposed for the left and right banks. However, the incremental increase in ladder passage provided to pikeminnows by the new ladders is likely to be small and not measurable. Other species such as hardhead, and Sacramento suckers are also not likely to measurably benefit from this alternative. These species also are known to successfully use fish ladders but their passage is greatly restricted by fish ladders principally designed for salmonids. Ladder modifications to attract and pass salmonids may increase their use by these species but not likely to a large degree. Splittail do not successfully pass fish ladders and therefore would not benefit from this alternative.

Adult passage of other resident non-native species (e.g. brown trout) may benefit somewhat from this alternative as this species readily passes fish ladders. Most of the other resident non-native fishes such as basses, sunfishes, catfishes and shiners that are commonly found near RBDD (see Table B-1) would not benefit from this alternative. On the other hand, most of these non-native species have life history characteristics that do not require migration over large geographic distances and therefore passage impediments such as RBDD do not greatly affect their populations.

Juveniles. For this alternative, there is no difference in the juvenile rainbow trout passage index when compared to NAA (Table B-12). This result is because of the lack of operational changes for the alternative that affects the principal impact mechanism for juvenile rainbow trout at RBDD, namely, predation. Juvenile passage indices are shown on Figure B-22. Juveniles of other resident native and resident non-native species would nether benefit or are adversely affected by this alternative. The alternative will not change any operation (RBDD gates) that affects predation of juvenile lifestages of these species.

1B: 4-month Bypass Alternative

Construction. Impacts from constructing a fish bypass channel, new right bank fish ladder, and a pump station, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. Impacts from constructing a new fish ladder, pump stations, including screens and screen bypasses, and a bypass channel would include direct and indirect losses of adult and or juvenile fish. These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing right (west) bank fish ladder, the take-out and put-back confluence areas of the bypass channel on the left (east) bank of the Sacramento River, and the new pump station location at the "Mill Site." At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. The exact dimensions of the coffer dammed areas for the bypass channel take-out and put-back areas is unknown.

The impacts would occur during installation of sheet piling and de-watering of project areas following sheet pile installation. Both adults and juveniles could be physically crushed during earth movement or sheet pile installation. Both adults and juveniles may be stranded and lost during de-watering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages would occur as a result of sediment disturbances and turbidity that would result from construction of project bypass channel and the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant.

Operations. No significant adverse impact to fishery resources would occur with operations of this alternative. Therefore, no mitigation is required.

Native Anadromous Salmonid Species (NAS)

Adults. As shown in Table B-7, the adult passage index values for the 4-month Bypass Alternative for the five NAS species are equal to or greater than those for NAA. The index values for these NAS species are shown on Figure B-20. As was previously stated for the 4-month Improved Ladder Alternative, there is no change or improvement in the adult passage index for late-fall chinook salmon for any project alternative (this species does not immigrate through the RBDD during the gates-in operational period). There are small (from 1 to approximately 2 percent) improvements in adult passage indices for winter-run, spring-run, and fall-run chinook salmon, and steelhead. These small improvements in adult passage are a result of small incremental increases in adult passage that may occur by these species using the bypass channel and a new right bank fish ladder. However, the magnitudes of these improvements are generally not sufficiently beneficial to be considered a measurable improvement for passage of these species with this alternative. A rather large (43 percent) component of threatened adult spring-run chinook salmon and smaller components of endangered adult winter-run (9 percent) and threatened adult steelhead (10 percent) remains blocked or impeded by the RBDD gates for this alternative (Figure B-20).

Juveniles. See the discussion of juvenile passage for NAS species for the 4-month Improved Ladder Alternative.

Other Native Anadromous Species (NAO)

Adults. The adult passage indices for the three NAO for the 4-month Bypass Alternative are greater than those for NAA (Table B-9). These indices are shown on Figure B-21. For this alternative, and compared to NAA, there is a small (6 percent) improvement in the adult passage index for green sturgeon. This is because adult green sturgeon may use the constructed bypass channel. However, the likelihood and ability of this species to use the bypass channel is unknown. Therefore, the uncertainty of adult green sturgeon to successfully pass through this channel is reflected as a small increase in passage index for this species. This alternative would likely result in no measurable passage benefit to adult green sturgeon.

There are similar small (2 percent) increases in passage indices for adult Pacific and river lamprey. These species may also use the bypass channel to some, but unknown, extent as well as passing through the improved right bank fish ladder featured for this alternative. The magnitude of these improvements as shown in Table B-9 are generally not sufficiently great enough to be considered a measurable benefit for adult passage for these species. As previously discussed, the passage indices for the lamprey species are large (>85 on a scale of 100) because of these species' life history characteristics and their ability to pass through salmonid fish ladders.

Juveniles. See the discussion of juvenile/transformer passage of NAO species for the 4-month Improved Ladder Alternative.

Non-native Anadromous Species (NNA)

Adults. Adult American shad and striped bass may benefit somewhat by successfully passing RBDD via the bypass channel that would be constructed for the alternative. A low gradient bypass channel that would be designed to provide slower water velocities and abundant resting segments that may assist species like shad and stripers which have some difficulty with or reluctance to pass conventional fish ladders designed primarily for salmonids. However, the extent to which these two species would successful pass through the bypass channel is unknown. As previously, stated, adult stripers currently prefer to remain immediately downstream of the RBDD and generally do not pass the existing fish ladders. It is likely that with the RBDD gates in the river (similar to the NAA) stripers would chose to remain downstream of the gates, preying on juvenile fish rather than re-distributing to upstream areas via the bypass channel.

The benefit to adult passage for either of these species is unknown or is likely small and not measurable. A more likely scenario, for this alternative, is that stripers would remain downstream of RBDD or possibly move into the bypass channel and continue to prey on juvenile salmonids or other species. Furthermore, given the opportunity to transit the bypass channel, shad may or may not actually move further upstream to spawn.

Juveniles. See the discussion for NNA species for the 2-month Improved Ladder Alternative.

Resident Native and Non-native Species (RN/RNN)

Adults. The adult passage index value for adult rainbow trout for the 4-month Bypass Alternative is approximately 4 percent greater than that for NAA (Table B-11). The index value for this species is shown on Figure B-20. The small improvement in passage index for adult rainbow trout for this alternative is a result of slight increases in efficiencies of attraction and passage in the new right bank fish ladder. There may also be some small but uncertain increase in passage through the bypass channel featured in this alternative. However, the magnitude of these improvements is generally not sufficient to be considered a measurable improvement for adult passage of rainbow trout. A rather large component (24 percent) of adult rainbow trout remains blocked or impeded by the gates at RBDD under this alternative (Figure B-20).

Adult passage of other RN/RNN species may benefit from the construction of the bypass channel. The channel will provide lower velocities than the existing fish ladders and will provide long segments of flatwater. These conditions would potentially be more suitable for successful passage of most if not all of these species. However, the extent and the successful use of this channel to migrate around RBDD is unknown, and therefore the benefits of this alternative to most RN/RNN species would have to be considered small and likely not measurably beneficial.

Juveniles. See the discussion of juvenile passage of RN/NNR species for the 4-month Improved Ladder Alternative.

2A: 2-month Improved Ladder Alternative

Construction. Impacts from constructing new left and right bank fish ladders and a pump station, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. The major construction impact areas are the, the right and left bank fish ladder vicinities, and the pump station location at the "Mill Site." These impacts would principally occur during installation of cofferdams. The construction areas would include areas near the existing east and west bank fish ladders and the new pump station location at the "Mill Site." At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF. Construction of the right bank fish ladder would require a 270-LF sheet pile cofferdam. Construction of the left bank fish ladder would require installation of a 166-LF sheet pile cofferdam.

In addition, impacts could also occur at these locations because of de-watering active channel areas following sheet pile installation. Both adults and juveniles may be stranded and lost during de-watering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages would occur as a result of sediment disturbances and turbidity that would result from construction of project fish ladders and the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant.

Operations. No significant adverse impact to fishery resources would occur with operations of this alternative. Therefore, no mitigation is required. Below is a summary of the adult passage index values for this alternative.

Native Anadromous Salmonid Species (NAS)

Adults. As shown in Table B-7, the adult passage indices for the five NAS species for the 2-month Improved Ladder Alternative are equal to or greater than those for NAA. These indices are shown on Figure B-20. As previously stated for all alternatives, there is no change in the adult passage index for late-fall chinook salmon with this alternative. There are, however, modest differences in adult passage indices for winter-run and fall-run chinook salmon, and steelhead (9 percent each). The principal benefit of this alternative occurs for spring-run chinook salmon where the adult passage index increased over 79 percent compared to NAA (Table B-7). This improvement is clearly a measurably large benefit to this species. The large passage improvement for adult spring-run chinook salmon occurs because the dam gates at RBDD would remain out until July 1, allowing nearly 94 percent of the adults of this species to migrate pass RBDD unimpeded.

An improvement to adult passage for this alternative also occurs during months of gates-in operation from the new fish ladders on the left and right banks of the river. However, the magnitude of these improvements to the ladders are, by far, less beneficial than the removal of the gates during the early to mid-summer months. The ladder improvements alone would not generally be considered a measurable improvement for adult passage (see discussion of adult NAS species for the 4-month Improved Ladder Alternative). However, the 2-month Improved Ladder Alternative is quite effective in reducing the impedance of the NAS species. Approximately 6 percent of threatened adult spring-run, 2 percent of endangered adult winter-run chinook salmon, and 3 percent of threatened adult steelhead would remain blocked or impeded under this alternative (Figure B-20).

Juveniles. Under this alternative, the juvenile passage indices for all five of the NAS species are greater when compared to NAA (Table B-8). However, the differences are small, and not measurably beneficial. The differences from NAA for these juvenile passage indices ranges from no change for spring-run to 5 percent for late-fall-run chinook salmon, and 7 percent for steelhead. These results are because of the reduction in rates of predation of these species during longer gates-out periods, especially during the early to mid-summer months (mid-May through June 30). The operational changes (gates-out) featured in the alternative reduces the effects of the principal impact mechanism (predation), but not measurably, for juvenile NAS species. Juvenile passages indices are shown on Figure B-22.

Other Native Anadromous Species (NAO)

Adults. The adult passage indices for the three NAO species for the 2-month Improved Ladder Alternative are all greater than those for NAA (Table B-9). The index values for these NAO species are shown on Figure B-21. This alternative provides a large (54) improvement in the adult passage index for green sturgeon (Table B-9). This large measurable benefit (54 percent compared to NAA) occurs because adults of this species primarily migrate past RBDD in the late spring-early summer ending July 1. This alternative would eliminate all blockage and impedance of adult green sturgeon at RBDD.

There are also smaller (17 percent), but measurably beneficial improvements in passage indices for adult Pacific and river lamprey from the implementation of this alternative (Table B-9). For this alternative, adult passage for the lamprey species may be improved to nearly 97 percent of unobstructed passage.

Juveniles. For the 2-month Improved Ladder Alternative, there are modest but measurably beneficial improvements in juvenile green sturgeon (21 percent) and river lamprey (15 percent) transformer passage indices (Table B-10) as compared to NAA. There is a small (1 percent) but not measurable Improvement in juvenile passage index for Pacific lamprey. This result is because of the juvenile Pacific lampreys' passage timing which principally occurs prior to the RBDD operational period for this alternative (before July 1). Juvenile passage indices are shown on Figure B-22.

Non-native Anadromous Species (NNA)

Adults. For this alternative, the RBDD gates would remain out until July 1. This gate operation would likely result in less congregation of predatory striped bass than would occur if gates remained in during this period. Stripers would either choose to move farther upstream of RBDD, remain in the deeper holding pools at RBDD, or possibly would not remain at RBDD in search of prey. This alternative, while it provides less restriction of upstream movement for stripers, may not be beneficial to this species because it removes the physical impediment that disorients and injures prey fish as they pass through the RBDD gates. Lake Red Bluff, which is good habitat for predatory species like stripers, would exist for only 2 months annually under this alternative. This is a disadvantage for striped bass. These fish would have fewer ambush opportunities to prey on juveniles salmonids and other species when they are transiting Lake Red Bluff. However, this alternative would allow adult stripers additional opportunity to migrate upstream as far as Redding. This may result in undesirable increases in predation by striped bass on juvenile salmonids upstream of RBDD.

The construction of new ladders as part of this alternative would provide little, if any, benefit for stripers because this species generally do not readily pass fish ladders designed principally for salmonid fishes. See the discussion for Non-native Anadromous species for the 4-month Improved Ladder Alternative above.

Upstream passage of adult shad upstream of RBDD would likely improve with this alternative. Approximately 80 percent of the annual spawning run would transit RBDD unimpeded during the gates-out period under this alternative. This would be in contrast to approximately 35 percent for NAA. The removal of the gates until July 1 each year would allow shad to move farther upstream into habitats that may (or may not) be more suitable for successful spawning, incubation, and early fry rearing. This however, may not provide benefits to the species because the reach of the Sacramento River upstream of RBDD is at the northernmost extent of their geographic range in the Sacramento River watershed. Furthermore, optimal spawning temperatures for shad range from 62 to 70°F (Skinnner, 1962), and these water temperatures are unlikely to occur in the Sacramento River upstream of RBDD during the months when shad would have access upstream of RBDD.

Juveniles. Juvenile American shad would likely benefit from this alternative by the reduction in the rate at which they are preyed upon by adult striped bass and Sacramento pikeminnow. The RBDD gates would be out until July 1 and would likely discourage predatory species, particularly pikeminnow, from congregating downstream of RBDD. This would lessen the potential for predation and allow a greater number of shad to pass unmolested downstream through the project area. There would be no benefit or adverse impact to juvenile striped bass, as this species does not occur in the project area.

Resident Native and Non-native Species (RN/RNN)

Adults. For the 2-month Improved Ladder Alternative, adult rainbow trout passage index is approximately 25 percent greater than that for NAA (Table B-11). The indices for this species are shown on Figure B-20. The improvement in adult rainbow trout passage for this alternative is a result of the gates-out operational period through June 30. A substantial number of adult rainbow trout pass RBDD during the period from May 15 through June 30. The adult passage index is 91 (on a scale of 100) and the magnitude of the passage improvement is considered measurably beneficial. However, approximately 9 percent of adult rainbow trout remain blocked or impeded by the gates at RBDD under this alternative (Figure B-20).

This alternative would provide measurably beneficial conditions for passage of other adult RN/RNN species. The removal of the RBDD gates for 2 months from mid-May to June 30 and after September 1 would remove passage impedance for these species for 2 months compared to NAA. The construction of a new fish ladder as a feature of this alternative would provide little or no benefit to most adults of RN/RNN species, with the exception of rainbow and brown trout.

Juveniles. For this alternative, there is a small improvement (approximately 7 percent) in the juvenile passage index for rainbow trout as compared to NAA (Table B-12). This small improvement in juvenile passage index would not measurably benefit this species. The change in passage index is because of the reduction in rates of predation of these species during longer gates-out periods, especially during the early to mid-summer months (through June 30). The operational changes of this alternative reduces, but not measurably, the effects of the principal impact mechanism (predation) for juvenile rainbow trout. Juvenile passage indices are shown on Figure B-22.

Other juvenile RN/RNN species would likely benefit from this alternative by reducing the rate somewhat at which they are preyed upon by adult striped bass and Sacramento pikeminnow. The RBDD gates would be out through June 30 and would likely discourage predatory species, particularly pikeminnow, from congregating downstream of RBDD. This would lessen the potential for predation and allow a greater number of juveniles of the RN/RNN species to pass unmolested downstream through the project area. This benefit, however, may be offset by the removal of Lake Red Bluff for 2 months annually. Habitats that are preferred by many of the RN/RNN species, particularly the non-native bass, sunfish, and catfish, would be reduced measurably for this alternative, particularly nesting sites and rearing habitats for many RNN species.

2B: 2-month Existing Ladders Alternative

Construction. Impacts from constructing a pump station, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. The major construction impact areas are at the pump station location at the "Mill Site." These impacts would occur during installation of sheet piling. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF.

In addition, impacts could also occur at these locations because of de-watering active channel areas following sheet pile installation. Both adults and juveniles may be stranded and lost during de-watering actions following the installation of sheet piling.

These activities would adversely affect migrating adult fish, rearing stages of fry and juveniles, and migrating smolts. These impacts would be significant and would require mitigation or conservation measures, depending on species, to reduce these impacts to less than significant.

Additionally, direct losses and adverse indirect effects to adults and juvenile life stages would occur as a result of sediment disturbances and turbidity that would result from construction of the pump station. These impacts would be significant and would require mitigation to reduce them to less than significant.

Operations. No significant adverse impact to fishery resources would occur with operations of this alternative. Therefore, no mitigation is required. Below is a summary of the adult passage index values for this alternative.

Native Anadromous Salmonid Species (NAS)

Adults. For the 2-month Existing Ladders Alternative, the adult passage indices for all five NAS species are equal to or greater than those for NAA (Table B-7). These indices are shown on Figure B-20. As previously stated for other alternatives, there is no benefits or adverse impacts to the adult late-fall chinook salmon for this alternative. There are modest differences (increases) compared to NAA in the passage indices for adult winter-run chinook salmon (9 percent), fall-run (8 percent) chinook salmon, and steelhead (8 percent). The principal benefit of NAS passage at RBDD occurs to adult spring-run chinook salmon. For this species, the adult passage index increased nearly 77 percent compared to NAA (Table B-7). This is clearly a measurably large benefit to this species. The large improvement to migrating adult spring-run chinook salmon occurs because the dam gates at RBDD would remain out until July 1, allowing approximately 93 percent of this species to pass RBDD unimpeded. When compared to the 2-month Improved Ladder Alternative, the 2-month Existing Ladders Alternative benefits are nearly identical.

This alternative is quite effective in reducing the blockage and impedance of RBDD on the NAS species. However, approximately 7 percent of threatened adult spring-run, 2 percent of endangered adult winter-run chinook salmon, and 4 percent of threatened adult steelhead remain blocked or impeded under this alternative (Figure B-20).

Juveniles. See the discussion for NAS species for the 2-month Improved Ladder Alternative.

Other Native Anadromous Species (NAO)

Adults. The adult passage indices for all three NAO species for the 2-month Existing Ladders Alternative are greater than those for NAA (Table B-9). The index values for these species are shown on Figure B-21. For this alternative, compared to NAA, there is a large (54 percent) improvement in the adult passage index for green sturgeon (Table B-9). This is a measurably large beneficial passage improvement and occurs because this species primarily migrates past RBDD during late spring-early summer ending July 1. This alternative would eliminate blockage and impedance of adult green sturgeon at RBDD. The relative benefits of this alternative to the NAO species are nearly identical to those for the 2-month Improved Ladder Alternative.

There are smaller (16 percent) but measurably beneficial improvements in passage indices for adult Pacific and river lampreys from the implementation of this alternative (Table B-9). Adult passage for the lamprey species may be improved to approximately 96 percent of unobstructed passage.

Juveniles. See the discussion for juvenile/transformers of NAO species for the 2-month Improved Ladder Alternative.

Non-native Anadromous Species (NNA)

Adults. This alternative may or may not benefit the adult passage of striped bass and American shad. See the discussion for adults of these species for the 2-month Improved Ladder Alternative above.

Juveniles. See the discussion for juveniles of NNA species for the 2-month Improved Ladder Alternative.

Resident Native and Resident Non-native Species (RN/RNN)

Adults. The adult rainbow trout passage index value for the 2-month Existing Ladders Alternative is approximately 23 percent greater than that for NAA (Table B-11). The passage indices for this species are shown on Figure B-20. The improvement in adult rainbow trout passage indices for this alternative is a result of gates-out operations through June 30. A substantial number of adult rainbow trout pass RBDD during the period ending June 30. The magnitude of these passage improvements is sufficient to be considered a measurable improvement for adult rainbow trout. However, approximately 10 percent of adult rainbow trout remain blocked or impeded by the gates at RBDD under the 2-month Improved Ladder Alternative (Figure B-20).

This alternative would result in the same benefits and liabilities for other adult RN/RNN species as described in the discussion of operational impacts of 2-month Improved Ladder Alternative above.

Juveniles. See the discussion for the RN/RNN species for the 2-month Improved Ladder Alternative.

3: Gates-out Alternative

Construction. Impacts from constructing a pump station, including screens and bypasses, would include direct and indirect losses of adult and or juvenile fish. The major construction impact area is at the pump station location at the "Mill Site." These impacts would principally occur during installation of cofferdams. At the Mill Site, a large sheet pile cofferdam would be required, up to approximately 1,400 LF.

These impacts would be the same as discussed for the 2-Month Improved Ladder Alternative.

Operations. No significant adverse impact to fishery resources would occur with operations of this alternative. Therefore, no mitigation is required. Below is a summary of the adult passage index values for this alternative.

Native Anadromous Salmonid Species (NAS)

Adults. The adult passage indices for all five NAS species for the Gates-out Alternative are equal to or greater than those for NAA (Table B-7). In all instances, the adult passage indices indicate unobstructed passage (optimal fish passage conditions = adult passage index of 100). The index values for these NAS species are shown on Figure B-20. As previously stated for other alternatives, there is no impact to or improvement in the adult passage index for late-fall chinook salmon from implementing this alternative (Table B-7). There are measurable differences (improvements) in passage indices for adult winter-run (12 percent) and fall-run (20 percent) chinook salmon, and steelhead (12 percent). The principal benefit for passage of adult NAS species occurs to spring-run chinook salmon. The passage index for spring-run increased approximately 91 percent compared to NAA (Table B-7). This is clearly a large measurable benefit for passage for this species. These improvements to migrating adult NAS species occurs because the dam gates at RBDD would remain out year-round and allows those species to pass unimpeded.

Juveniles. The juvenile passage indices for all NAS species are improved, but do not measurably, when compared to NAA (Table B-8). These juvenile passage improvements range from less than 1 percent for spring-run to 7 percent for late-fall-run chinook salmon, and 8 percent for steelhead. However, this alternative would result in passage indices of 100 (on a scale of 100). These species benefit from reductions predation when the RBDD gates are removed throughout the entire year. Juvenile passage indices are shown on Figure B-22.

Other Native Anadromous Species (NAO)

Adults. The adult passage indices for all three NAO species for the Gates-out Alternative are greater than those for NAA (Table B-9). The index values for these species are shown on Figure B-21. For green sturgeon adults, there is a large (54 percent) improvement from NAA with this alternative (Table B-9). For Pacific lamprey and river lamprey, adult passage indices indicate improved passage by approximately 20 percent over that for NAA. This alternative would result in unimpeded passage (index of 100) and a measurable benefit for adult NAO species.

Juveniles. For the Gates-out Alternative there is a measurably large improvement, compared to NAA (38 percent) in the juvenile passage index for green sturgeon Table B-10. For river lamprey transformers, a smaller (15 percent) but measurably beneficial increase, compared to NAA, in the passage index occurs. As compared to NAA, there is a small (1 percent), but not measurable, improvement in the passage index for Pacific lamprey transformers. Under the Gates-out Alternative, juvenile/transformer passage is optimal (indices of 100) for all NAO species. These results are because of the reduction in rates of predation on these species when the RBDD gates are removed throughout the entire year, thereby eliminating the congregations of predatory fish downstream of the gates. Juvenile passage indices are shown on Figure B-22.

Non-native Anadromous Species (NNA)

Adults. This alternative would allow full-unimpeded passage of both American shad and striped bass to upstream habitat. However, as stated in the discussion for the 2-month Improved Ladder Alternative above, this may or may not be beneficial for adults of these species. The alternative would allow adult stripers to migrate unimpeded as far as Redding, and by doing so, may result in undesirable increases in predation of rearing anadromous salmonids in the Sacramento River upstream of RBDD.

Juveniles. Similar to the 2-month Alternative, juvenile American shad would benefit from the Gates-out Alternative. This would occur because of dispersal of predator species like striped bass and particularly Sacramento pikeminnow. No benefit or adverse impact would occur to juvenile striped bass as they would not be expected to occur at RBDD.

Resident Native and Non-native Species (RN/RNN)

Adults. The adult rainbow trout passage index for the Gates-out Alternative is approximately 37 percent greater than that for NAA (Table B-11). The index values for rainbow trout is shown on Figure B-20. The passage improvement in adult rainbow trout for this alternative is a result of gates up operations year-round. The magnitude of these improvements over NAA is sufficiently beneficial to be considered a measurably large benefit for passage of adult rainbow trout. This alternative would result in unimpeded passage of adult rainbows.

For the other resident native species at RBDD, this alternative would also greatly benefit adult passage. The reach of the Sacramento River at Red Bluff would return to natural riverine habitats with the RBDD Gates-out Alternative. With the gates removed year-round unrestricted movement for reproduction, rearing, and foraging needs would occur. Many of the resident non-native species however, would suffer losses in preferred habitats with this alternative. The lacustrine (lake) habitat created by Lake Red Bluff would be lost with the Gates-out Alternative. Many of the non-native species prefer these habitats, and without the lake, habitat quantity and quality would diminish. As a result, resident non-native species abundance's may decline. This however, may be a benefit to the resident native and the anadromous native species because of less competition with and predation from aggressive and predatory species such as bass and crappie.

Juveniles. For the Gate-out Alternative, there is a small difference (approximately 8 percent) in the juvenile rainbow trout passage index compared to NAA (Table B-12). This difference in and of itself would not be measurably beneficial, but with the implementation of the Gates-out Alternative, juvenile rainbow passage is optimal with a passage index of 100. The small improvement is because of the reduction in rates of predation on these species during the entire year by eliminating the congregations of predatory fish downstream of the gates. Juvenile passage indices are shown on Figure B-22.

Juveniles of the resident native and non-native species would benefit from less predation downstream of RBDD than NAA. Furthermore, as previously described for the 2-month Alternative, juvenile resident native fishes would benefit from less predation if Lake Red Bluff were to no long exist. Juveniles of resident non-native species may not benefit from the elimination of Lake Red Bluff, as rearing habitats favoring these species would be lost.

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Personal Communications:

M. Tucker

K. Brown

D. Killam

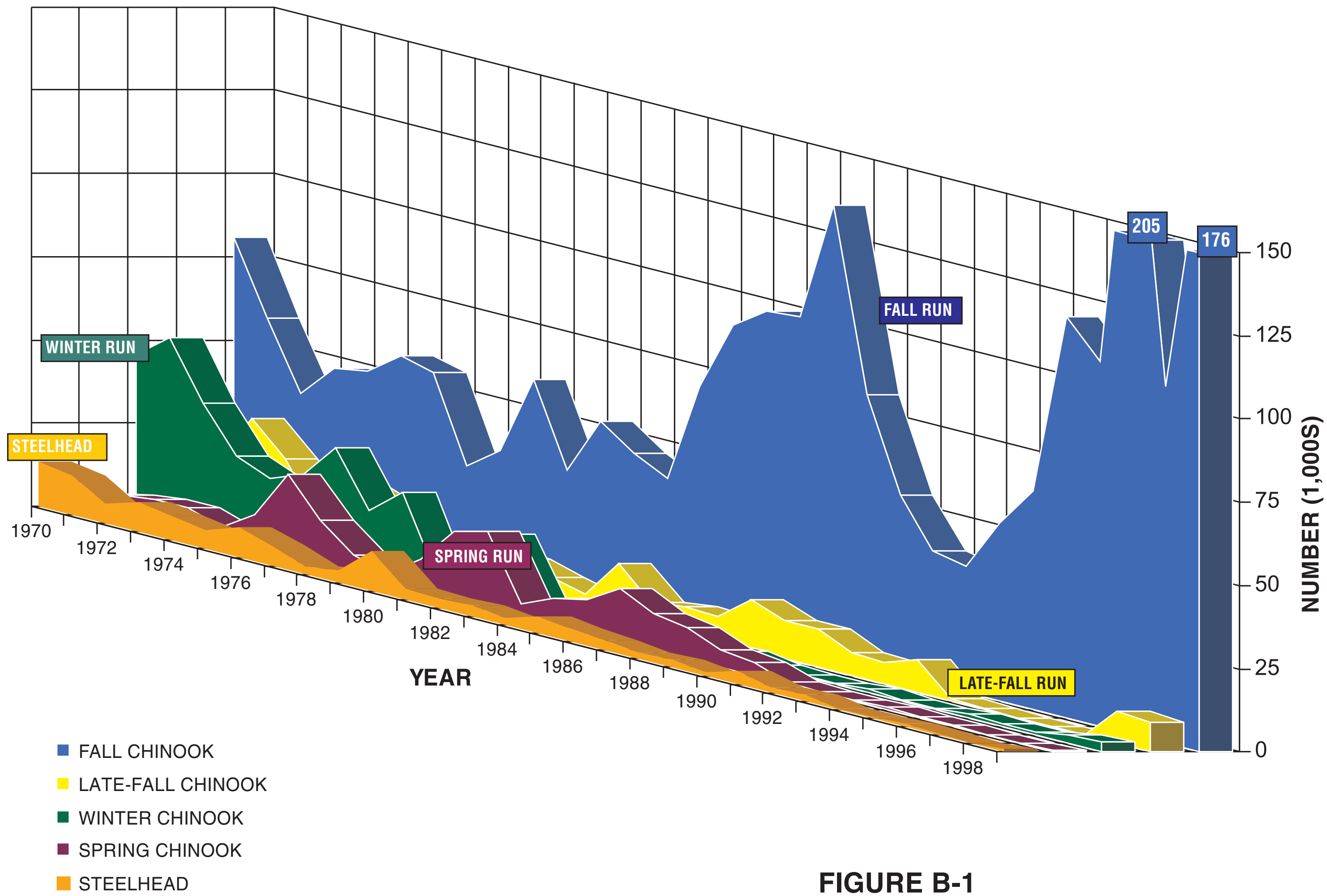

FIGURE B-1
SACRAMENTO RIVER CHINOOK SALMON AND STEELHEAD SPAWNING ESCAPEMENT ESTIMATES FOR 1970 TO 1999 UPSTREAM OF RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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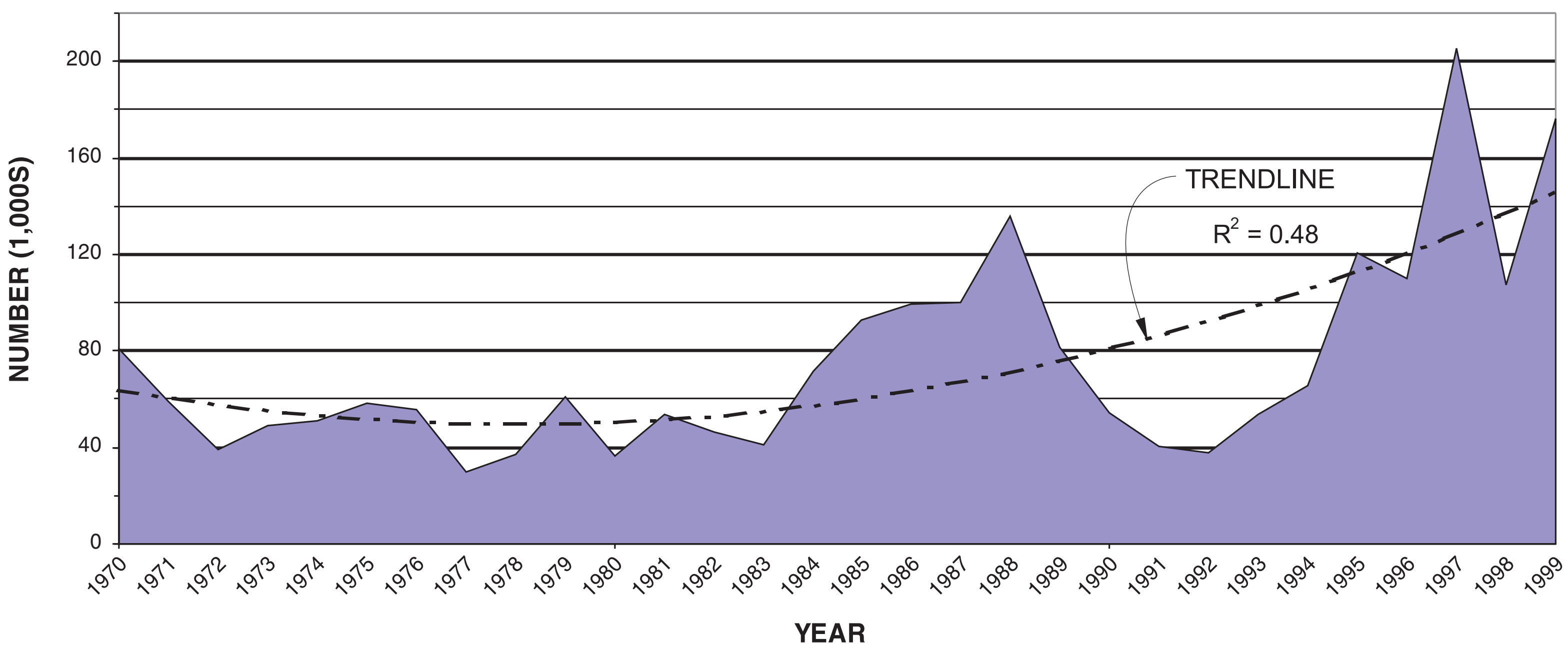

FIGURE B-2
SACRAMENTO RIVER FALL-RUN CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATES UPSTREAM OF RBDD FROM 1970 TO 1999
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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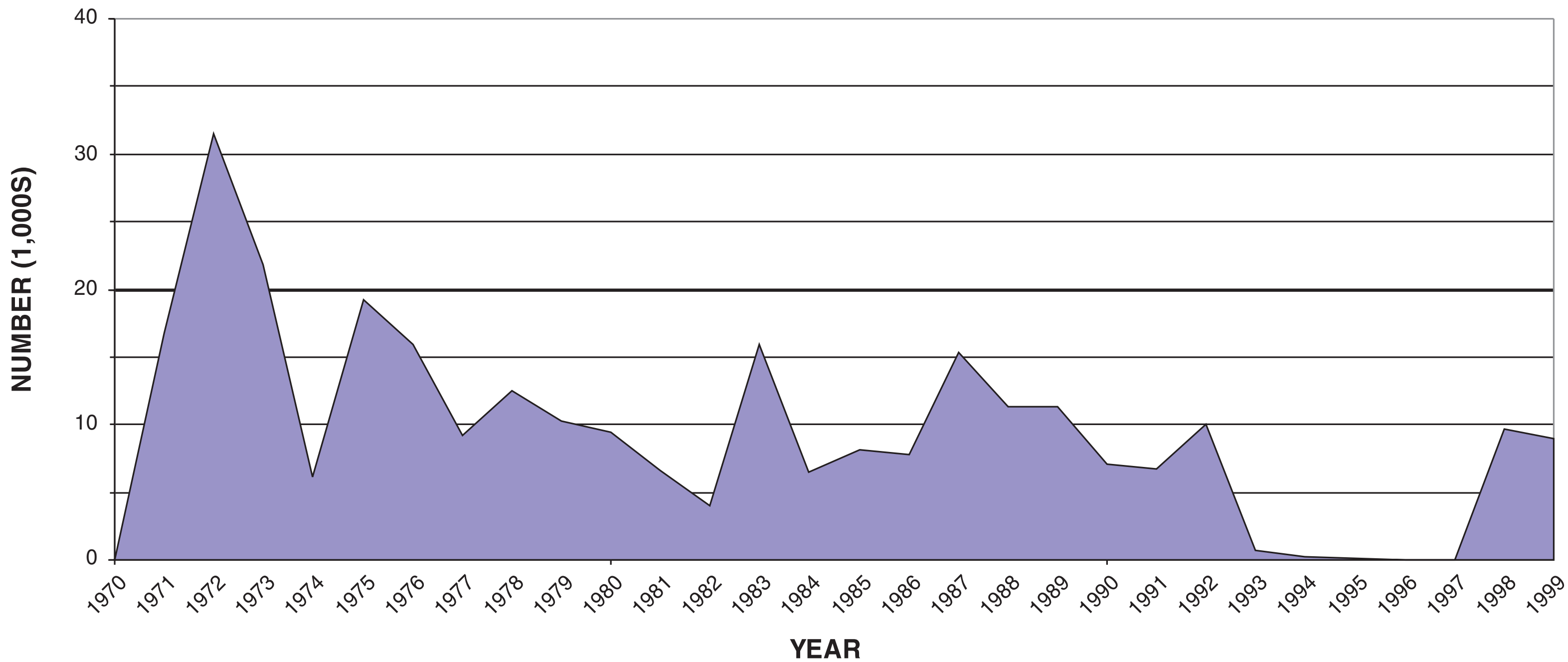

FIGURE B-3
SACRAMENTO RIVER LATE- FALL-RUN CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATES UPSTREAM OF RBDD FROM 1970 TO 1999
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

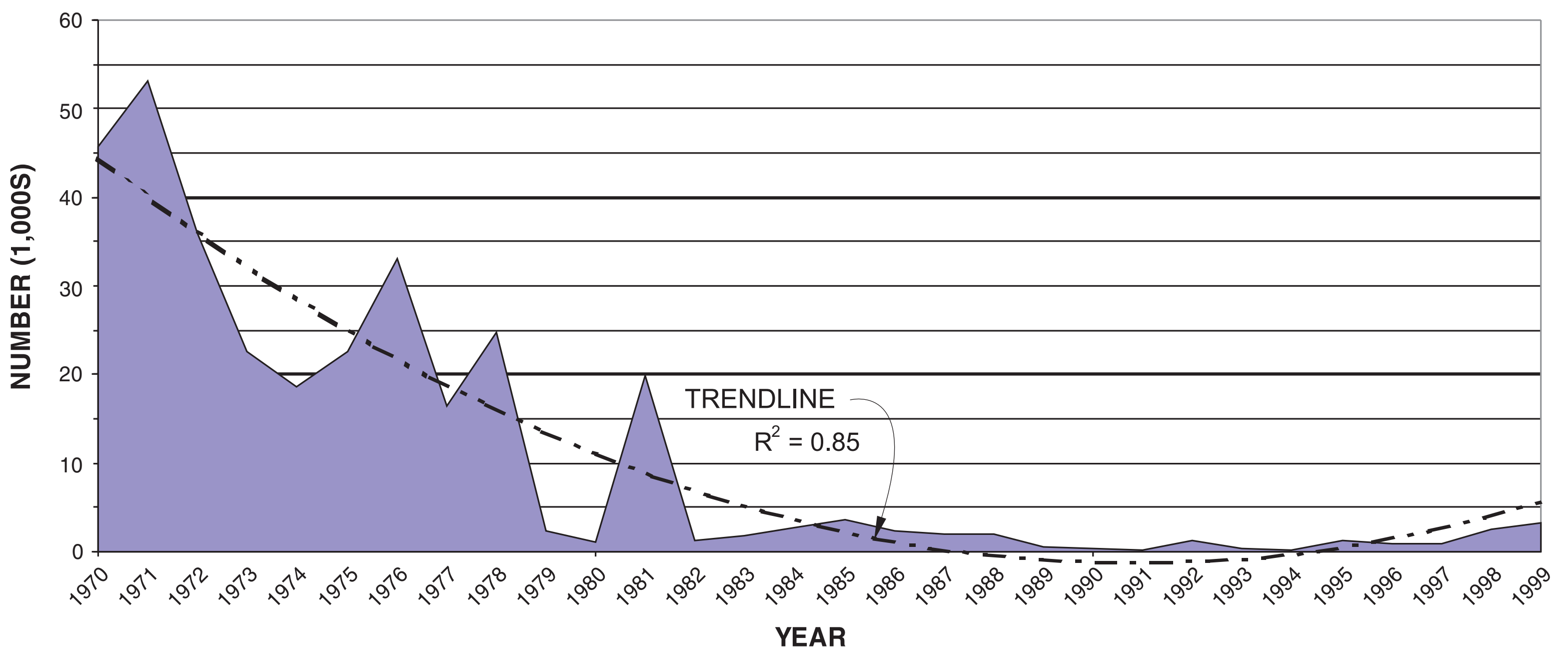

FIGURE B-4
SACRAMENTO RIVER WINTER-RUN CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATES UPSTREAM OF RBDD FROM 1970 TO 1999
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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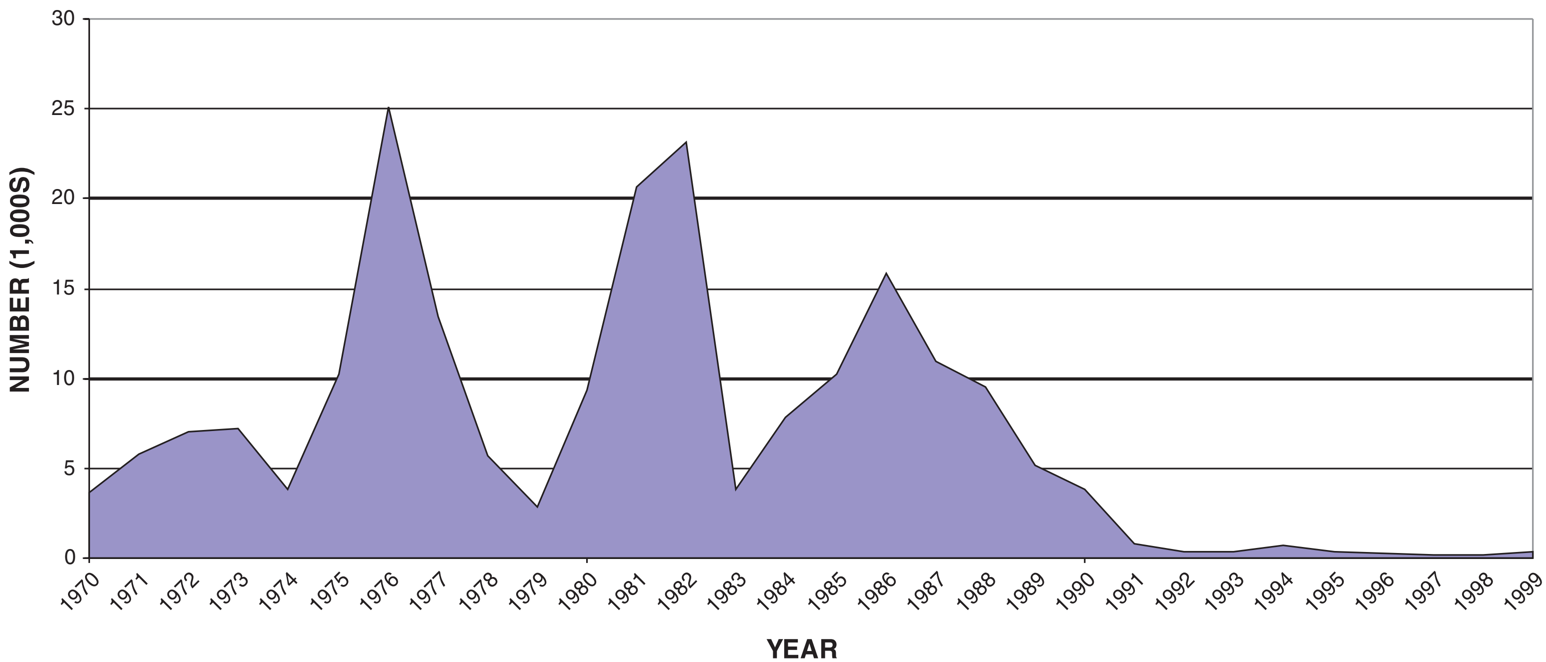

FIGURE B-5
SACRAMENTO RIVER SPRING-RUN CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATES UPSTREAM OF RBDD FROM 1970 TO 1999
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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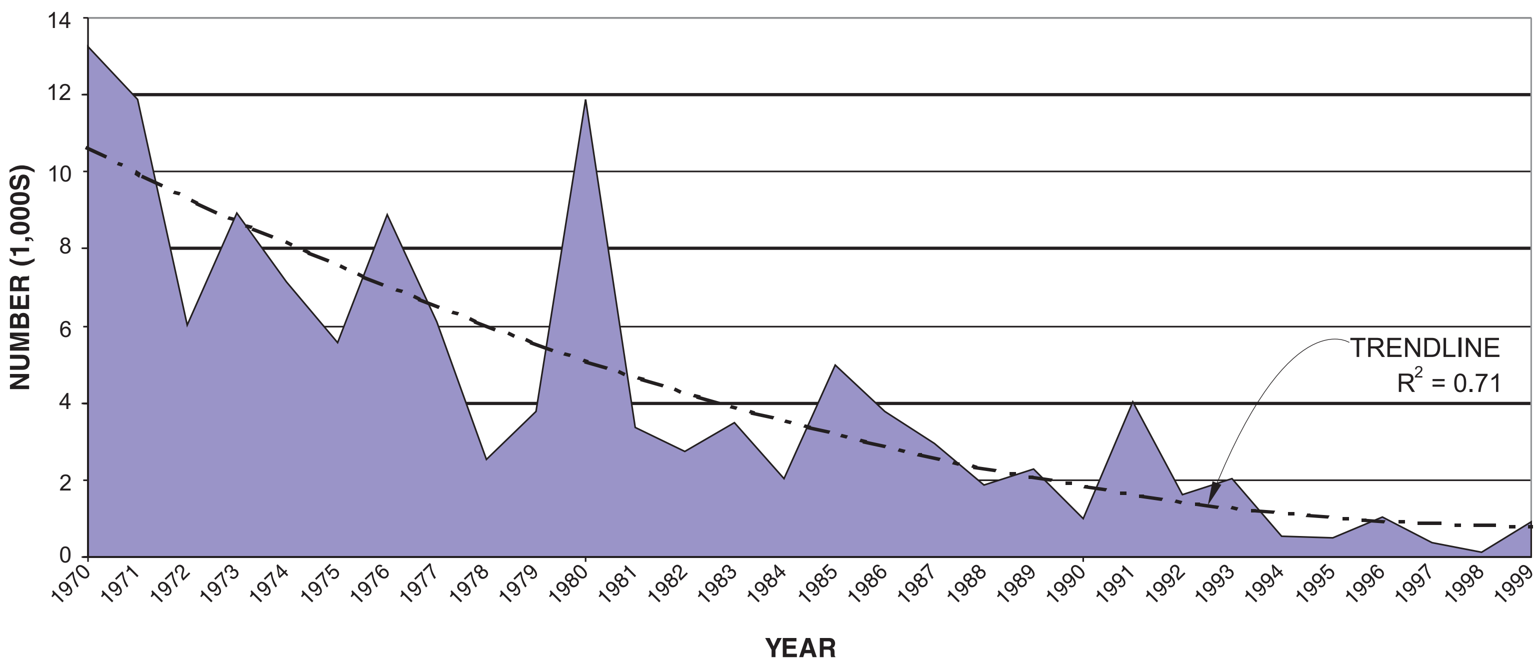

FIGURE B-6
SACRAMENTO RIVER STEELHEAD SPAWNING ESCAPEMENT ESTIMATES UPSTREAM OF RBDD FROM 1970 TO 1999

FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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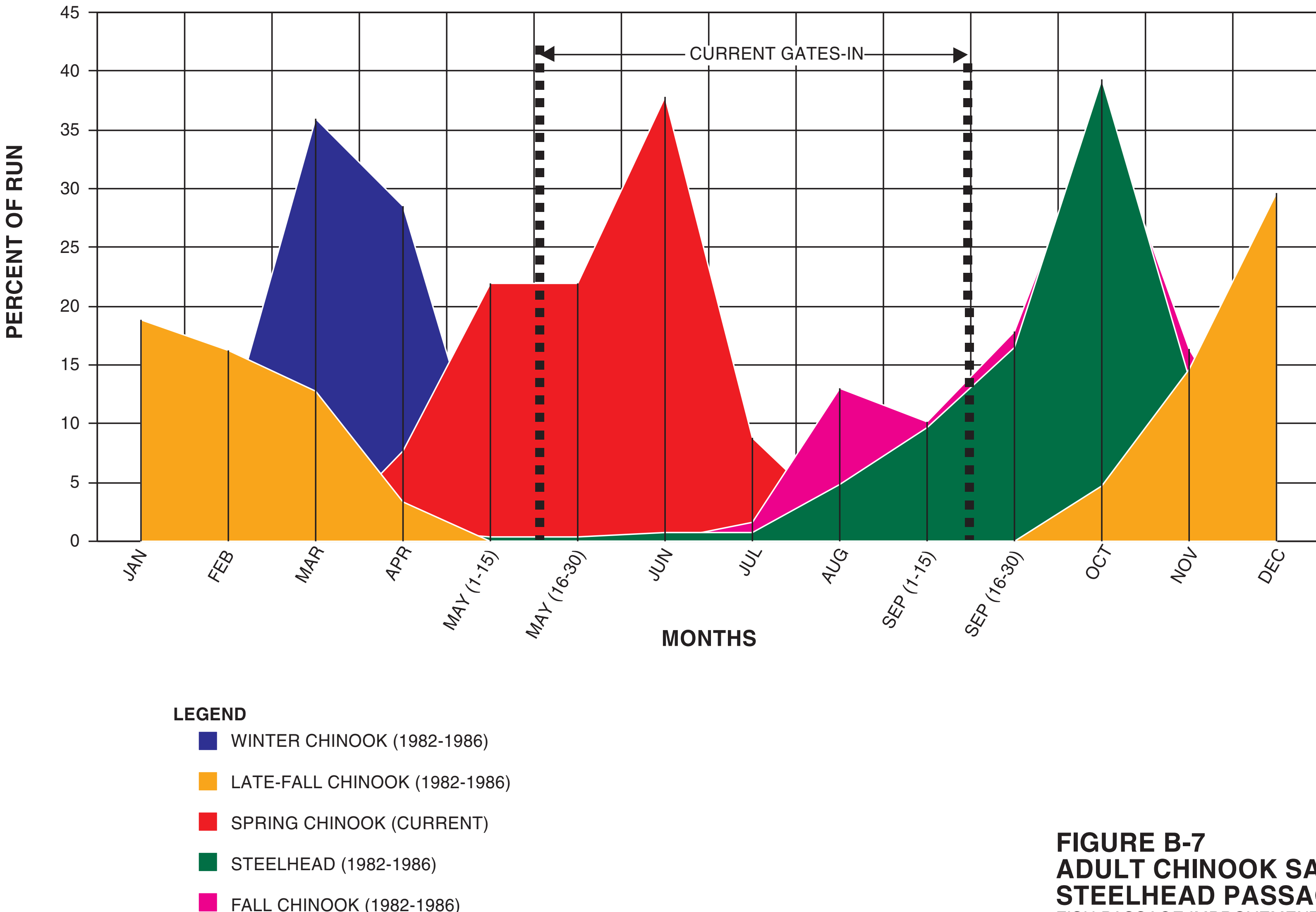

FIGURE B-7
ADULT CHINOOK SALMON AND STEELHEAD PASSAGE AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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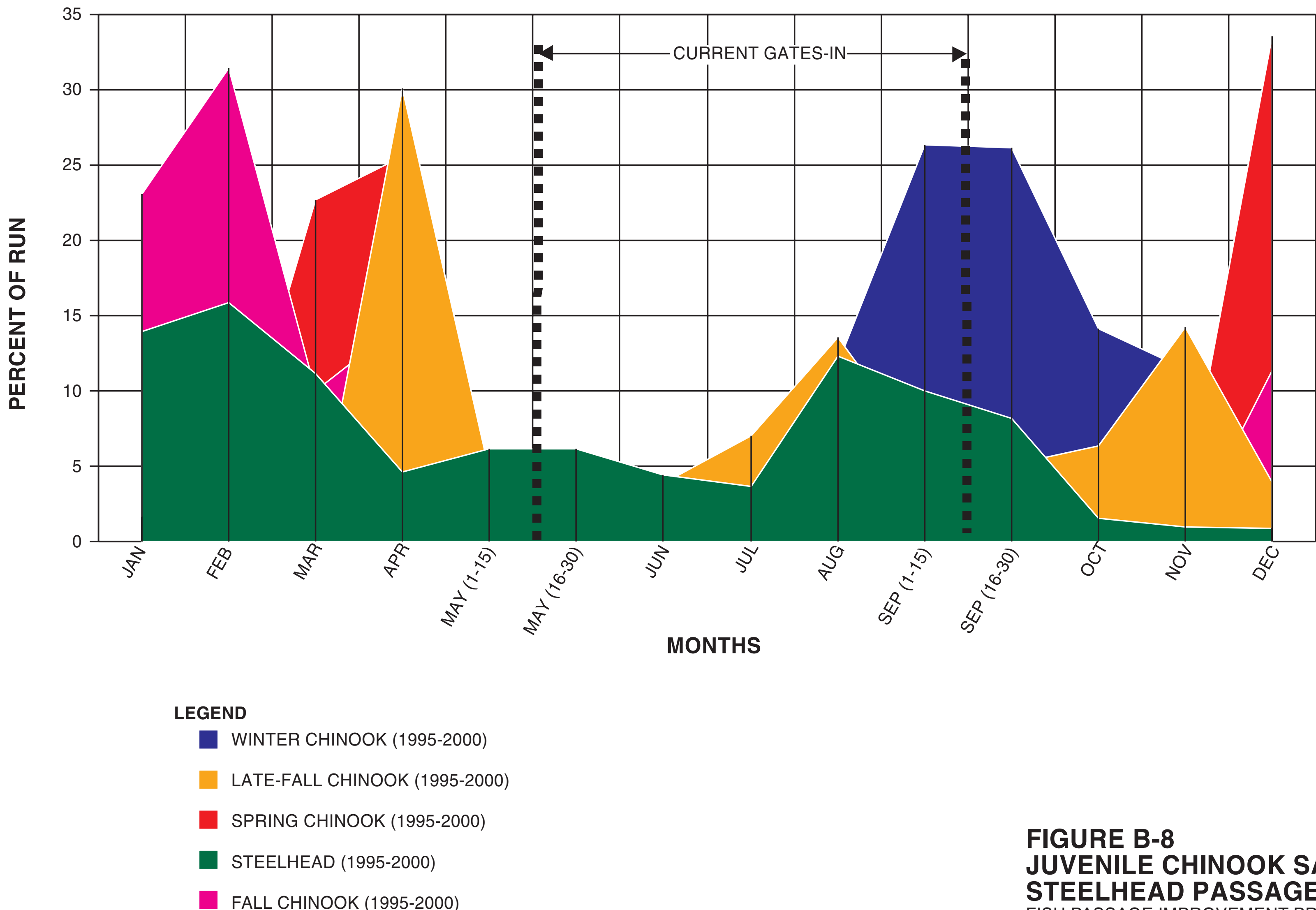

FIGURE B-8
JUVENILE CHINOOK SALMON AND STEELHEAD PASSAGE AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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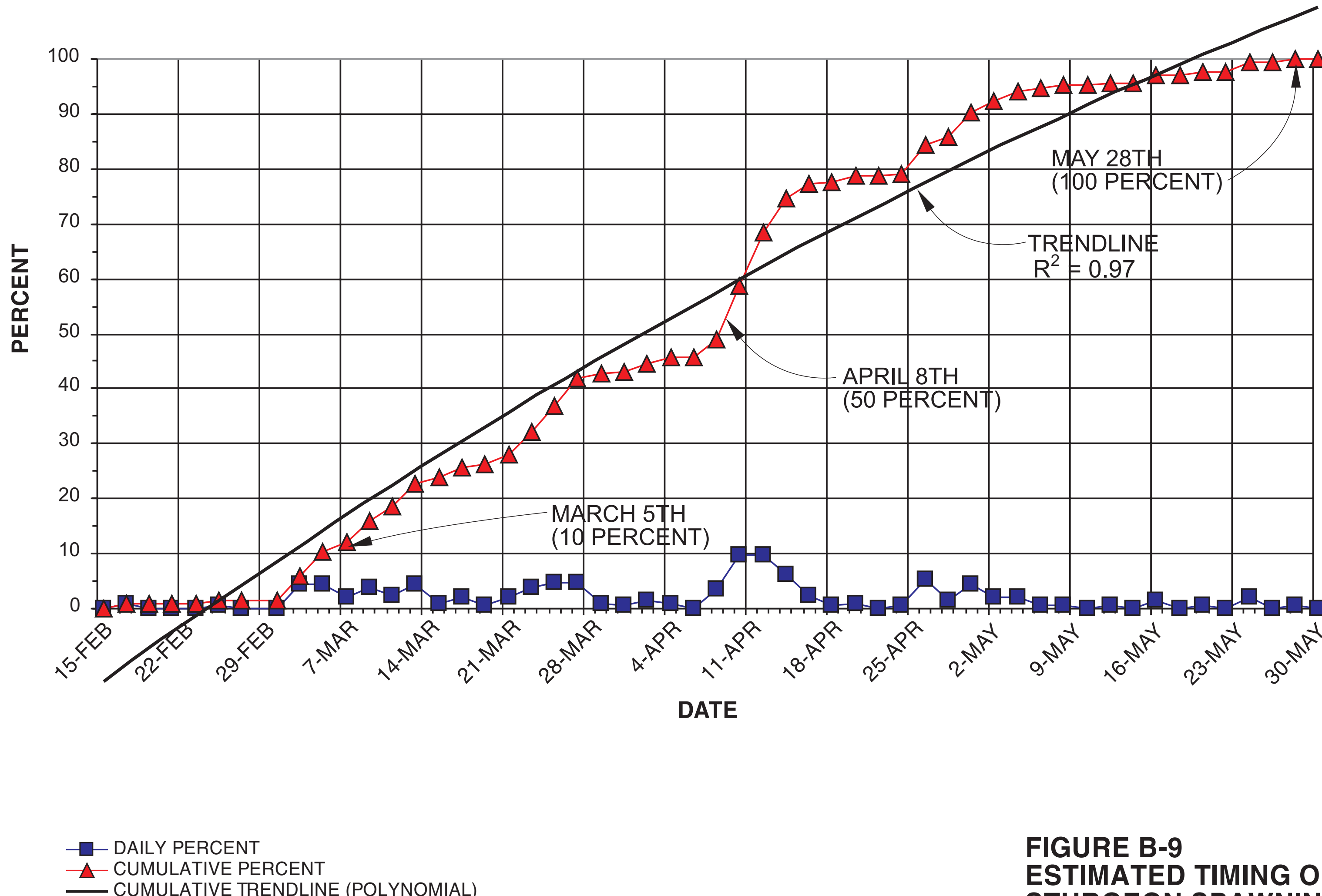

FIGURE B-9
ESTIMATED TIMING OF WHITE STURGEON SPAWNING IN THE SACRAMENTO RIVER DURING 1973
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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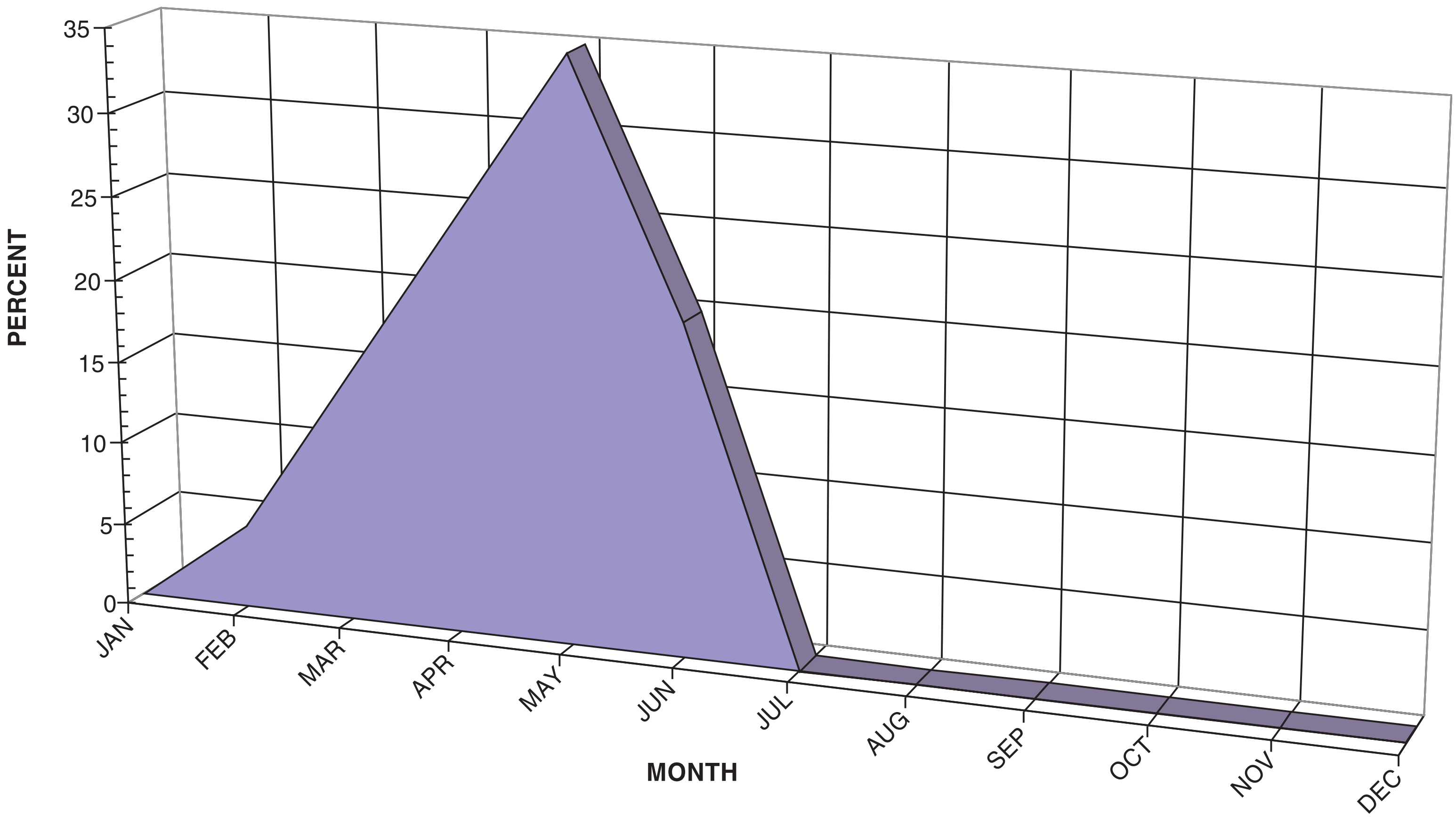

FIGURE B-10
ESTIMATED PRESENCE OF MIGRATING ADULT GREEN STURGEON IN THE SACRAMENTO RIVER IN THE VICINITY OF RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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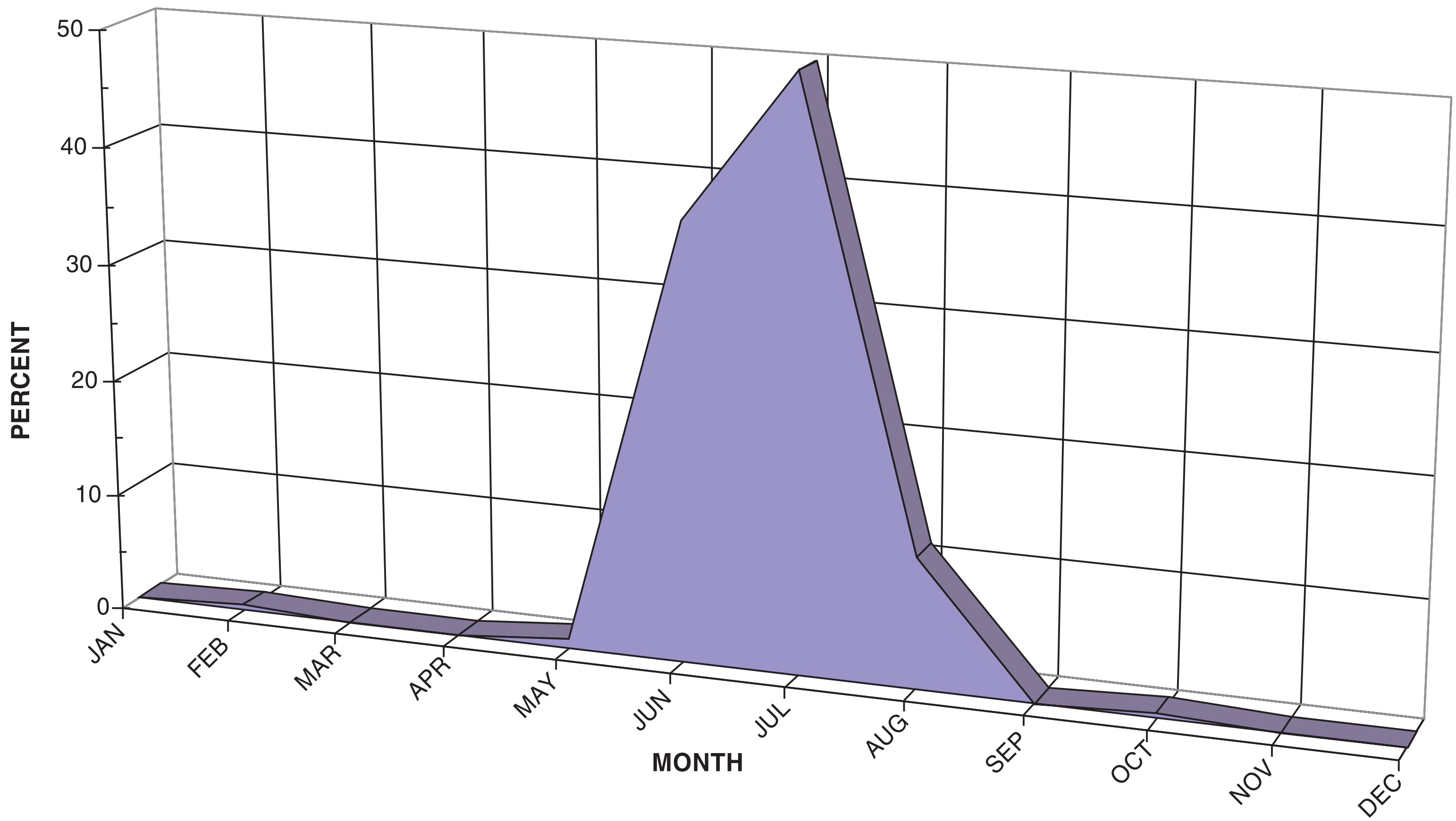

FIGURE B-11
PRESENCE OF JUVENILE GREEN STURGEON IN THE SACRAMENTO RIVER CAPTURED IN THE VICINITY OF RBDD (1995 TO 1999)
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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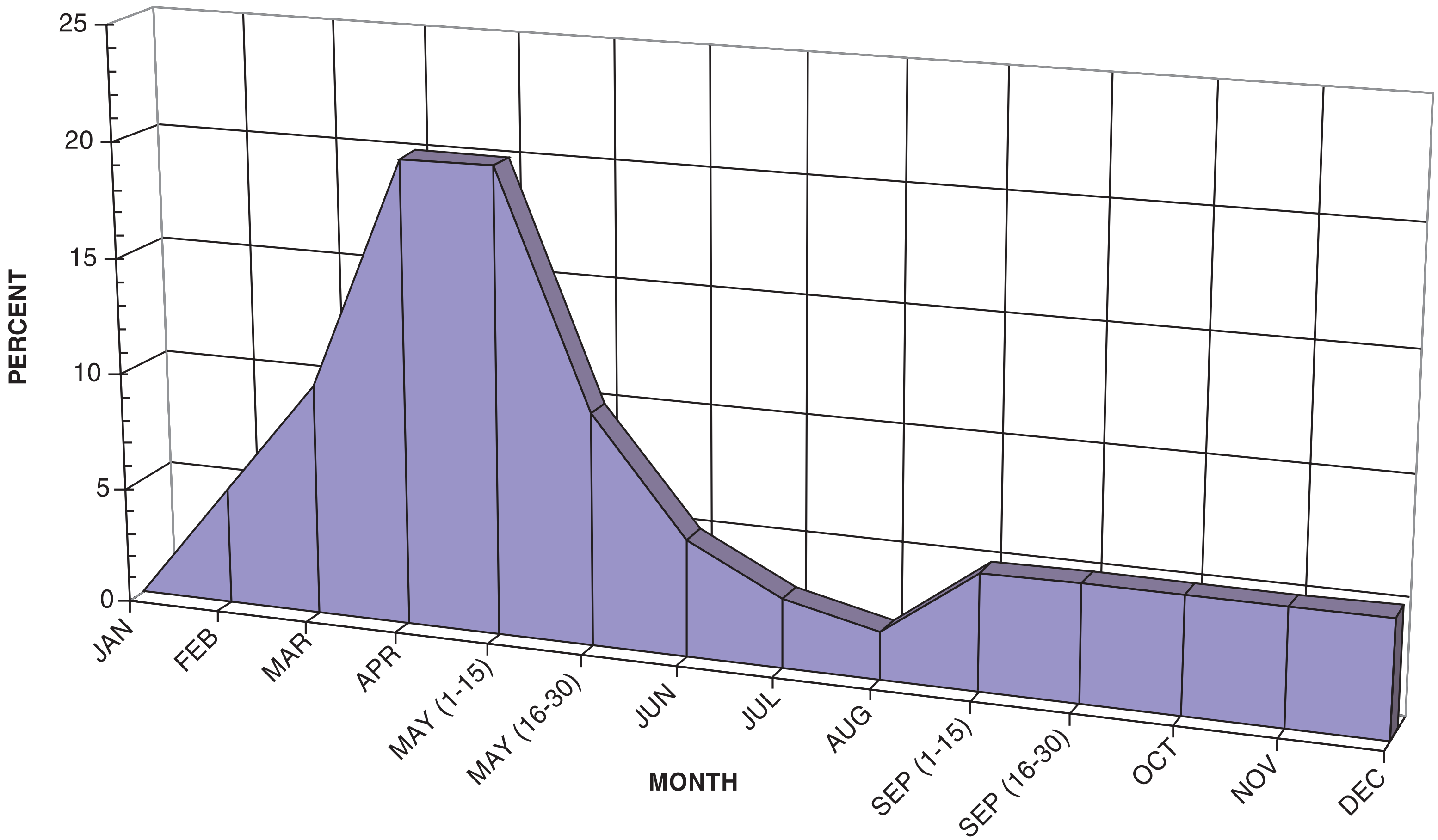

FIGURE B-12
PASSAGE/PRESENCE OF MIGRATING ADULT PACIFIC LAMPREY IN THE SACRAMENTO RIVER IN THE VICINITY OF RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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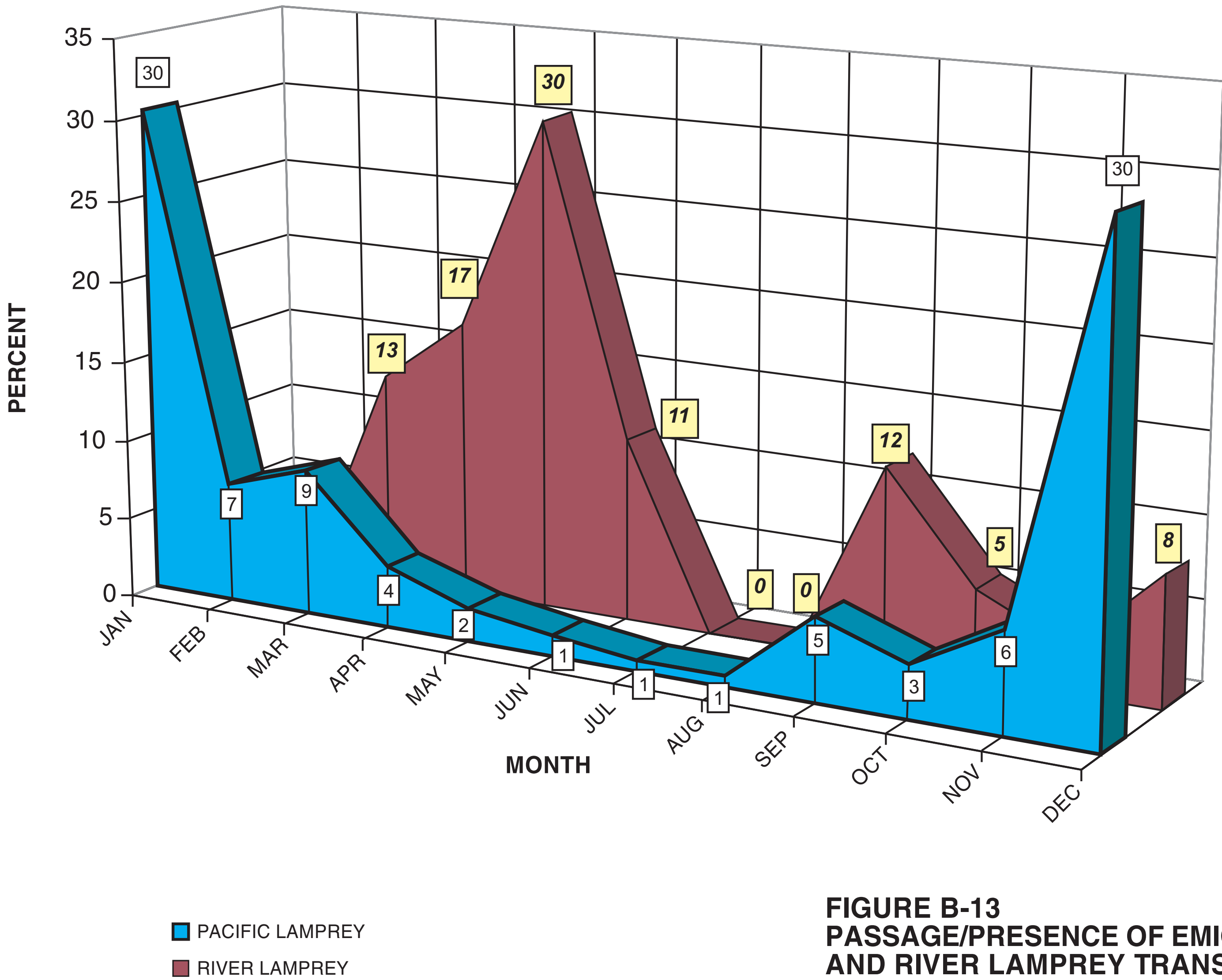

FIGURE B-13
PASSAGE/PRESENCE OF EMIGRATING PACIFIC AND RIVER LAMPREY TRANSFORMERS IN THE SACRAMENTO RIVER IN THE VICINITY OF RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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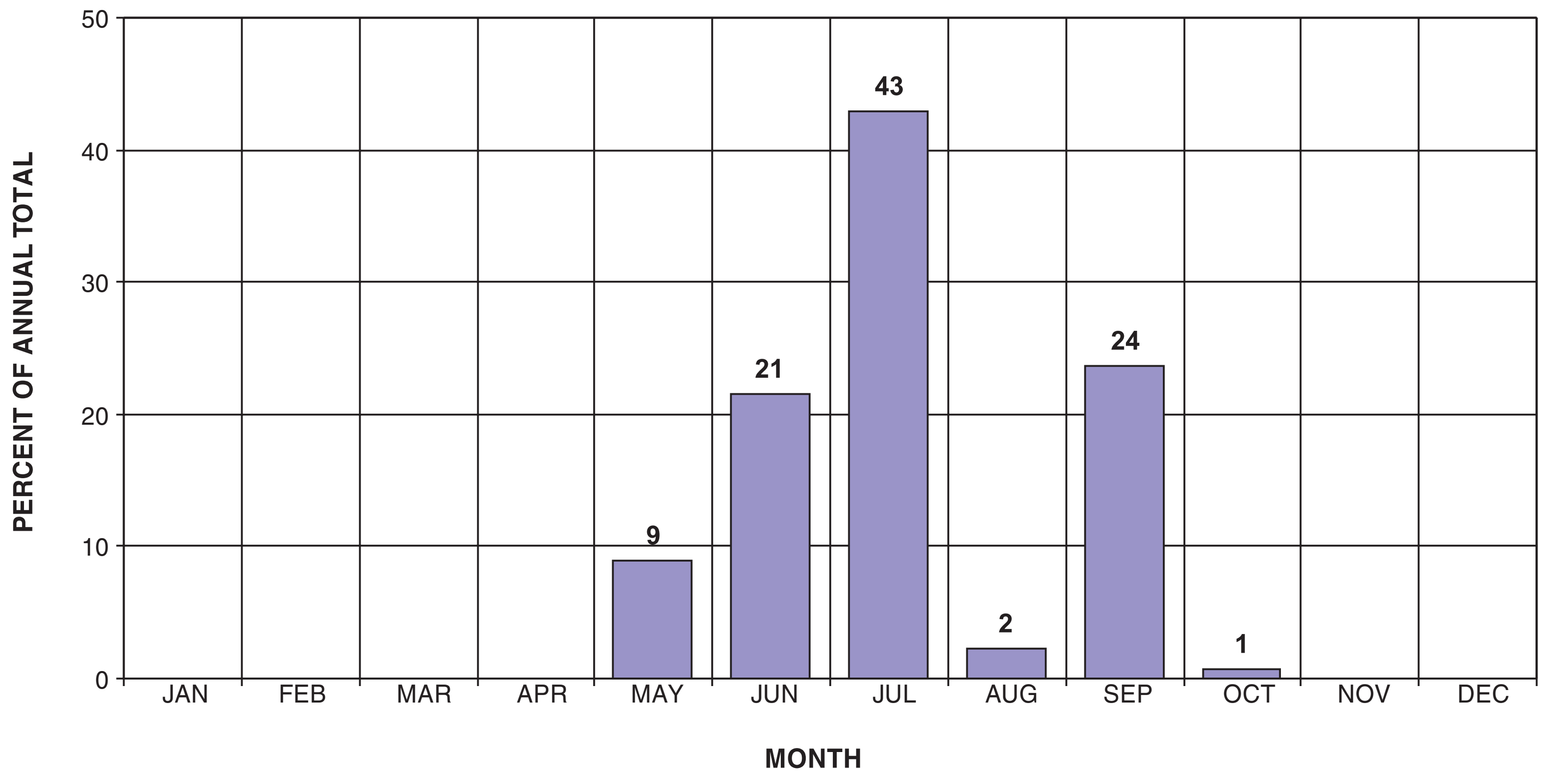

FIGURE B-14
THE MONTHLY RELATIVE ABUNDANCE OF ADULT STRIPED BASS IN THE VICINITY OF RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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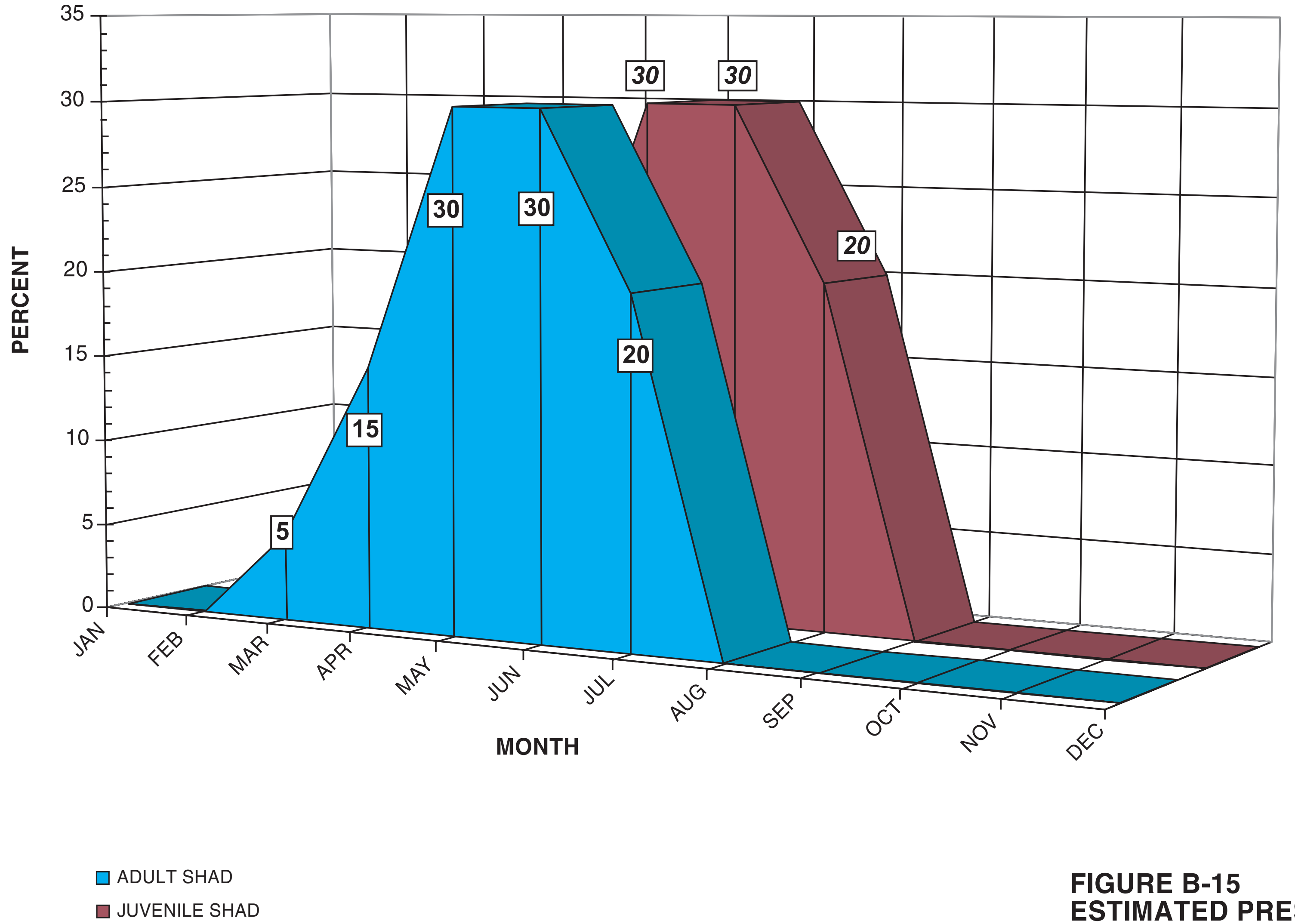

FIGURE B-15
ESTIMATED PRESENCE OF AMERICAN SHAD NEAR RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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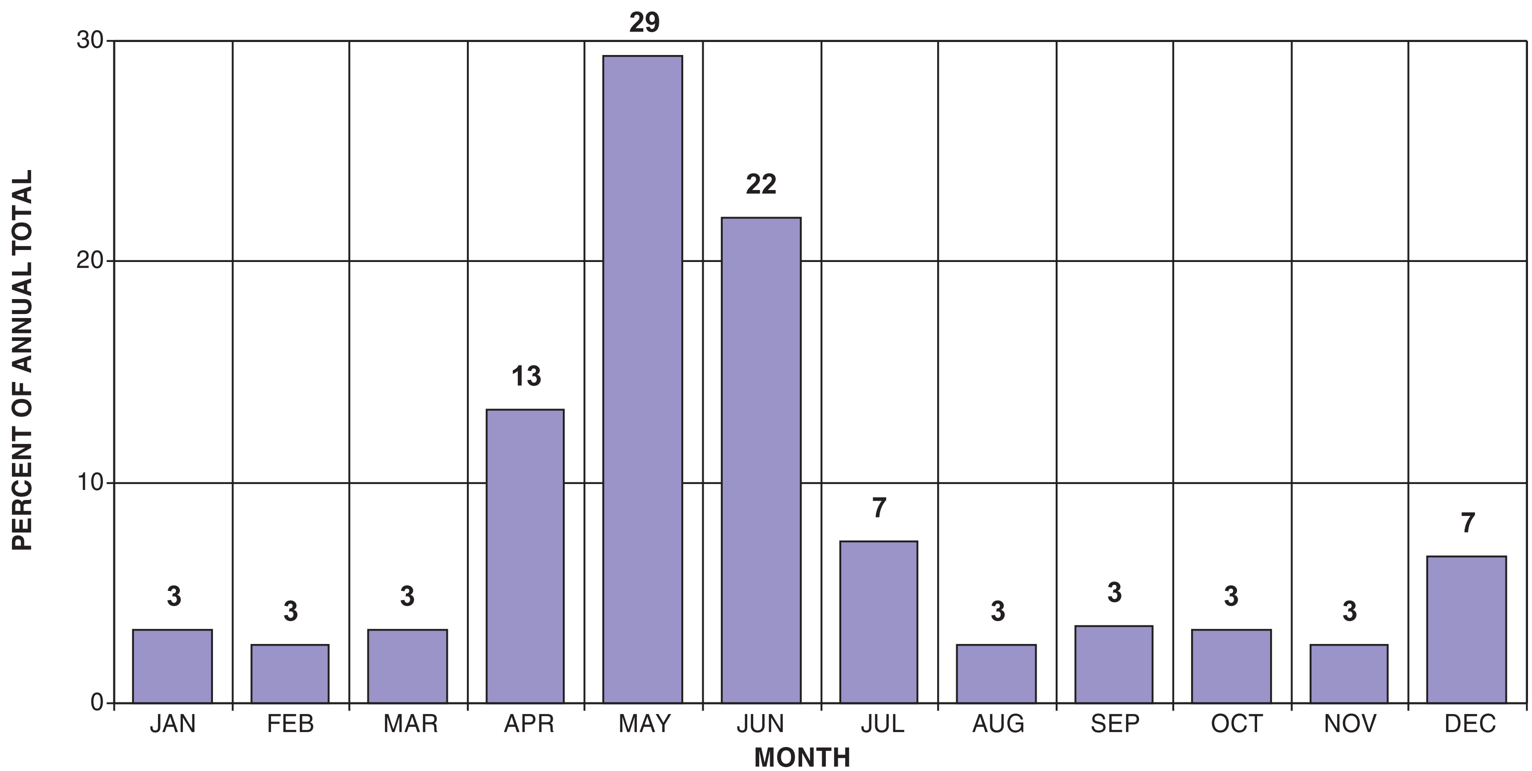

FIGURE B-16
RELATIVE ABUNDANCE OF ADULT SACRAMENTO PIKEMINNOW AT RBDD (1994 TO 1996)
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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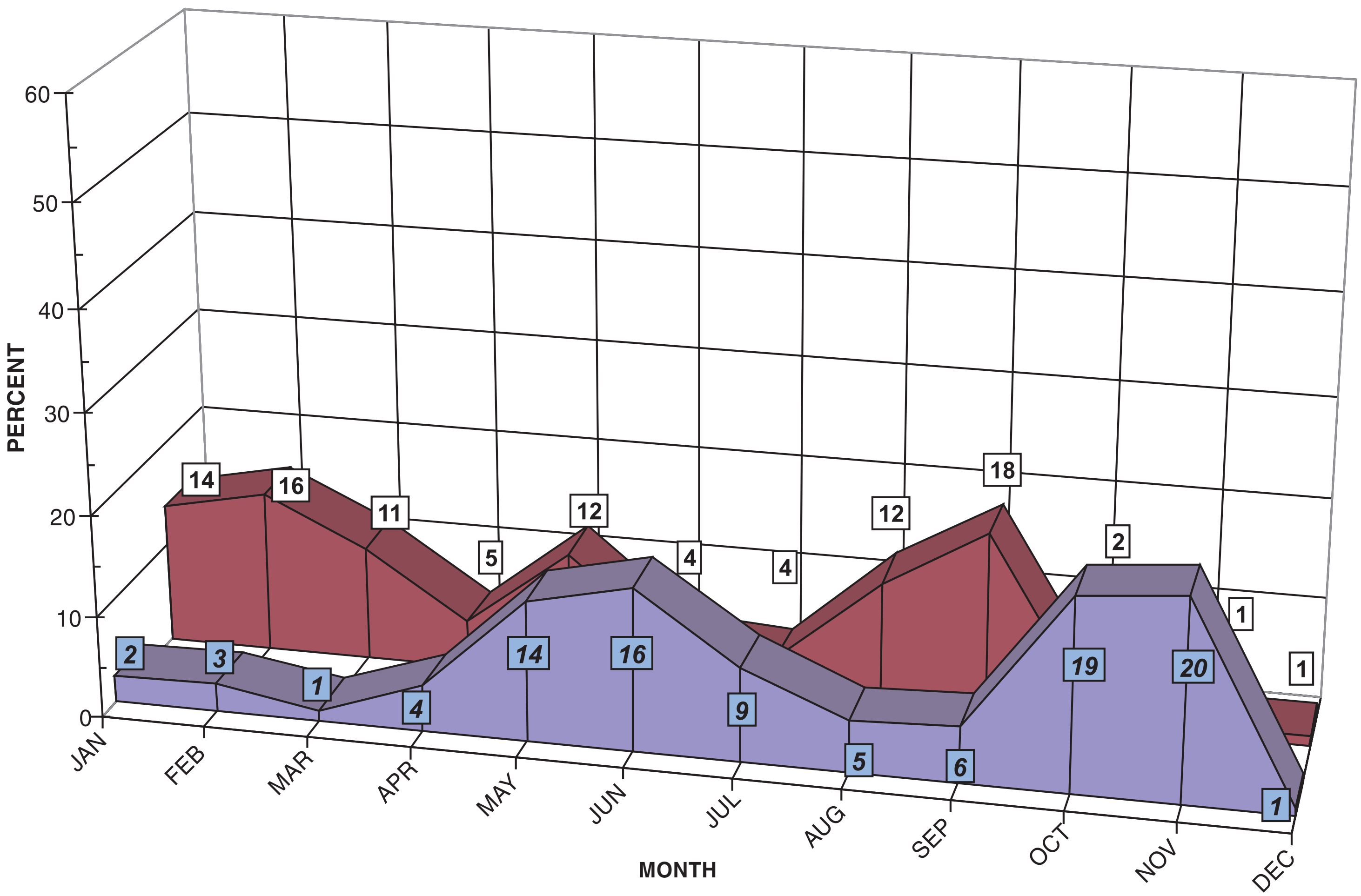

ADULT RAINBOW (1984 TO 2000)

JUVENILE RAINBOW (1995 TO 1999)

FIGURE B-17
PRESENCE AND PASSAGE OF RAINBOW TROUT AT RBDD

FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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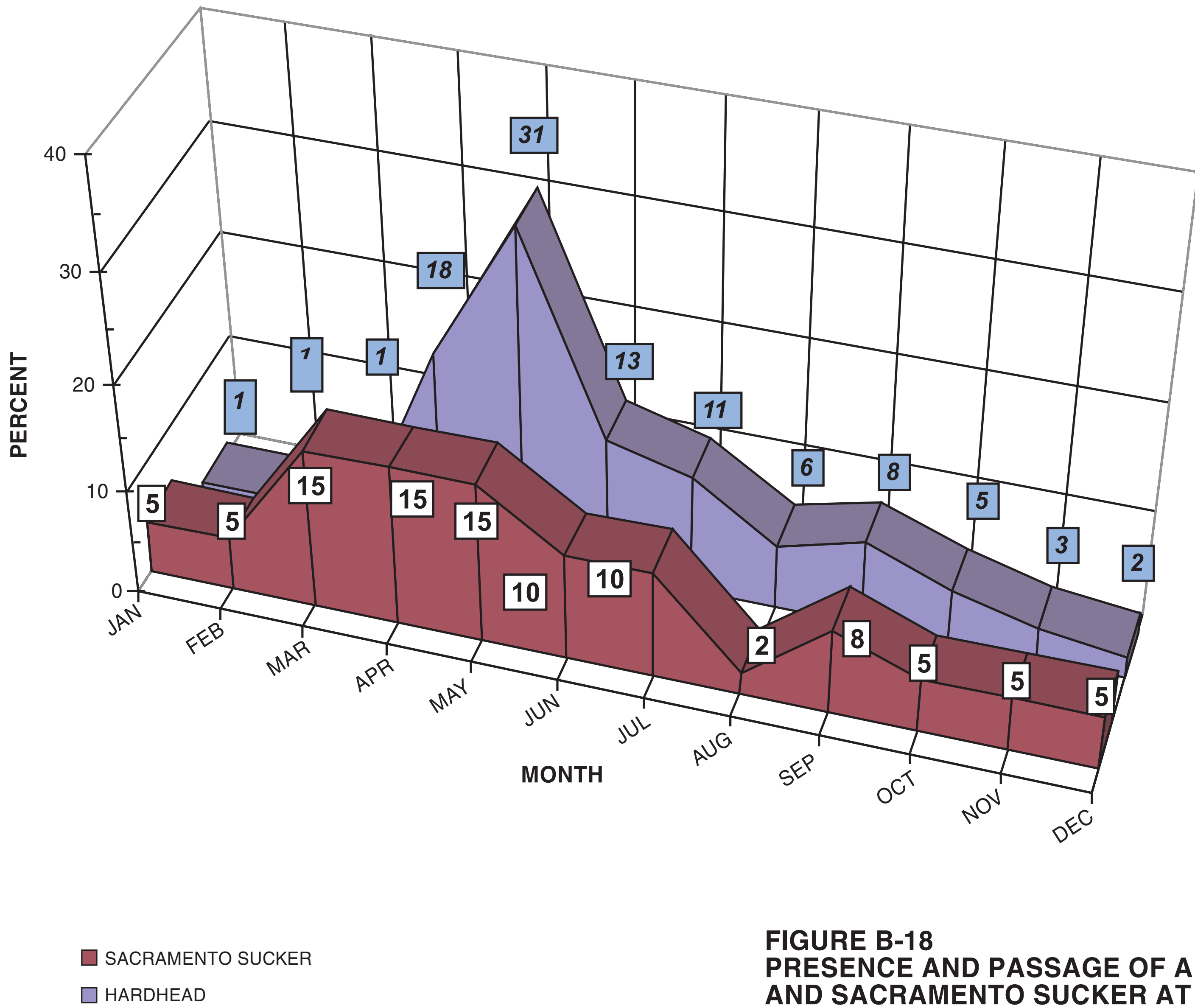

FIGURE B-18
PRESENCE AND PASSAGE OF ADULT HARDHEAD AND SACRAMENTO SUCKER AT RBDD

FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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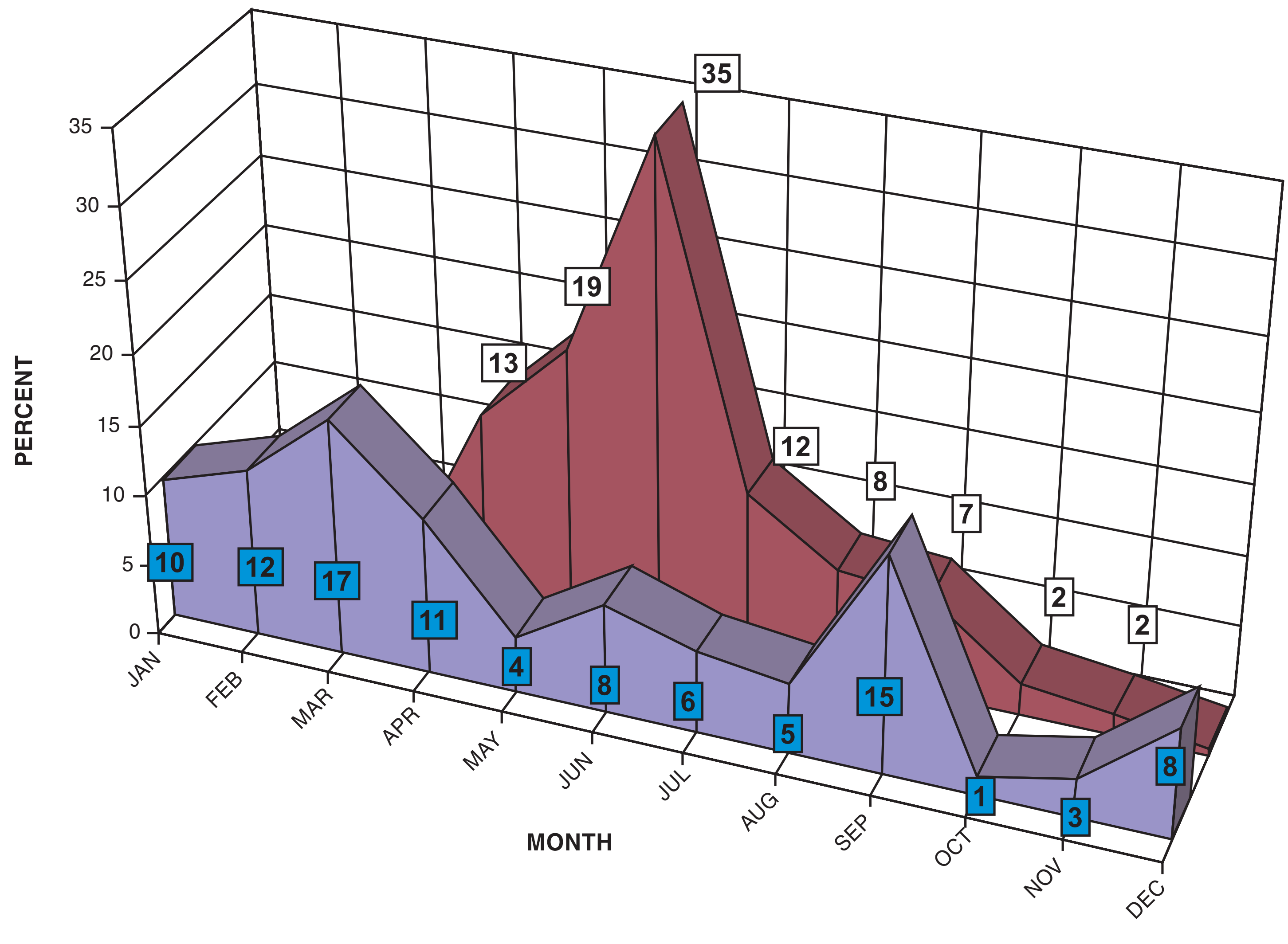

FIGURE B-19
PRESENCE AND PASSAGE OF JUVENILE HARDHEAD AND SACRAMENTO SUCKER AT RBDD
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W072002003RDD_09 (8/8/02)

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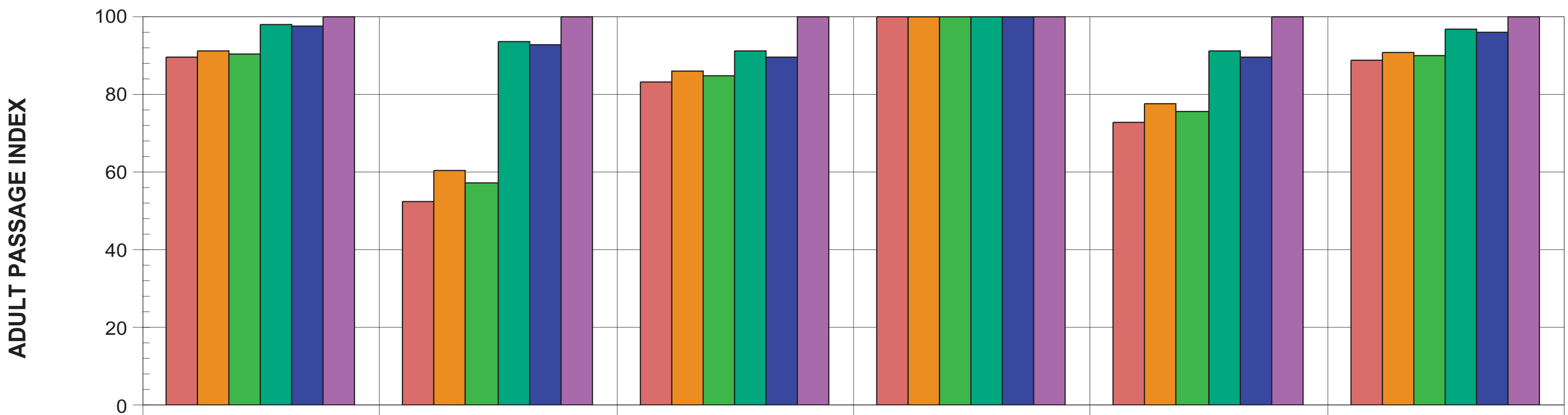

	WINTER-RUN CHINOOK SALMON	SPRING-RUN CHINOOK SALMON	FALL-RUN CHINOOK SALMON	LATE-FALL-RUN CHINOOK SALMON	RAINBOW TROUT	STEELHEAD
NAA	89	52	83	100	73	89
ALT. 1A	91	61	86	100	78	91
ALT. 1B	91	57	85	100	76	90
ALT. 2A	98	94	91	100	91	97
ALT. 2B	98	93	89	100	90	96
ALT. 3	100	100	100	100	100	100

NAA
ALTERNATIVE 1A
ALTERNATIVE 1B
ALTERNATIVE 2A
ALTERNATIVE 2B
ALTERNATIVE 3

FIGURE B-20
ADULT PASSAGE INDICES FOR NATIVE ANADROMOUS SALMONID SPECIES AND RESIDENT NATIVE RAINBOW TROUT
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

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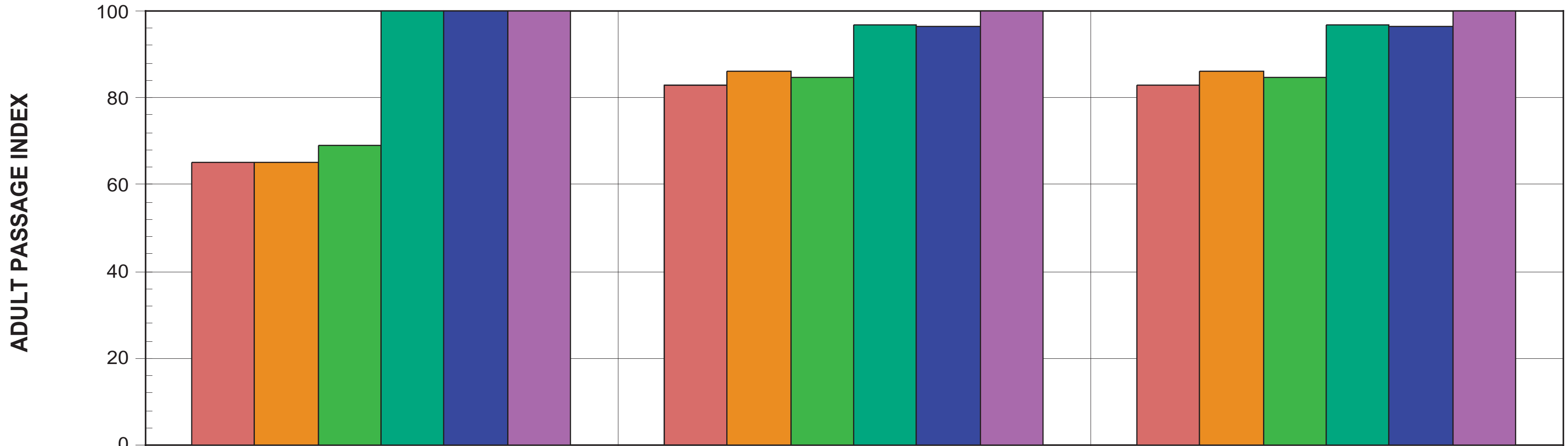


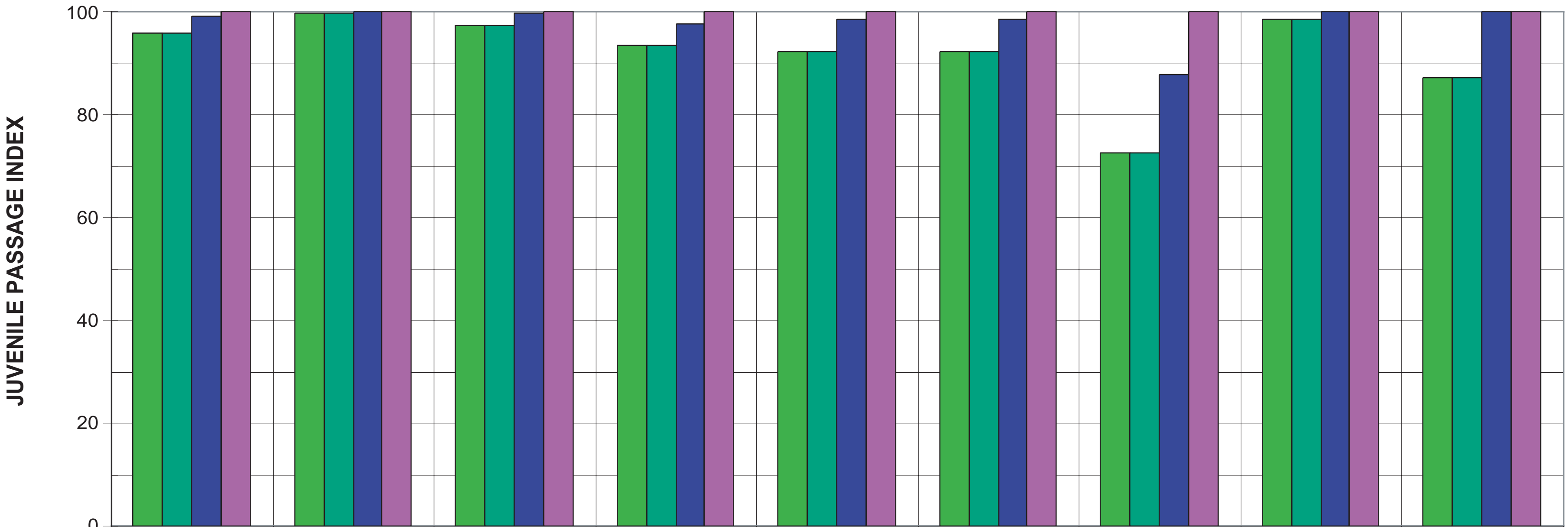
	GREEN STURGEON	PACIFIC LAMPREY	RIVER LAMPREY
NAA	65	83	83
ALT. 1A	65	86	86
ALT. 1B	69	85	85
ALT. 2A	100	97	97
ALT. 2B	100	96	96
ALT. 3	100	100	100

NAA
ALTERNATIVE 1A
ALTERNATIVE 1B
ALTERNATIVE 2A
ALTERNATIVE 2B
ALTERNATIVE 3

FIGURE B-21
ADULT PASSAGE INDICES FOR OTHER NATIVE ANADROMOUS SPECIES
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

W072002003RDD_103 (8/14/02)



	WINTER-RUN	SPRING-RUN	FALL-RUN	LATE-FALL RUN	RAINBOW TROUT	STEELHEAD	GREEN STURGEON	PACIFIC LAMPREY	RIVER LAMPREY
NAA	96	100	97	93	92	92	73	99	87
ALT. 1	96	100	97	93	92	92	73	99	87
ALT. 2	99	100	100	98	99	99	88	100	100
ALT. 3	100	100	100	100	100	100	100	100	100

NAA
ALTERNATIVE 1
ALTERNATIVE 2
ALTERNATIVE 3

FIGURE B-22
JUVENILE PASSAGE INDICES SPECIES ANALYZED USING THE FISHTASTIC! TOOL
FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

W072002003RDD_22 (8/14/02)

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Attachment B1
Fishtastic! Approach, Assumptions, and Methodology

ATTACHMENT B1

Fishtastic! Approach, Assumptions, and Methodology

Introduction

The following describes the development of a tool for quantifying fish passage under a variety of dam facility management scenarios (Project Alternatives), and to describe the results and repercussions of this analysis. The analytical tool is called Fishtastic!, and was developed specifically to gain a better understanding of fish passage at the Red Bluff Diversion Dam (RBDD) in Red Bluff, California. Although quantification of natural processes, particularly involving complex organisms, is at best, only an approximation based on many assumptions, Fishtastic! was designed to be a decision-making tool. It is not intended to predict actual changes in numbers of individuals or populations of fish and thus is not a “spawner-recruit model.” Its function is to distinguish differences between project alternatives using life history characteristics for several key Sacramento River fish species under average or “typical” conditions.

The selection of a preferred management alternative would therefore reflect factors aimed at improving dam passage efficiency for species requiring the most assistance, while maintaining an adequate water supply for agriculture and other uses. The macro-based spreadsheet tool was developed to calculate an average annual index of fish passage efficiency at RBDD. This index is intended to represent an annual cumulative measure of energy expenditure, stress, delay, blockage, injury, or loss, affecting a species as it transits the RBDD project area. The annual index calculated ranges from zero (the species is negatively affected fully) to 100 (the species is unaffected whatsoever). The greater the index value, the less adversely affected the species is.

The RBDD has a unique operation, in that it utilizes movable gates to control flow in the Sacramento River. With the gates in the down position (gates-in), water ponded behind the dam (Lake Red Bluff) is diverted into the Tehama-Colusa irrigation canal (TC Canal) to serve agricultural needs. Currently, gates are in from mid-May to mid-September, per direction of the 1993 Biological Opinion (National Marine Fisheries Service [NMFS], 1993) during which three ladders facilitate adult fish passage through the dam and upstream within the Sacramento River. Fishtastic! attempts to evaluate the use of the existing and improved ladders, as well as alternative passage approaches such as an engineered bypass channel alone or in combination with ladders, as well as different gates-in operations timings.

To develop a detailed understanding of the factors affecting fish passage, a number of Fishtastic! versions were developed. Each new version includes modifications to the types of input information and the nature of the calculations, as Fishtastic! development has been an iterative process. The two versions presented below have provided the most valuable and useful information. The following sections principally describe the methodology of versions

5.2-5.5, the latest operational version of Fishtastic!. However, version 1.4 is also briefly described to provide background on the results of early analysis efforts and their effects on the development and output of versions 5.2-5.5.

Assumptions

Adult Module

Adult fish passage simulation analysis included a variety of assumptions regarding immigration, structural facilities and their configurations, and facility passage efficiencies. The following describes input variable assumptions for the adult Fishtastic! module.

In Fishtastic! versions 5.2-5.5, seven management alternatives were evaluated for selected species. These included:

- No Action Alternative – RBDD Gates-in 4 months (May 15 through September 15), existing ladders in all positions
- 1A: 4-month Improved Ladder Alternative – Gates-in 4 months (May 15 through September 15), new ladders in two positions (left and right banks)
- 1B: 4-month Bypass Alternative – Gates-in 4 months (May 15 through September 15), new left bank bypass channel, new fish ladder on right bank
- 2A: 2-month Improved Ladder Alternative – Gates-in 2 months (July and August), new fish ladders in two positions (left and right banks)
- 2B: 2-month with Existing Ladders Alternative – Gates-in 2 months (July and August), existing fish ladders
- 3: Gates-out Alternative – Gates-out year-round, no operational fish ladders

Annual adult temporal migration distributions, which represent the percentages of each species' annual migration occurring each month, are provided in Table 1. As previously stated, these values are the monthly passage percentages at RBDD without any impediments and would correspond to the Gates-out Alternative. Temporal distributions for many species affected by RBDD were developed by reviewing existing RBDD fish ladder and trapping data over several years. Additional historical data for species currently in low abundance were reviewed and incorporated into the adult and juvenile distributions. Finally, through consensus of fishery professionals familiar with the upper Sacramento River watershed, workshops were conducted by this Technical Working Group to determine and finalize the life-history characteristics of species used for the analyses.

The number of days of delay related to locating RBDD dam facilities are shown in Table 2. These values are based on radio telemetry data collected from 1999 through 2001 for fall-run chinook salmon captured and released at RBDD by the U.S. Fish and Wildlife Service (USFWS). The existing (with "old" ladders) average delay value, which was based on the 3 years of radio telemetry data currently available, is approximately 21 days to pass RBDD. The efficiency values assigned to the "future" facilities (e.g., "new" ladders) were estimated based on perceptions of their relative efficiency as compared to the existing facilities'

TABLE 1
Average Monthly Adult Temporal Distribution at RBDD

Species	Jan	Feb	Mar	Apr	May (1-15)	May (16-30)	Jun	Jul	Aug	Sep (1-15)	Sep (16-30)	Oct	Nov	Dec	Total
Winter-run Chinook Salmon[a]	5.1	9.6	36.0	28.6	3.6	5.3	6.8	3.4	0.0	0.0	0.0	0.0	0.0	1.7	100
Spring-run Chinook Salmon[b]	0.0	0.0	0.0	7.6	22	22	37.8	8.8	1.7	0.0	0.0	0.0	0.0	0.0	100
Fall-run Chinook Salmon[a]	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.6	13.0	10.1	17.8	37.0	16.3	4.0	100
Late-fall-run Chinook Salmon[a]	18.8	16.2	12.7	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.7	14.6	29.6	100
Rainbow Trout[c]	2.5	2.7	1.0	4.4	6.9	6.9	16.1	9.3	5.0	2.8	2.8	18.8	20.0	0.8	100
Sacramento Pikeminnow[d]	1.0	1.0	1.0	18.0	16.0	15.0	13.0	11.0	6.0	4.0	4.0	5.0	3.0	2.0	100
Steelhead[a]	2.9	1.8	1.9	1.0	0.3	0.4	0.8	0.7	4.8	9.6	16.5	39.3	13.9	6.1	100
Splittail[e]	10.0	10.0	20.0	20.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Green Sturgeon[e]	0.0	5.0	15.0	25.0	20.0	15.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
White Sturgeon[f]	0.0	5.8	37.4	42.7	9.7	3.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Pacific Lamprey[e]	0.0	5.0	10.0	20.0	20.0	10.0	5.0	3.0	2.0	5.0	5.0	5.0	5.0	5.0	100
River Lamprey[e]	0.0	5.0	10.0	20.0	20.0	10.0	5.0	3.0	2.0	5.0	5.0	5.0	5.0	5.0	100
Striped Bass[e]	1.0	1.0	1.0	10.0	8.0	8.0	20.0	27.0	4.0	5.0	6.0	7.0	1.0	1.0	100
Hardhead[e]	1.0	1.0	1.0	18.0	16.0	15.0	13.0	11.0	6.0	4.0	4.0	5.0	3.0	2.0	100
American Shad[e]	0.0	0.0	5.0	15.0	15.0	15.0	30.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	100
Sacramento Sucker[e]	5.0	5.0	15.0	15.0	10.0	5.0	10.0	10.0	2.0	3.0	5.0	5.0	5.0	5.0	100

[a]RBDD ladder counts/trapping from 1982-1986.

[b]RBDD ladder counts/trapping from 1970-1988; CDFG, 1998; RBDD ladder counts/trapping from 1995-2000, consensus of Technical Working Group.

[c]RBDD ladder counts/trapping 1984-2000.

[d]Tucker, 1997.

[e]Consensus of Technical Working Group.

[f]Consensus of Technical Working Group, Kohlhorst, 1976 (note: this species may not actually pass RBDD).

TABLE 2
Estimated (Assigned) Number of Days of Delay for Each of the Facility Structures at RBDD Based on Radio Telemetry Data for Fall-run Chinook Salmon During 1999 through 2001

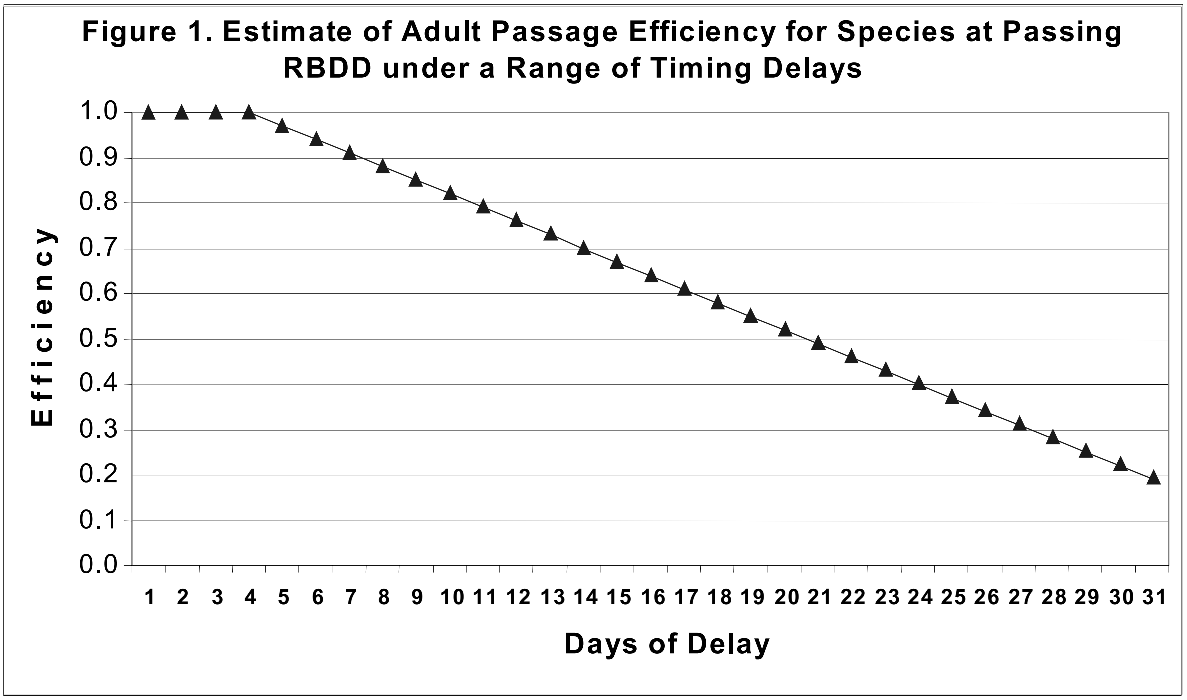
Species	Old Ladders	New Ladders	Bypass	Old Ladders and Bypass	New Ladders and Bypass	Lock	Old and New Ladders
Winter-run Chinook Salmon	21	18	19	19	16	21	19
Spring-run Chinook Salmon	21	18	19	19	16	21	19
Fall-run Chinook Salmon	21	18	19	19	16	21	19
Late-fall-run Chinook Salmon	21	18	19	19	16	21	19
Other	21	18	19	19	16	21	19
Sacramento Pikeminnow	21	18	19	19	16	21	19
Steelhead	21	18	19	19	16	21	19
Splittail	21	18	19	19	16	21	19
Green Sturgeon	21	18	19	19	16	21	19
White Sturgeon	21	18	19	19	16	21	19
Pacific Lamprey	21	18	19	19	16	21	19
River Lamprey	21	18	19	19	16	21	19
Striped Bass	21	18	19	19	16	21	19
Hardhead	21	18	19	19	16	21	19
American Shad	21	18	19	19	16	21	19
Sacramento Sucker	21	18	19	19	16	21	19

efficiencies. For example, new ladders as compared to the existing ladders that were designed for salmonids, but are decades old, may reduce average passage by 3 days. However, compared to the old ladders alone, the old ladders with a bypass channel may only reduce passage delay by 1 day.

Due to a limited set of actual field data, the delay values for any structural facility other than existing fish ladders that were used in the analysis were assumed to be the same among all of the species. It is recognized that it is likely that there are differences in delay timing dependent on species/run of fish, time of year, water temperatures/quality, and river flow conditions. In some instances, values used in the analysis are conservative estimates, and this was necessary because the facility component being assessed has not yet been built. For example, only existing ladders have been used at RBDD. Therefore, the assumed adult passage delay from other dam facilities (e.g., new ladders or a bypass channel), were extrapolated and were subjective. However, these efficiency values were applied uniformly across all alternatives for all species. A detailed explanation of the passage delay calculations as they were applied in the analysis is described later in this attachment.

In the case of the bypass channel, the efficiency of a facility such as this to successfully pass species such as salmon, sturgeon, and others is highly uncertain. The bypass channel as proposed is a highly designed channel with "hardscape" features such as cement/rock baffles and weirs to control velocity. This bypass channel would more resemble an alternative "fish ladder." However, because of its total size and other features that would be necessary to physically locate this bypass, its efficiency to pass fish is very uncertain. In the case of conventional fish ladders, there is sufficient experience documenting the successful use of this technology, and therefore, the uncertainty of passage efficiency is much less that that for a bypass channel. There is no practical means to test or determine the usefulness of a bypass channel other than to build one and then determine its efficiency.

Figure 1 presents the estimated passage efficiencies as they relate to the number of days delayed, where an increase in the number of delay days reduced the passage efficiency of the species. As with delay days in Table 2, values for delay-related passage efficiencies are the same among all of the species, due to the scarcity of available field data. As there are no empirical data to develop a curve of passage delay versus time (efficiency), a linear relationship was assumed. The Technical Working Group estimated that biologically, a delay of less than 3 days would result in no adverse biological consequences. Therefore, on Figure 1, the reduction in efficiency does not begin until delays greater than three days occur.



As described in the methodology discussion (below), passage efficiencies for each facility (e.g., right bank dam) represent a portion of the total passage. Table 3 provides passage efficiencies used in the analysis for ladders and bypass for each management alternative. Ladder efficiencies vary depending on whether a given alternative includes old or new ladders at specific locations. The efficiencies assigned in Table 3 were developed by the Technical Working Group based on a relative basis of efficiencies. For example, it was assumed that the passage efficiency of the existing left bank ladder component of the No Action passage facilities was 0.2 (out of a total efficiency of 0.5 for the alternative). Then the passage efficiency of a new left bank fish ladder (e.g., 4-month Improved Ladder Alternative) might be 25 percent more efficient or have a resulting component efficiency of 0.25. Furthermore, for the bypass channel it was assumed that the efficiency of this facility may be similar to that of a new ladder (0.25) and thereby was assigned an efficiency value of 0.25 for that component.

TABLE 3
Facilities' Specific Passage Efficiencies for Adult Analysis Module

Alternative	Left Bank Ladder	Center Ladder	Right Ladder	Bypass
No Action	0.2	0.1	0.2	n/a
1A	0.25	0.1	0.25	n/a
1B	0.25	0.1	0.2	0.25
2A	0.25	n/a	0.25	n/a
2B	0.2	n/a	0.2	n/a
3	n/a	n/a	n/a	n/a

Juvenile Module

Fishtastic! analyses for juvenile fish were run on similar, albeit less complicated, alternatives as the adult simulations. Facilities management alternatives included:

- No Action Alternative – Gates-in 4 months (May 15 through September 15), existing ladders in current locations (left and right banks and in the center)
- 4-month Alternatives – Gates-in 4 months (May 15 through September 15), functionally identical to No Action Alternative
- 2-month Alternatives – Gates-in 2 months (July and August)
- Gates-out – Gates out all year (natural river flow)

It was assumed that ladder designs were not sufficiently important in estimating juvenile fish downstream passage efficiency. The assumption was that predation was the single most important factor contributing to reduced passage efficiency at RBDD. It was assumed that any alternative would include juvenile fish protection facilities in accordance to existing NMFS and California Department of Fish and Game (CDFG) criteria, and therefore, there would be no difference in juvenile passage efficiencies related to these facilities. Thus, it was assumed that ladder design (and pump station/fish screen designs) would have no calculable effect on juvenile passage efficiency and calculation of their indices. The principal mechanism of impact to downstream migrating juvenile fish was therefore assumed to be from predation related to RBDD facilities.

Similar to adult temporal distributions, monthly juvenile presence at RBDD was determined using the most pertinent and current data available and consensus of knowledgeable fishery specialists from the Technical Working Group. Monthly temporal distribution (presence) for juveniles of each species are illustrated in Table 4. As is evident from the table, juvenile fish migration for each species occurs at different times than adult fish due to the life history characteristics and life stages (spawning, incubation, growth and development, migration, and re-distribution) for each species. Thus, passage improvements for juvenile life stages due to changes in RBDD facilities, management, or operations may not necessarily be reflected similarly to adults and juveniles of the same species.

In the juvenile analysis module of Fishtastic!, provisions for spatially distributing down-stream migrating juvenile fish present at RBDD were built into the tool. The parsing of juveniles could be assigned to each of the RBDD's facilities and other locations around RBDD depending upon the proportion of river flow at each location. However, after much discussion with the Fish Technical Advisory Team, it was decided that differential predation rates based on the location of juveniles within the river or at various RBDD facilities was not feasible. Therefore, in Fishtastic!, juveniles were subjected to the predation assessment ("*E. A. Gobbler*" sub-routine) without regard to any flow-based spatial juvenile distributions. The principal factors applied to assess potential predation at RBDD were based on a maximum literature value for predation for juvenile salmonids (Vogel et al., 1988) and the actual presence of predatory species at RBDD (Tucker, 1997). The estimated predation rate of 55 percent (Vogel et. al, 1988) was weighted by predator presence as estimated by catch per unit effort (CPE) of Sacramento pikeminnow and striped bass at RBDD (Tucker, 1997).

TABLE 4
Average Monthly Juvenile Temporal Presence (percent of total annual) at RBDD

Species	Jan	Feb	Mar	Apr	May (1 through 14)	May (15 through 30)	Jun	Jul	Aug	Sep (1 through 15)	Sep (16 through 30)	Oct	Nov	Dec	Total
Winter-run Chinook Salmon[a]	2.8	2.3	1.4	0.1	0.0	0.0	0.0	1.3	11.8	26.3	26.2	14.1	11.4	2.3	100
Spring-run Chinook Salmon[a]	8.2	3.2	22.7	25.6	1.0	0.6	0.1	0.0	0.0	0.0	0.0	2.4	2.6	33.6	100
Fall-run Chinook Salmon[a]	23.1	31.4	10.0	14.5	2.0	1.9	3.4	1.7	0.6	0.1	0.1	0.0	0.0	11.3	100
Late-fall-run Chinook Salmon[a]	1.6	0.1	0.0	30.1	4.7	4.0	3.8	7.0	13.6	5.7	5.1	6.3	14.2	3.9	100
Sacramento Pikeminnow[a]	8.6	15.3	11.9	4.7	1.7	2.0	26.2	7.8	3.8	3.1	3.0	0.5	4.0	7.4	100
Steelhead/ Rainbow Trout[a]	13.9	15.9	11.2	4.6	6.2	6.2	4.4	3.7	12.3	10.0	8.2	1.5	1.0	0.9	100
Splittail[b]	0.0	10.0	10.0	20.0	20.0	10.0	10.0	10.0	10.0	0.0	0.0	0.0	0.0	0.0	100
Green Sturgeon[a]	0.0	0.4	0.0	0.0	0.3	0.5	37.1	50.1	11.1	0.0	0.0	0.5	0.0	0.0	100
White Sturgeon[c]	0.0	0.0	5.8	37.4	42.7	9.7	3.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	100
Pacific Lamprey[d]	30.3	7.4	9.0	3.8	1.1	1.0	1.3	0.7	0.7	2.6	2.6	3.3	6.3	30.1	100
River Lamprey[d]	0.0	0.0	13.1	17.2	15.3	15.0	11.3	0.0	0.0	5.9	6.0	5.4	2.9	8.0	100
Striped Bass[e]	1.0	1.0	1.0	1.0	10.0	8.0	8.0	20.0	27.0	4.0	5.0	6.0	7.0	1.0	100
Hardhead[a]	10.0	11.9	16.7	11.1	4.1	4.0	3.8	5.8	5.1	8.0	7.4	1.5	2.8	7.9	100
American Shad[b]	0.0	0.0	0.0	5.0	15.0	15.0	15.0	30.0	20.0	0.0	0.0	0.0	0.0	0.0	100
Sacramento Sucker[a]	0.2	0.7	1.1	13.4	9.2	10.0	34.7	11.7	7.7	4.0	3.0	2.3	1.5	0.5	100

[a]From juvenile trapping data collected during 1995-1999 by USFWS at RBDD.

[b]Consensus of Technical Working Group (note: this may be theoretical as adults of this species may not pass RBDD).

[c]Consensus of Technical Working Group; Kohlhorst (1976) (note, this may be theoretical as adults of this species may not pass RBDD).

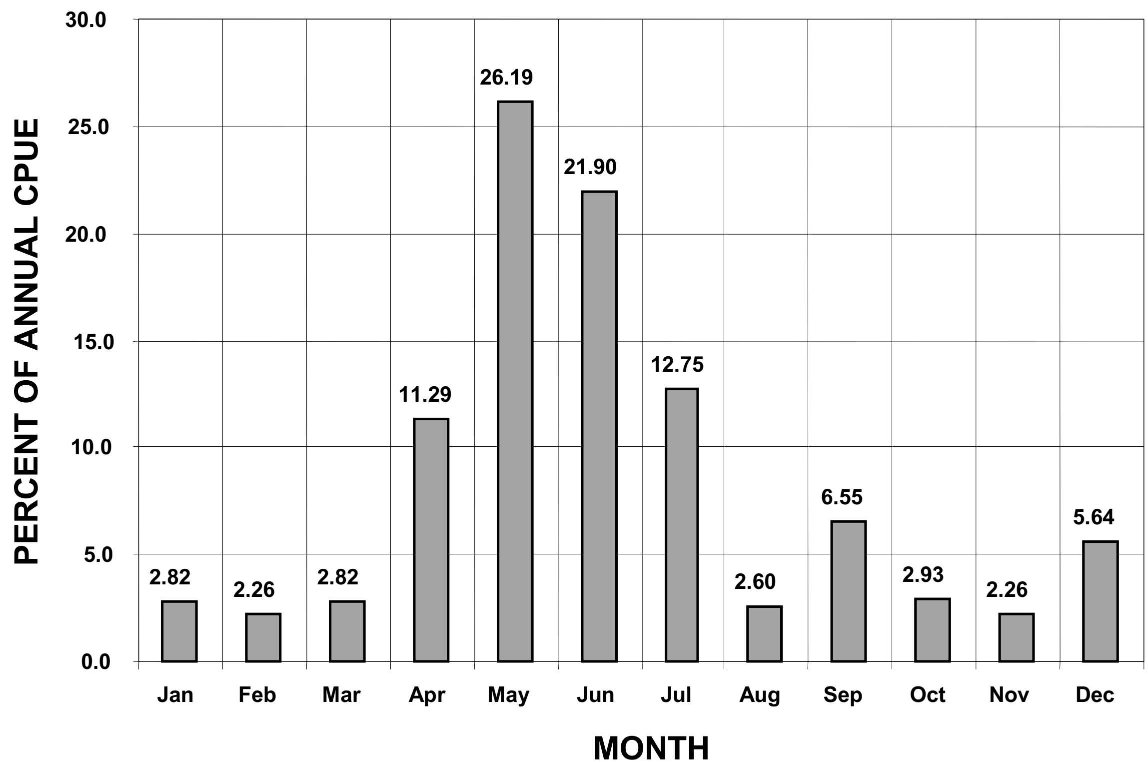
[d]From lamprey transformer trapping data collected during 1995-1999 by USFWS at RBDD.

[e]Consensus of Technical Working Group.

Monthly combined predator presence at RBDD as derived for this analysis is shown on Figure 2.

To estimate monthly rates of predation, or a predation hazard index, the maximum predation rate (55 percent) estimated by Vogel et al. (1988) was scaled against the monthly weighted combined predator presence estimates. The resulting monthly predator hazard index was then applied in the calculations for the *E.A. Gobbler* sub-routine of Fishtastic! juvenile analysis module. These monthly hazard indices are shown in Table 5.

Figure 2. Combined Monthly Percent of Total Striped Bass and Pikeminnow Catch/Unit Effort at RBDD (1994-1996)



Methods: Fishtastic! Version 1.4

Fishtastic! version 1.4 used a large set of tabular input data for adult fish inputs, specifically low-end and high-end flow-based passage efficiencies for fish at various facilities. Project alternatives included a no change alternative (current conditions) with gates-in from May 15 through September 15 and current ladders, a second alternative with new fish ladders and the same gate timings (current conditions), a bypass channel alternative, and a gates-out scenario (natural river flow).

For juvenile fish, data input tables relate reduced passage efficiencies to a variety of hazards (e.g., increased predation in Lake Red Bluff and downstream of the dam, impingement or entrainment on dam structures, or injury). In version 1.4, juvenile fish were also distributed to various structures on the dam (e.g., right ladder, diversion channel, etc.) depending on river flow and behavioral placement in the river channel. Hazards causing reduced passage efficiency were selected by the user depending on the location to which fish were flow-distributed.

TABLE 5
Estimated Monthly Hazard Estimate Used to Assess Predation in the *E.A. Gobbler* Sub-routine of the Fishtastic! Juvenile Analysis Module

Month	CPUE (% of yearly total)	Scaled Predation Rate (%)	Hazard Multiplier (0-1)
Jan	2.82	5.88	0.94
Feb	2.26	4.83	0.95
Mar	2.82	5.88	0.94
Apr	11.29	23.72	0.76
May	26.19	55[(2)]	0.45
Jun	21.90	45.97	0.54
Jul	12.75	26.87	0.73
Aug	2.60	5.46	0.95
Sept	6.55	13.85	0.86
Oct	2.93	6.09	0.94
Nov	2.26	4.83	0.95
Dec	5.64	11.76	0.88

Sources: Tucker (1997); Vogel et al., 1988.

Output from Fishtastic 1.4 provided enlightening information on the factors affecting fish passage. Perhaps most importantly, passage efficiencies were similar with old and new ladders, contrary to the hypothesis that improved ladder design would result in substantial increases in passage efficiency. These results indicated that reduced passage efficiencies associated with ladder designs only incorporated reduced efficiencies at the dam itself, but not delays in the approach to the dam. Fishtastic! version 5.2-5.5 therefore included delays due to locating dam passage facilities, as well as a greater number of facilities management combinations for simulation.

Scrutiny of the results of the juvenile fish analysis from Fishtastic! version 1.4 revealed that the analysis tool incorporated many factors that most likely will not be substantially affected by modifications to the dam. Essentially, the most important factor affecting juvenile fish passage was determined to be predation. Thus, versions 5.2-5.5 was simplified, whereby facilities-related injury, entrainment, and impingement factors were removed from the inputs. The resultant version was a simpler approach employing flow routing and predation at specific areas of the dam.

Methods: Fishtastic! Versions 5.2-5.5

These versions of Fishtastic! provide interfaces for both adult and juveniles of 15 species commonly found at RBDD, including anadromous salmonids (e.g., chinook salmon and steelhead), other native anadromous species (e.g., sturgeon and lamprey species), non-native anadromous species (e.g., striped bass and American shad), and native/non-native resident species (e.g., rainbow trout and brown trout). The following sections highlight the operational and user interface characteristics of Fishtastic! versions 5.2-5.5. Descriptions of the assumptions included in the program were previously detailed (above). Discussions are provided in the systematic order in which the user encounters each data entry step of the program.

Adult Analysis Module

The adult computations in Fishtastic! involve the approach and subsequent passage of upstream migrating adult fish species at RBDD. The ultimate output of the adult module in Fishtastic! is neither actual numbers of fish passing the dam, nor percentages of the overall population passing the dam, but instead a relative index score (from 0 to 100). At each step in the adult module, an ecological "cost" or consequence of passage to that species is calculated. Although this concept is relative and somewhat abstract, it is necessary to avoid inappropriate assumptions or conclusions regarding species survivorship or injury and consequent changes in populations. Therefore, the passage index represents a relative score in terms of a composite of possible costs, such as reduced energy for egg development, swimming stamina, reduced survivorship, recovery from injury, etc. Thus, it is important for the user to understand that Fishtastic! is merely a tool for evaluating the relative effects of RBDD facilities management, rather than an absolute cost, in numbers (mortalities), to a given population.

The objective of the adult analysis computations is to aid in estimating which dam facilities impact the success of upstream migrating adults and to what extent passage of these fish are affected. The challenge to this analysis is to account for the variety of each species' life history characteristics in a manner that will produce the most meaningful results in collectively distinguishing the effects of project alternatives on those species.

Step 1. Adult Temporal Distribution

Data entry in adult Fishtastic! begins with establishment of the timing distributions of immigrating adult fish. Temporal distribution values are the fractional proportion of each species' adult migrating population reaching RBDD during each month. For example, if 44 percent of all adult spring-run chinook salmon annually migrate past RBDD in May, then the May temporal distribution is 0.44 (of the annual total of 1.00). In this manner, each month was assigned a temporal passage value that when summed represents the annual temporal distribution (100 percent or a value of 1.00). Because the gates have historically been lowered in mid-May and raised in mid-September, each of those months is split into two 2-week components.

Thus the annual temporal distribution score for any species cannot exceed 1.00, representing 100 percent of the annual migration. In the spreadsheet input area, where the temporal distribution data is entered into the spreadsheet, the summation area is highlighted orange if the annual distribution sum exceeds 1.00, indicating an error in data entry. All subsequent passage index scores calculated in Fishtastic! due to RBDD facilities and operations are relative to these initial ("natural or unaffected") temporal distributions. Therefore, subsequent calculations of passage indices, due to project-specific facilities and operation at RBDD will result in index scores that are some fraction of 1.00 (unaffected passage). Figure 3 summarizes the temporal distribution data for adults of the species commonly found at RBDD.

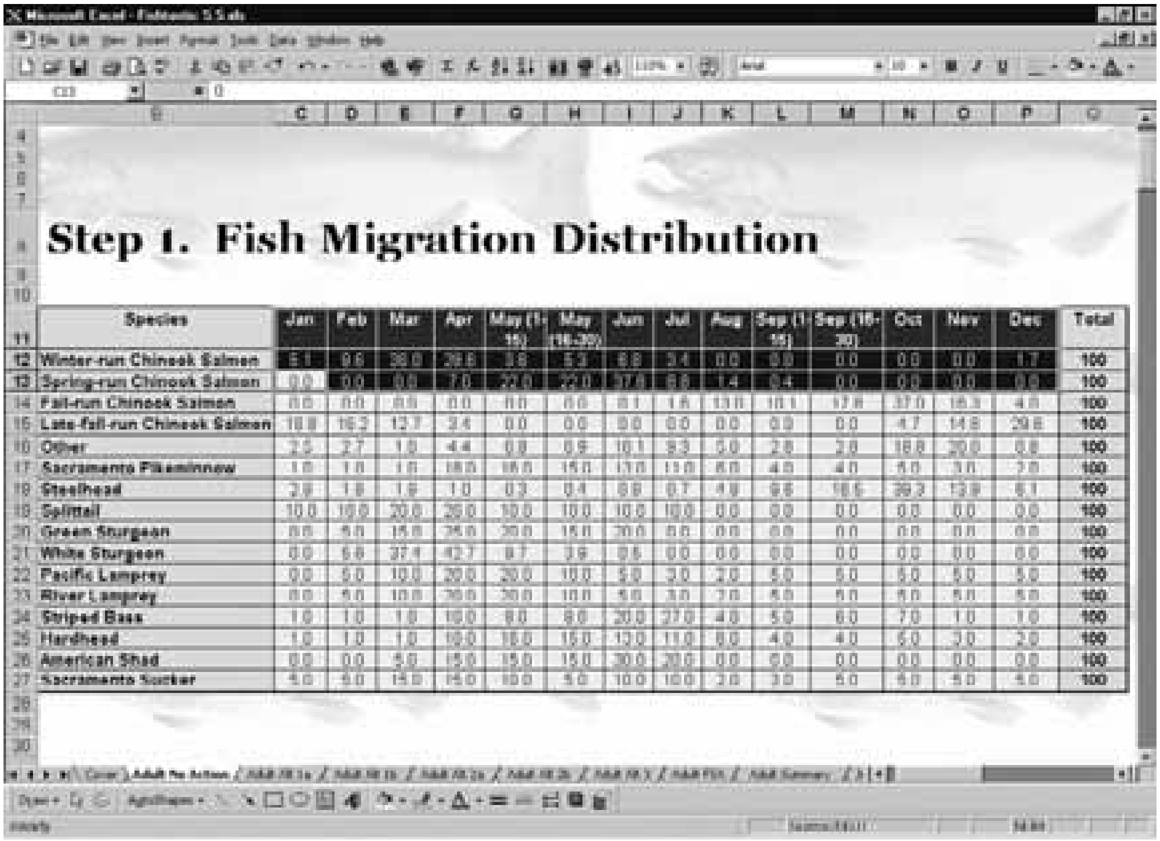


Figure 3. Step 1-The Adult Analysis Module's Temporal Distribution Data Input Area.

Step 2. Select Monthly Gate Positions

The next user data entry step is simple in its interface and operation, but critical in determining all passage calculations after the adult temporal distribution entry. RBDD gate positions are selected by toggle button for each month, where the toggle-on position (button pushed) indicates that all gates are down and passage must occur through dam facilities (e.g., fish ladders) for the given time period (Figure 4). Ecological cost calculations associated with the approach to the dam and subsequent passage are then performed for all species of that month as described later in this discussion.

If the gates are up (toggle-out) for any month, RBDD and its facilities are assumed to not affect the migration of adult fish, as the river becomes free flowing ("natural-state"). In this case, the output of the adult module will simply default to the monthly temporal distribution value entered by the user in Step 1. This does not suggest that there will be no ecological cost to adult fish moving past the RBDD during the gate-out operation, only that this is the facility-operational "unaffected" condition. As in any other part of the river, migrating fish will encounter natural hazards that incur some ecological cost in the freely flowing river. Therefore, during the gates-in operation at RBDD, the ecological costs to the passage of adult fish are due to anthropogenic activities calculated by Fishtastic! and are considered relative to naturally occurring ecological costs.

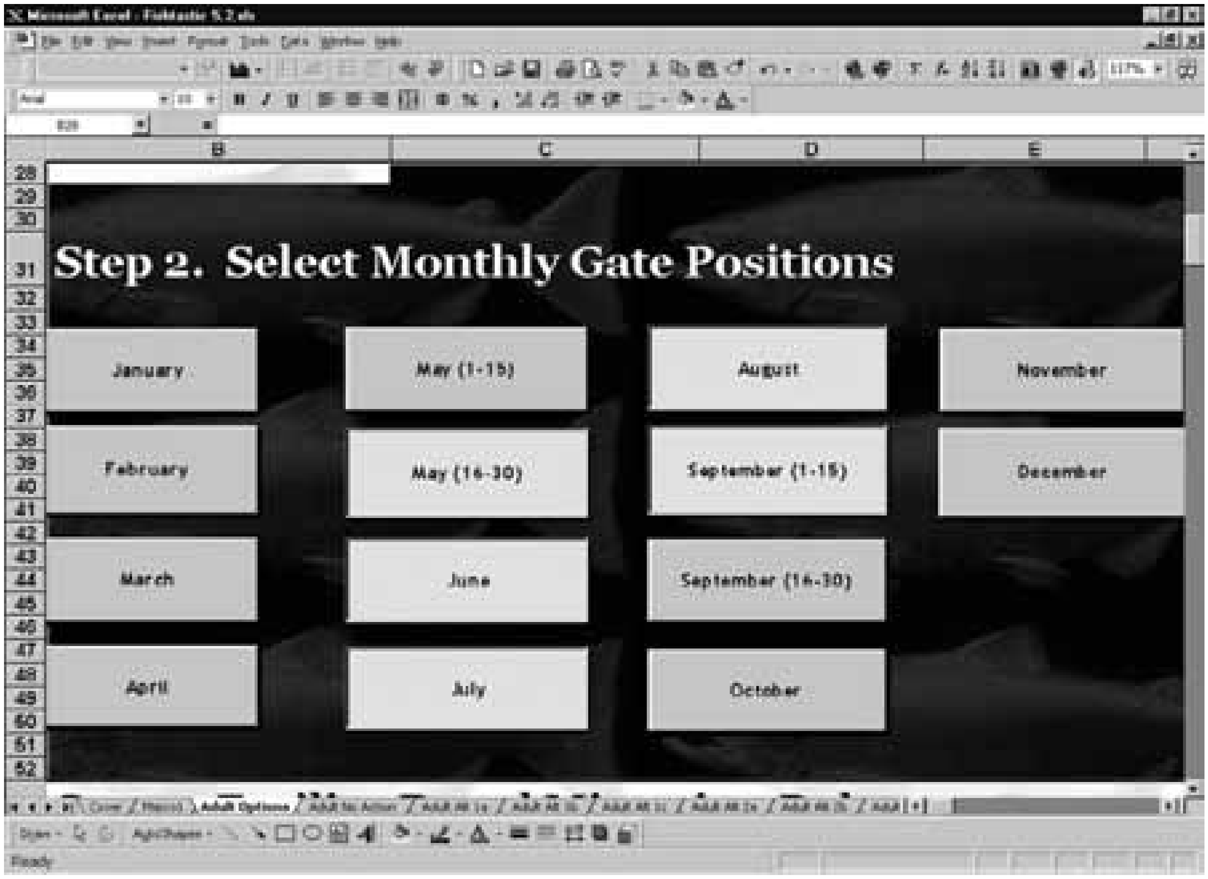


Figure 4. Monthly Gate Position Selection (Note: May 16-30, June, July, August, and September 1-15 are all toggled to down position in this example).

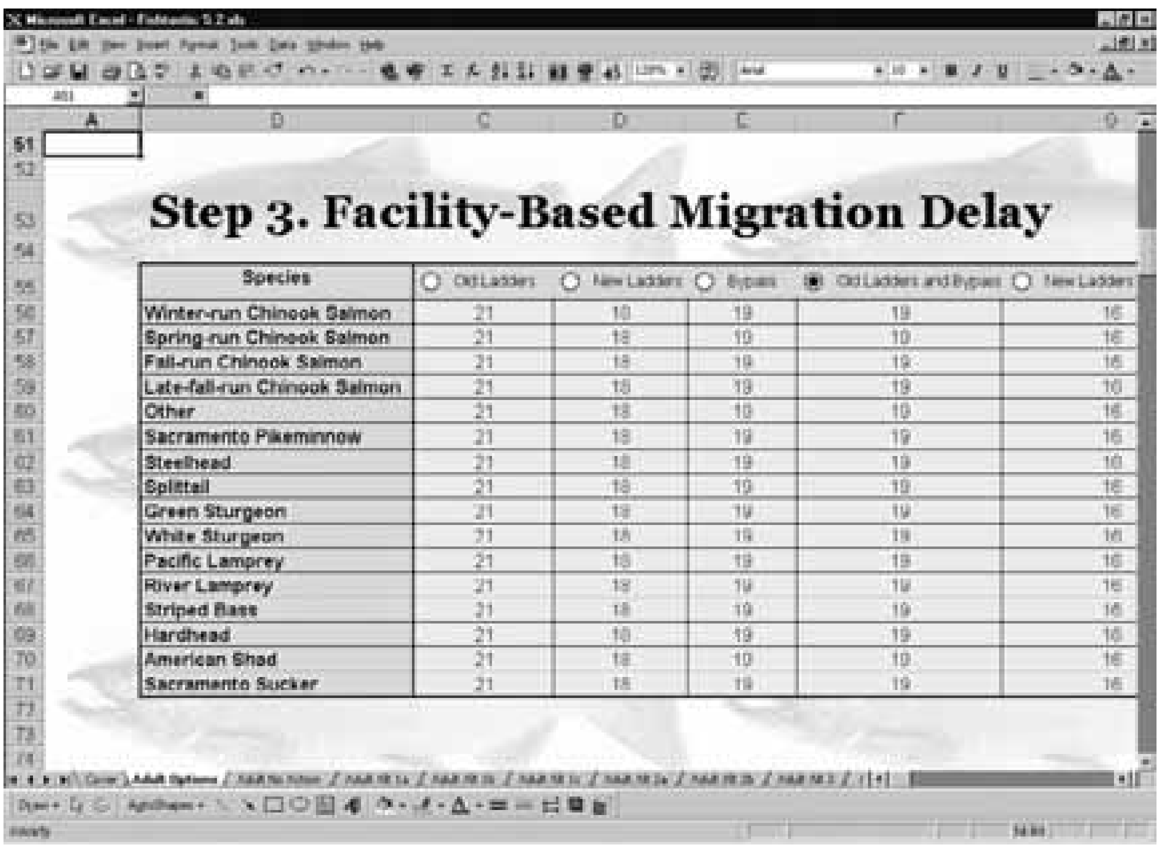
Step 3. Facility-based Migration Delay

If gates are toggled in (gates-in), Fishtastic! calculates the first level of ecological costs incurred by upstream-migrating adult fish. Step 3 requires the user to enter species-specific delay estimates for each of six possible dam facility configurations: 1) old ladders, 2) new ladders, 3) dam bypass channel, 4) old ladders used in conjunction with a dam bypass channel, 5) new ladders used in conjunction with a dam bypass channel, and 6) fish lock/mechanical lift.

This step requires the user to enter an estimate of the average behavioral delay (in days) exhibited by each species with a given facility configuration. The delay data used here were empirically derived from radio-tagging studies recently performed by USFWS (unpublished data) over a number of years with chinook salmon at RBDD and are consistent with findings of Vogel (1989). A discussion of the derivation of the delay times is provided in the assumptions for the adult analysis module above. It is important to note that these delays are not flow-based (flow-weighted) (i.e., varying time of delay depending on the proportion of the ladder flow to river flow during any month). Flow-weighted delay relationship data was omitted for two reasons: 1) flow-specific delay data are not available; and 2) the use of flow-weighted delay values without supporting empirical data increases the complexity of the analysis methodology without a concomitant increase in precision. Thus, given the limitations in available data, the approach that minimizes the magnitude of the error is that which maintains simplicity.

Each facility, whether a set of old ladders, new ladders, or other combination has a given capability to delay fish passage by providing impediments or distractions. Ideally, passage facilities are designed to attract fish into them, thereby improving the efficiency at which the fish find and pass through the dam. However, a variety of factors related to flow, velocity, turbulence, facility location and orientation, and/or other hydraulic conditions may serve to hinder a fish's ability to locate and efficiently transit the specific structure. Thus, the implicit assumption in the Step 3 calculation is that a passage facility (e.g., ladder) can either result in some delay to migration or no delay relative to migration in a freely flowing river (the gate-out condition).

Figure 5 provides an illustration of the Step 3 input table. To operate, the user enters facility-specific migration delay estimates (in days of delay-Table 2) for each species (green boxes), and then selects the radio button for the facility configuration under analysis.



Step 3. Facility-Based Migration Delay

Species	Old Ladders	New Ladders	Bypass	Old Ladders and Bypass	New Ladders
Winter-run Chinook Salmon	21	18	19	19	16
Spring-run Chinook Salmon	21	18	19	19	16
Fall-run Chinook Salmon	21	18	19	19	16
Late-fall-run Chinook Salmon	21	18	19	19	16
Other	21	18	19	19	16
Sacramento Pikeminnow	21	18	19	19	16
Steelhead	21	18	19	19	16
Splittail	21	18	19	19	16
Green Sturgeon	21	18	19	19	16
White Sturgeon	21	18	19	19	16
Pacific Lamprey	21	18	19	19	16
River Lamprey	21	18	19	19	16
Striped Bass	21	18	19	19	16
Hardhead	21	18	19	19	16
American Shad	21	18	19	19	16
Sacramento Sucker	21	18	19	19	16

Figure 5. Step 3-Facility-based Migration Delay (Note: this example has the "Old Ladders" and "Bypass" channel facilities toggled on).

Step 4a. Delay versus Efficiency Values Worksheet

Step 3 required the user to enter the length of time over which each species' migration is delayed at RBDD due to various facility configurations. Step 4a requires the length of delay to be related to an ecological (passage) cost. The implicit assumption in this step is that the longer the delay incurred below RBDD, the greater the magnitude passage cost. Although some species, such as the lamprey, may actually benefit from delay, particularly if migrating prey accumulate at the dam as they search for suitable passage, Step 4a assumes that there will be either delay or no delay. For the latter, particularly with the absence of either empirical evidence that suggests a potential facility migratory delay, the default delay value will be 1.00 (no delay), indicating the natural riverine condition.

If a species will experience some degree of energetic, reproductive, or other ecological diminishment (passage cost) related to delay, the user enters cost values proportional to the length of the delay. Figure 6 illustrates the user interface for this exercise. Costs for each number of delay days (from 0-30 days) are entered for each species. As illustrated on Figure 6, an important assumption is that a short delay (3 days or less) will have no measurable impact on migrating adults. The length of this no-impact period is likely species-dependent; however, the assumption was that effects of delay of passage was similar for all species (see discussion of assumptions above). In all cases, as the number of delay days continues to increase, ecological costs to passage concomitantly increases.

In likely cases where empirical data are only available for parts of this curve, other points must be interpolated. For example, there may be data or evidence available for the point at which relative passage efficiency equals 0, but not other points. Even with this scarcity of data, it may be possible to enter values for this curve using only hypothesis. In other words, it is accurate to imply that a short delay will not result in a change in relative passage efficiency. The assumption was that the relative efficiency values in this case are 1.00 (for the first 3 days) and was entered as such. If data or evidence were available, the user would enter that information for the most likely point(s) at which the relationship curve would change (i.e., rate of relative efficiency changes with increasing delay). For other portions of the relationship curve, a linear relationship to a known point on the curve (e.g., relative efficiency of zero) would be extrapolated and used.

Step 4b. Delays

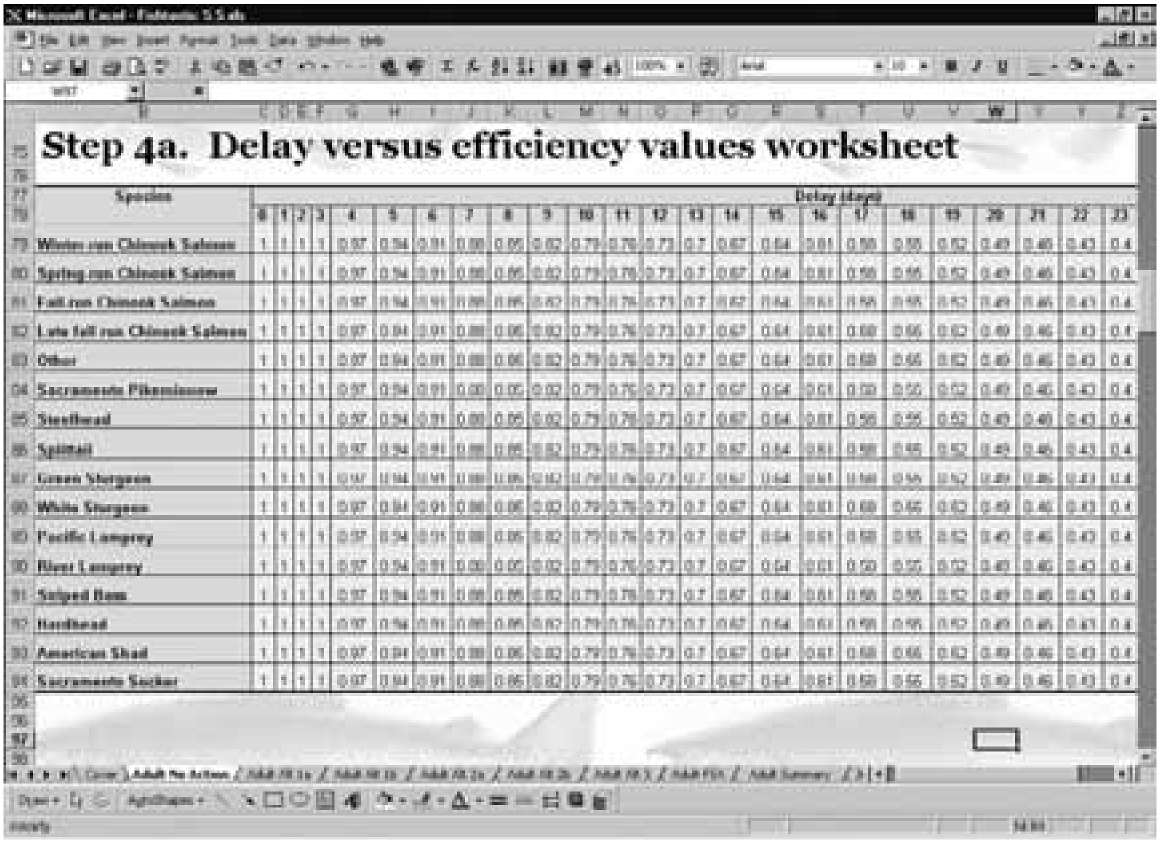
Once delay-relative efficiency data have been entered, Step 4b presents an automated efficiency value lookup. The efficiency for the selected facilities scenario delay duration is automatically generated. This is the first ecological cost with which the temporal distribution values are multiplied together if the RBDD gates are in.

Step 5. Dam Passage

Once migrating adult fish reach the dam, regardless of the time of delay, it was assumed that there is a physiological cost (e.g., fatigue) associated with actual passage (e.g., within a ladder or the bypass channel). For some species, such as sturgeon, passage through the ladders is likely not possible. For many other species, improvement in ladders may result in increased efficiency and reduction in physiological cost to pass RBDD.

Step 5a. RBDD Facility Structure Passage Efficiency

Step 5 consists of a macro-based program where the inherent passage efficiency for a structural facility is entered for each species and each facility. Facility efficiency values for the: 1) right bank ladder; 2) center ladder; 3) left- bank ladder; and 4) bypass channel are entered into the macro.



Step 4a. Delay versus efficiency values worksheet

Species	Delay (days)																						
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Winter-run Chinook Salmon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Spring-run Chinook Salmon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Fall-run Chinook Salmon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Late fall-run Chinook Salmon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Other	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Sacramento Pikeminnow	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Steelhead	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Splittail	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Green Sturgeon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
White Sturgeon	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Pacific Lamprey	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
River Lamprey	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Striped Bass	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Hardhead	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
American Shad	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4
Sacramento Sucker	1	1	1	1	0.97	0.94	0.91	0.88	0.85	0.82	0.79	0.76	0.73	0.7	0.67	0.64	0.61	0.58	0.55	0.52	0.49	0.46	0.43	0.4

Figure 6. Efficiency Value Entry for Delay Days (note in this example the efficiency at day 4 is 0.97).

The passage efficiency program reflects two mathematical processes that occur in Fishtastic! simultaneously. First, upstream migrating adult fish are parsed evenly among the existing facilities in the dam. Therefore, if the right bank, center, and left bank ladders were the only facilities in operation, each would receive a 33 percent distribution (0.33) of the fish reaching ladders. (Recall that delays in approaching the ladders have already reduced the ecological efficiency of migrating fish, whereby reaching the ladder are at some level less than their natural temporal distribution). Because observations at RBDD indicate no consistent flow-related preference in the distribution of fish to one ladder over another, an even distribution was assigned to each structural facility.

In the above example, if adult fish reaching the facility passed each of the facilities with 100 percent efficiency (i.e., all fish passed the ladders successfully and with no ecological cost), the total score for Step 5 would be 1.0 (0.33 + 0.33 + 0.33). However, as with other aspects of migration, ladder passage has some ecological cost, whereby the overall passage efficiency for a given species will be some value less the 1.0.

Therefore, the second element that is reflected in the facilities passage efficiency score for Step 5a is a reduction in the ideal (or no ecological cost) distribution at each facility. Table 3 provides an example of this operation. In the No Action Alternative, it was assumed that

33 percent of the fish reached the right bank, center, and left bank ladders (the bypass was not considered in this alternative). Therefore, the scores of 0.25 for right bank and left bank ladders indicated the ladder passage reduced the maximum possible passage from 0.33 (at each facility) to 0.25, the difference being the ecological cost of passing that facility. Therefore, approximately 75 percent of the fish reaching the right bank and left bank ladders passed the dam with no ecological cost. For the center ladder, the ecological cost was even greater, whereby the maximum potential passage efficiency of 0.33 was reduced to 0.1, indicating the only 30 percent of the fish reaching the center ladder passed the dam with no ecological cost.

For Alternatives 1A, 1B, and 2A, new ladders were simulated in the right bank and left bank positions, resulting in a slightly greater facility-based passage efficiency of 0.25, compared to 0.20 in the No Action Alternative (Table 3). In all cases, passage efficiencies of dam facilities (70 percent for old right bank and left bank ladders and 75 percent for new right bank and left bank ladder) were based on evidence of fish passage at RBDD and assuming typical design parameters for salmonid fish ladders.

Step 5b. Dam Structure Selection

Unlike previous steps, Step 5b is an automated table, where the selected RBDD facility (e.g., right bank ladder) is matched with the appropriate facilities configuration (Step 3) (e.g., old ladders). Thus, if the user selected the radio button for new ladders and bypass in Step 3 (see Figure 4), the matching facilities' passage efficiency values (right bank ladder, left bank ladder, center ladder, and bypass) would be multiplied by the monthly temporal distribution values.

Step 6. Output

The final step in Fishtastic!'s adult analysis module computation is an automated generation of output. As previously stated, the output reflects two possible analysis routes for each month: 1) gates-out configuration with output values equaling the monthly temporal distribution in Step 1; or 2) passage efficiency values reflecting delays and inherent passage efficiency at the structural facilities for each species.

In the event that the second scenario is toggled in the spreadsheet, Fishtastic! calculates its output stepwise. Migration distribution values are first multiplied by delay-specific efficiencies. These values are then multiplied by facility-specific passage efficiency values, where the output is parsed to each facility. The final output stage adds efficiency values for each facility into a combined table.

The last user interface is the Output Generator, where the user selects the management alternative under evaluation and selects the appropriate button. Output data are then copied to an output sheet with the appropriate name, where graphs or other media may be viewed.

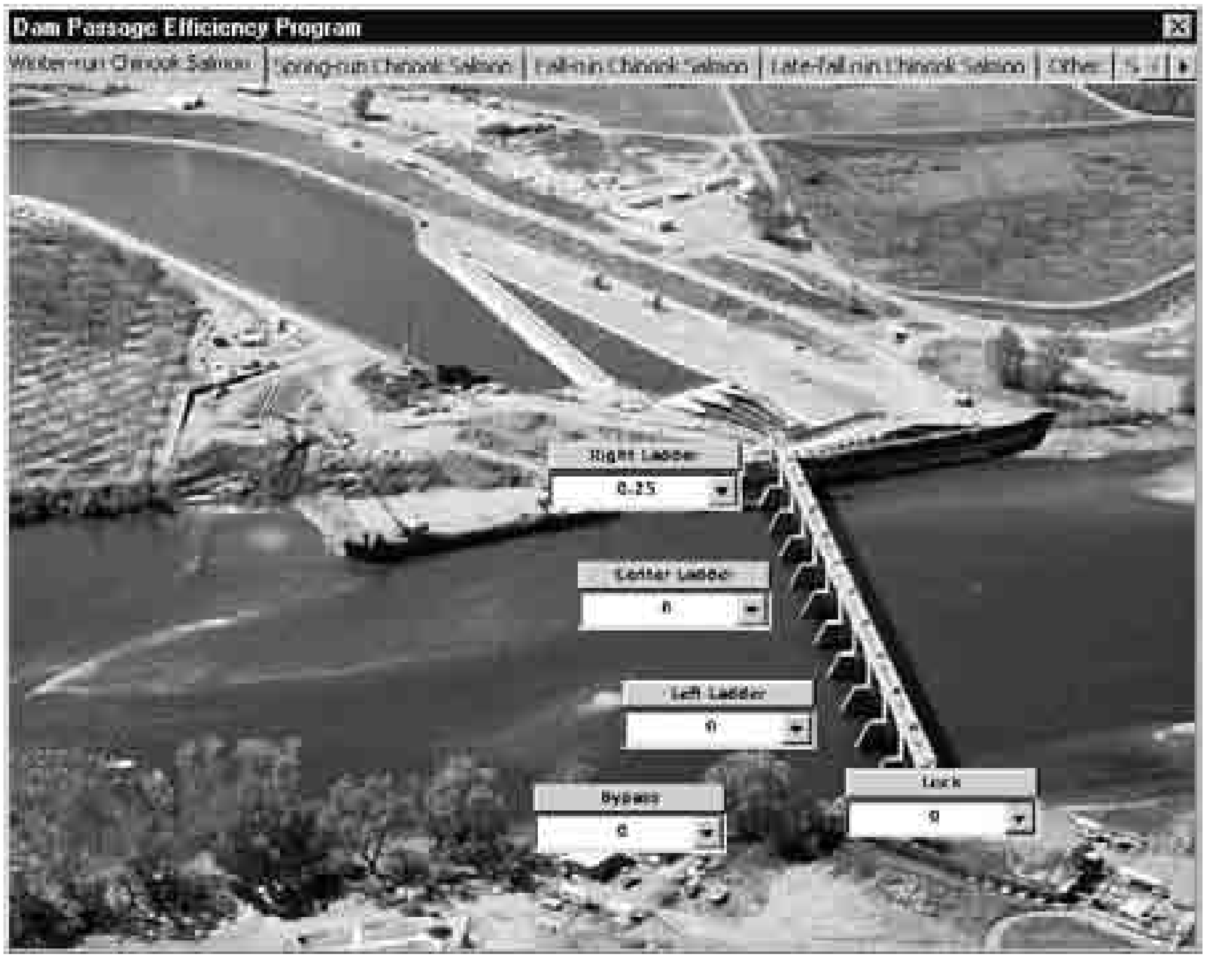


Figure 7. Facility Passage Efficiencies Data Entry for Each Species Is Entered Using a Macro-based Form Program.

Juvenile Analysis Module

Juvenile fish computations in Fishtastic! all relate to the cost of downstream migration of juvenile fish passing RBDD dam. The interface and computations are simpler than in the adult analysis module, as they account for only predation losses. The assumption used in the juvenile analysis module is that ecological costs, such as injury or entrainment of juvenile fish at various facilities will not be appreciably changed with structural improvements in ladder design, the addition of bypass channels, or other structural changes.

Step 1. River Flow Data

The adult computations of Fishtastic! assumes that fish have some level of control over which facility they use, based on delays, attraction flow, and other rudimentary decision processes. In contrast, juvenile fish are likely to pass through facilities based upon flow to each facility. Furthermore, unlike the adult module, juvenile computations in Fishtastic! incorporate a spatial element in assessing ecological cost.

In Step 1, the user enters river flow to each of the facilities or other areas at the dam, accounting for all of the flow passing RBDD (Figure 8). These include the facilities with which the user may be familiar from the adult module (e.g., right bank ladder, bypass channel), as well as other possible areas to which flow may carry juvenile fish (e.g., spill flows under the dam). Ecological (predator) costs for each flow area will affect only the fish at that specific location.

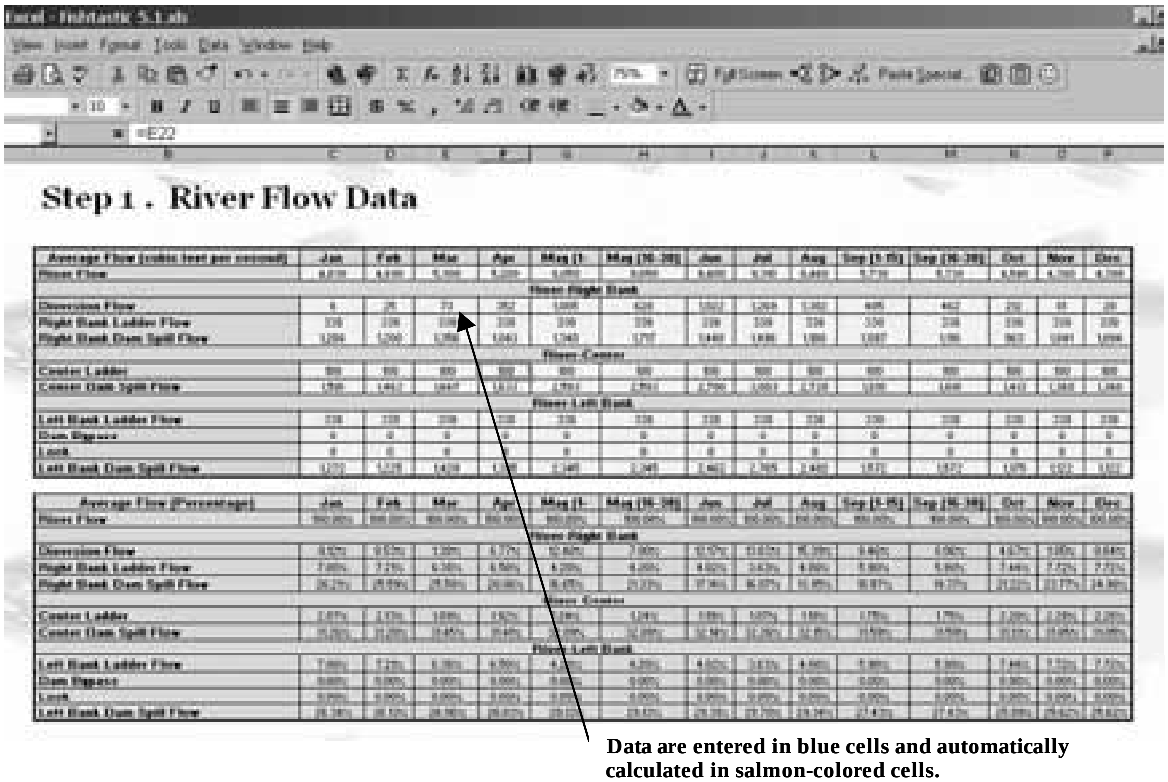


Figure 8. River Flow Data Entry for Spatial Placement of Downstream-migrating Juvenile Fish.

Step 2. Juvenile Temporal Distribution

Step 2 of the juvenile analysis module is identical in its function to the adult analysis module. The temporal distribution of juvenile fish moving past RBDD is entered for each month (or half month for May and September) for each species. As with the adult analysis module, data may be collected from empirical data, such as trapping.

Step 3. Flow-weighted Spatial Distribution of Juvenile Fish

Step 3 is a fully automated series of calculations based upon river flow and migration data. Because predator computations in the juvenile analysis module may be designed for each area or facility, Step 3 is required to distribute juvenile fish based upon flow. Subsequent calculations will be performed on fish at each of the locations. Only at the end of the juvenile analysis module will efficiency scores for each species be re-totaled to calculate an overall score.

Step 4. Select Monthly Gate Position

Step 4 is identical to Step 2 in the adult analysis module in both its user execution and consequences. If gates are toggled in the out position, then the final score will be equal to the original migration distribution. As with the adult analysis module, these scores reflect natural predator effects, rather than predation augmented by dam facilities.

Step 5. Predator Factor Distribution

Step 5 is the most critical data entry component in Fishtastic!'s juvenile analysis module. The gates-in operation of RBDD results in more ideal foraging conditions for predators such as the Sacramento pikeminnow and striped bass.

As in the adult analysis module, juvenile scores reflect an ecological cost or passage efficiency, rather than loss of numbers of fish. However, regardless of the intention of Fishtastic! to compute the ecological costs from all potential impact mechanisms, the cost of predator presence is more closely related to changes in actual numbers of juveniles than are ecological costs related to the facilities' passage efficiency or delay. Predator factors are based empirically upon the presence of adult pikeminnows and striped bass (both known predator species) at various RBDD locations. The cost to migrating juveniles reflects both direct predation (i.e., actual reduction of juveniles from the population), but also other factors, such as energy costs due to predator avoidance, altered feeding behavior, or delayed migration ultimately affecting the viability of the population.

In Step 5, the user selects a general juvenile passage efficiency value for each facility at each month. Because there are not sufficient data to provide species-specific dietary preferences for predators, the passages efficiency values are not species-specific. The efficiency value selected by the user (see Figure 9) for each facility is calculated as the reciprocal of predator presence, where predator presence is determined empirically using predator study data (Vogel et al., 1988). Based on that data, the maximum predator effect is a 55 percent reduction in juvenile passage efficiency, corresponding to a downstream dam passage efficiency value of 0.45.

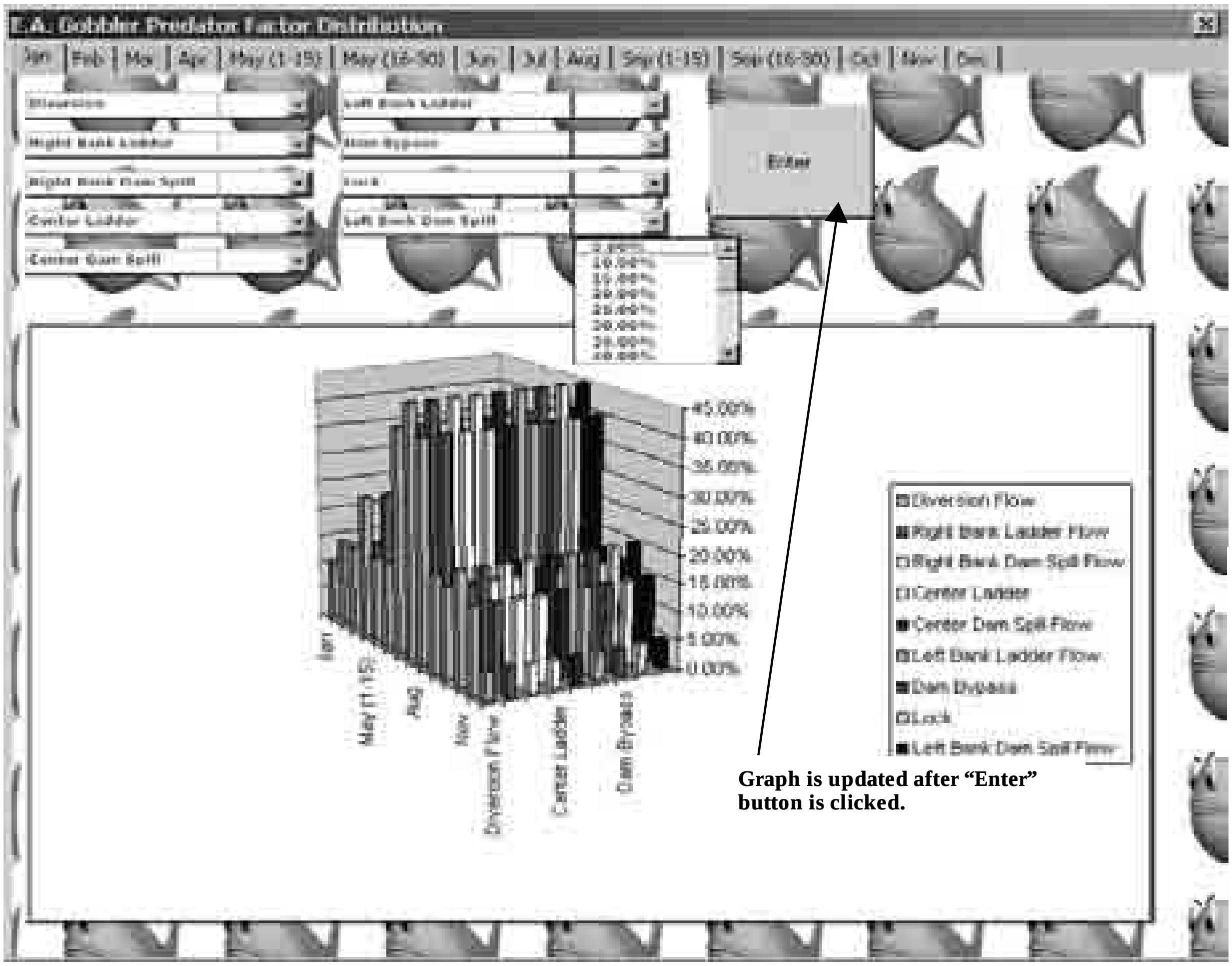


Figure 9. Predator Factor Distributions for Each Month or Half Month Are Entered with Drop-down Menus and Viewed with an Interactive 3-D Graph.

Attachment B2
Results Summary

ATTACHMENT B2

Results Summary

Significance Criteria

For the purposes of distinguishing project alternatives from No Action using the Fishtastic! analysis tool, the following significance criteria were used:

- No Difference in Passage Indices = No change
- Difference in Passage Indices of <10= No measurable impact (-) or benefit (+)
- Difference in Passage Indices of ≥10<25 = Measurable impact (-) or benefit (+)
- Difference in Passage Indices of ≥25 =Large measurable impact (-) or benefit (+)

Native Anadromous Salmonid Species

Adults

The results of the fish passage impact analysis using the Fishtastic! for adult native anadromous salmonid species (NAS) are summarized in Table 1. In all cases, for all species, and all alternatives, the adult passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in measurable adverse impacts to adults of any of the five NAS species. The Gates-out Alternative (or Alternative 3) resulted in no impediment to passage for any species. Therefore, the benefits to all NAS species shown in Table 1 are a result of year-round gates-out operation. Additionally, the analysis indicated there are no measurable impairments to passage from the implementation of any of the alternatives for late-fall chinook salmon (Table 1). Due to this species' life history characteristics, adult late-fall chinook salmon are not immigrating past RBDD during the months of May through September; therefore, there in no passage impediment of migrating adults. The adult passage indices for project alternatives for all NAS species are shown on Figures 1a through 1e. (All figures are located at the end of this attachment; note "Key to Figures" on page B2-10).

The implementation of the 4-month gates-in with new fish ladder (1A) and the 4-month gates-in with bypass channel (1B) alternatives resulted in no measurable improvements for adult passage for any of the five NAS species (Table 1 and Figure 2). The 2-month gates-in with new fish ladder (2A) and 2-month gates-in with existing fish ladders (2B) alternatives provided large measurable differences and improvements for passage of spring-run chinook as compared to the No Action Alternative. The improvement in the passage index difference over that for the No Action Alternative was 41, a 79 percent passage improvement for Alternative 2A. A passage index difference of 40 over that for the No Action Alternative and a 77 percent improvement was seen for Alternative 2B. The monthly adult passage indices for all alternatives for spring-run chinook salmon are shown on Figure 1c.

These results indicate that the alternatives that remove the gates for 2 months, and Gates-out all year are largely beneficial to spring-run chinook. For the Gates-out Alternative, passage conditions improve to a measurable extent for the other adult NAS species compared to the No Action Alternative (Figure 2). As seen on Figure 1b, large improvements in adult spring-run chinook passage are provided by the Alternatives 2A, 2B, and 3 during the May 15 to July 1 period, and additionally during the September 1 to 16 period for the Gates-out Alternative. These improvements for adult passage have crucial implications for adult spring-run chinook salmon that must reach upstream tributary streams before those streams become blocked due to low flows and or high water temperatures. Continued delay and blockage of spring-run chinook salmon at RBDD has severe consequences for this species and may jeopardize its recovery. Action alternatives that remove or greatly reduce impediments to passage for this species would allow adults to successfully pass RBDD in a timely manner.

TABLE 1
Adult Passage Indices, Relative Difference, and the Improvement in Passage Indices for Native Anadromous Salmonid Species between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
Winter-run Chinook Salmon				
No Action	89	n/a	n/a	*n/a*
1A	91	2	2	*No Measurable Benefit*
1B	91	1	1	*No Measurable Benefit*
2A	98	8	9	*No Measurable Benefit*
2B	98	8	9	*No Measurable Benefit*
3	100	10	12	*Measurable Benefit*
Spring-run Chinook Salmon				
No Action	52	n/a	n/a	*n/a*
1A	61	8	16	*No Measurable Benefit*
1B	57	5	9	*No Measurable Benefit*
2A	94	41	79	*Large Measurable Benefit*
2B	93	40	77	*Large Measurable Benefit*
3	100	48	91	*Large Measurable Benefit*
Fall-run Chinook Salmon				
No Action	83	n/a	n/a	*n/a*
1A	86	3	4	*No Measurable Benefit*
1B	85	2	2	*No Measurable Benefit*
2A	91	8	8	*No Measurable Benefit*
2B	89	6	8	*No Measurable Benefit*
3	100	17	20	*Measurable Benefit*
Late-fall run Chinook Salmon				
No Action	100	n/a	n/a	*n/a*
1A	100	0.0	0.0	*No change*
1B	100	0.0	0.0	*No change*
2A	100	0.0	0.0	*No change*
2B	100	0.0	0.0	*No change*
3	100	0.0	0.0	*No change*
Steelhead				
No Action	89	n/a	n/a	*n/a*
1A	91	2	2	*No Measurable Benefit*
1B	90	1	1	*No Measurable Benefit*
2A	97	8	9	*No Measurable Benefit*
2B	96	7	8	*No Measurable Benefit*
3	100	11	12	*Measurable Benefit*

Juveniles

The results of the analysis of the juvenile passage indices for NAS species are summarized in Table 2 and Figures 3a through 3e. In all cases, for all species and all alternatives, the juvenile passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in measurable adverse impacts to juveniles of any of the NAS species. However, while the indices indicated differences in passage indices, juvenile passage for the NAS species did not measurably benefit from any of the alternatives compared to the No Action Alternative (Figure 4). For the 4-month Alternative, the annual juvenile passage indices for NAS species, compared to No Action, would remain unchanged. For the 2-month Alternative, the differences (improvements) in the annual juvenile passage indices for NAS species, compared to the No Action Alternative, were from less than 1 to approximately 6, depending on species. Similarly, for the Gates-out Alternative, the difference (improvement) in the annual juvenile passage indices were only from less than 1 to approximately 8 compared to the No Action Alternative (Table 2). None of the alternatives would measurably improve (<10 percent improvement) the passage of juveniles compared to the No Action Alternative (Figure 4). These results are due to the life history characteristics of these species. Compared to other periods of the year, relatively few NAS juveniles pass RBDD during the current operational period (mid-May to mid-September).

With the implementation of the Gates-out Alternative, the passage indices for juvenile NAS species would be maximized. While the juvenile passage indices for this alternative were not measurably greater than those for the No Action Alternative, there were some passage benefits for juveniles of NAS species during the mid-May through mid-September period (Table 2 and Figures 3a through 3e). These are small to moderate passage improvements for juvenile salmonids during this 4-month operational period.

TABLE 2
Juvenile Passage Indices, Relative Difference, and the Improvement in Passage Indices for Native Anadromous Salmonid Species between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
Winter-run Chinook Salmon				
No Action	96	n/a	n/a	*No Change*
4-month Gates-in	96	0	0	*No Change*
2-month Gates-in	99	3	3	*No Measurable Benefit*
Gates-out	100	4	4	*No Measurable Benefit*
Spring-run Chinook Salmon				
No Action	100	n/a	n/a	*No Change*
4-month Gates-in	100	0	0	*No Change*
2-month Gates-in	100	0	0	*No Change*
Gates-out	100	0	0	*No Change*

TABLE 2
Juvenile Passage Indices, Relative Difference, and the Improvement in Passage Indices for Native Anadromous Salmonid Species between No Action and the Action Alternatives.

Fall-run Chinook Salmon				
No Action	97	n/a	n/a	*No Change*
4-month Gates-in	97	0	0	*No Change*
2-month Gates-in	100	2	2	*No Measurable Benefit*
Gates-out	100	3	3	*No Measurable Benefit*
Late-fall run Chinook Salmon				
No Action	93	n/a	n/a	*No Change*
4-month Gates-in	93	0	0	*No Change*
2-month Gates-in	98	4	5	*No Measurable Benefit*
Gates-out	100	7	7	*No Measurable Benefit*
Steelhead				
No Action	92	n/a	n/a	*No Change*
4-month Gates-in	92	0	0	*No Change*
2-month Gates-in	99	6	7	*No Measurable Benefit*
Gates-out	100	8	8	*No Measurable Benefit*

Other Native Anadromous Species

Adults

The results of the adult fish passage analysis for other native anadromous (NAO) species are summarized in Table 3. The Gates-out Alternative resulted in no impediments to passage to any of the three NAO species. This is a result of a year-round gates-out operation. There was no change from the No Action Alternative for adult green sturgeon passage with Alternative 1A. It was assumed that ladders would not assist adults of this species (Table 3) and Figure 5. The analysis indicated there is no measurable difference from the No Action Alternative for the adult green sturgeon passage index with the implementation of Alternative 1B. The improvement in the adult green sturgeon passage index for Alternative 1B is approximately 6 percent when compared to the No Action Alternative. It was assumed that adult green sturgeon would be able to use the bypass channel to some extent to move past RBDD. However, due to the uncertainty of the success of this species in passing through an artificial channel, its passage index increased by only a small increment (Figure 6). The majority of adult green sturgeon migrate past RBDD during the months of April through the end of June. Therefore, the removal of the dam gates with the implementation of Alternatives 2A, 2B, and 3 greatly improves (54 percent greater than the No Action Alternative) the annual passage indices for adult green sturgeon (Figure 6). Both of the

2-month alternatives and the Gates-out Alternative result in unimpaired passage for adults of this species.

The changes in adult passage indices for Pacific and river lamprey are shown in Table 3. Unlike green sturgeon, passage indices for both lamprey species would increase with the construction of new ladders in Alternative 1B (Figures 7a and 7b). However, there are only small improvements in passage indices, and these are not measurably different from the No Action Alternative. Similarly, the passage indices for both lamprey species also improved from the No Action Alternative, but not measurably, for Alternative 1B. This is because of the uncertainty of use of the bypass by the lamprey species. Measurable passage improvement (approximately 16 to 17 percent) from the No Action Alternative for adult Pacific and river lamprey would result from Alternatives 2A and 2B (Table 3 and Figures 7a and 7b). The Gates-out year round alternative would remove all passage impedance for adult lampreys and would result in an annual improvement of approximately 20 percent over the No Action Alternative (Table 3 and Figure 8 and 9).

The summary of the changes in adult passage occurring during the 4-month operational period (mid-May to mid-September) for the three NAO species is shown in Table 3. As discussed above, the passage of adult green sturgeon greatly improves during the period from mid-May through mid-September for Alternatives 2A, 2B, and 3. During this period, the percent passage improvements for adult lamprey for both of the 2-month gates-in alternatives and the Gates-out Alternative are measurably large (Figure 8). However, these results are numerically misleading. The potential numerical difference in the adult lamprey passage indices for the 2-month and Gates-out alternatives is an increase in passage index value of up to 25 (from approximately 8 for the No Action Alternative) for a maximum index difference of 17. Therefore a passage index improvement of approximately 14 results in a extremely large numerical improvement (172 percent improvement) for this 4-month period as shown on Figure 8. However, the actual increment of passage improvement during the 4-month period is rather small.

In summary, passage conditions for adult green sturgeon largely benefit from Alternatives 2A, 2B, and 3 resulting in unimpeded passage. Adult lamprey of both species also benefit from all of these alternatives, but to a lessor extent than green sturgeon. This is principally because these species pass RBDD on their upstream migration at times outside of when the RBDD gates are in. All of the NAO species would pass unimpeded with the Gates-out Alternative.

TABLE 3
Adult Passage Indices, Relative Difference, and the Improvement in Passage Indices for Other Native Anadromous Species between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
Green Sturgeon				
No Action	65	n/a	n/a	*n/a*
1A	65	0	0[a]	*No Change*
1B	69	4	6	*No Measurable Benefit*
2A	100	35	54	*Large Measurable Benefit*
2B	100	35	54	*Large Measurable Benefit*
3	100	35	54	*Large Measurable Benefit*

(a) % improvement cannot be calculated.

TABLE 3
Adult Passage Indices, Relative Difference, and the Improvement in Passage Indices for Other Native Anadromous Species between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
Pacific Lamprey				
No Action	83	n/a	n/a	*No Change*
1A	86	3	4	*No Measurable Change*
1B	85	2	2	*No Measurable Change*
2A	97	14	17	*Measurable Benefit*
2B	96	13	16	*Measurable Benefit*
3	100	17	20	*Measurable Benefit*
River Lamprey				
No Action	83	n/a	n/a	*No Change*
1A	86	3	4	*No Measurable Change*
1B	85	2	2	*No Measurable Change*
2A	97	14	17	*Measurable Benefit*
2B	96	13	16	*Measurable Benefit*
3	100	17	20	*Measurable Benefit*

Juveniles

There would be no benefit to juvenile green sturgeon from the 4-month Alternative (Table 4). This is due to no change in RBDD gate operations or a resulting reduction in predation of juvenile green sturgeon by Sacramento pikeminnow or striped bass. However, juvenile green sturgeon would measurably benefit from reductions in predation from congregations of pikeminnows and striped bass when the gates are removed under the 2-month (21 percent improvement) and Gates-out (38 percent improvement) alternatives (Table 4). The improvement in downstream passage for juvenile green sturgeon is a measurable benefit for the 2-month Alternative and a large measurable benefit for Gates-out Alternative. The passage improvements for juvenile green sturgeon are shown on Figure 9 (entire year) and Figure 10 (mid-May to mid-September).

Yearly passage indices for downstream migrating Pacific and river lamprey transformers are shown on Figure 11. The differences between the No Action Alternative and project alternatives for lamprey transformers are summarized in Table 4. The 4-month Alternative results in no benefit to either of these species as there is no change in predation or passage of predators congregating downstream of the RBDD. For the 2-month and 4-month alternatives, the passage indices for Pacific lamprey transformers improves, but not measurably (Figure 9). This is principally due to the passage timing of transformers of this species in which greater than 99 percent move downstream prior to mid-May. However, the passage index for river lamprey transformers is measurably greater than that of the No Action Alternative (an increase in the passage index of approximately 13) for both the 2-month and the Gates-out alternatives (Table 4 and Figure 9). This species benefits from these two alternatives due to its outmigration timing in which a substantial portion pass RBDD after mid-May and prior to September 15 of each year.

In summary, with the implementation of the Gates-out Alternative, the yearly juvenile passage indices for NAO species would be maximized, and passage would be unimpeded.

Juvenile green sturgeon and river lamprey transformers would measurably benefit from reductions of predation downstream of RBDD for the 2-month as well as the Gates-out alternatives.

Resident Native Species

Adults

The results of the fish passage impact analysis using the Fishtastic! tool for adult resident rainbow trout are summarized in Table 5. Adult rainbow trout passage indices for all alternatives are shown on Figure 12. For all alternatives, the adult passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in measurable adverse impacts to adult rainbow trout. The Gates-out Alternative resulted in no impediment to passage for this species. A 37 percent improvement in adult passage index for the Gates-out Alternative is a result of year-round gates-out operation (Figure 13). Alternatives 1A and 1B resulted in small differences (<7 percent) in passage indices from the No Action Alternative. These alternatives would provide no measurable benefit for adult rainbow trout populations (Figure 13).

TABLE 4
Juvenile and Transformer Passage Indices, Relative Difference, and the Improvement in Passage Indices for Other Native Anadromous Species between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
Green Sturgeon Juveniles				
No Action	73	n/a	n/a	*n/a*
4-month Gates-in	73	0	0	*No Change*
2-month Gates-in	88	15	21	*Measurable Benefit*
Gates-out	100	27	38	*Large Measurable Benefit*
Pacific Lamprey Transformers				
No Action	99	n/a	n/a	*n/a*
4-month Gates-in	99	0	0	*No Change*
2-month Gates-in	100	1	1	*No Measurable Benefit*
Gates-out	100	1	1	*No Measurable Benefit*
River Lamprey Transformers				
No Action	87	n/a	n/a	*n/a*
4-month Gates-in	87	0	0	*No Change*
2-month Gates-in	100	13	15	*Measurable Benefit*
Gates-out	100	13	15	*Measurable Benefit*

Measurable improvements in adult passage indices, from the No Action Alternative, occurred for both Alternatives 2A and 2B (Table 5). Approximately 25 percent improvement in annual adult passage resulted for Alternative 2A. Similarly, a passage improvement of 23 percent over that for the No Action Alternative occurred for Alternative 2B (Figure 13). The small difference in the benefits to adult passage between these two alternatives occurred as a result of the new ladder component of Alternative 2A. The passage benefit to adult rainbows principally occurred during the period from May 16 through June 30 (Figure 12), with a lesser improvement for the July 1 through September 15 period.

Juveniles

The results of the analysis of the annual juvenile passage indices for rainbow trout are summarized in Table 6. The annual juvenile rainbow trout passage indices for all alternatives are seen on Figure 14. In all cases, for all alternatives, the juvenile passage indices were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in measurable adverse impacts to juvenile rainbow trout. However, while the results indicated differences (improvement) in annual passage indices compared to the No Action Alternative for the 2-month an the Gates-out alternatives, juvenile passage for this species did not measurably benefit (Figure 15).

TABLE 5
Adult Passage Indices, Relative Difference, and the Improvement in Passage Indices for Resident Rainbow Trout between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
No Action	73	n/a	n/a	*n/a*
1A	78	5	7	*No Measurable Change*
1B	76	3	4	*No Measurable Benefit*
2A	91	18	25	*Measurable Benefit*
2B	90	17	23	*Measurable Benefit*
3	100	27	37	*Large Measurable Benefit*

TABLE 6
Juvenile Passage Indices, Relative Difference, and the Improvement in Passage Indices for Resident Rainbow Trout between No Action and the Action Alternatives.

Alternative	Index Value	Difference	% Improvement	Effect on Species
No Action	92	n/a	n/a	*n/a*
4-month Gates-in	92	0	0	*No Change*
2-month Gates-in	99	6	7	*No Measurable Benefit*
Gates-out	100	8	8	*No Measurable Benefit*

Summary

The analysis of adult and juvenile fish passage at RBDD indicated several benefits for fish passing RBDD. The discussion below summarizes the overall outcome of this analysis by fish assemblages. In all cases, for all species and all alternatives, the adult and juvenile passage indices generated using the Fishtastic! tool were equal to or greater than those for the No Action Alternative. Therefore, no alternative resulted in measurable adverse impacts to adults or juveniles of any of the species analyzed.

Native Anadromous Salmonid Species

The analysis revealed that passage for adult late-fall chinook salmon were unaffected by any proposed alternative compared to the No Action Alternative. This is due to characteristics of this species' life history, for they migrate past RBDD from October through April – outside the period of gates-in operations at RBDD. The results also indicated that the alternatives that removed the gates for 2 months and the gates-out all year operation are highly beneficial to spring-run chinook. Alternatives 2A, 2B, and 3 provided large improvements in passage for adult spring-run chinook salmon compared to the No Action Alternative (79 percent, 77 percent, and 91 percent improvement, respectively). The improvements in passage provided by these alternatives are especially important to this species. Spring-run chinook salmon must reach upstream tributary streams (e.g., Cottonwood, Clear, and Battle creeks) to successfully migrate into their cool headwater reaches prior to the occurrence of inhospitable water temperature and discharge conditions. Alternatives 2A, 2B, and 3 would provide that opportunity.

Only small improvements in adult passage of NAS species resulted from Alternatives 1A and 1B. The new fish ladder and/or bypass channel components of these alternatives provided only small incremental improvement in passage. Alternatives 2A, 2B, and 3 provided somewhat better passage conditions due to gates-out operations, but again provided only small benefits for the other chinook salmon and steelhead species.

Juveniles of NAS species did not measurably benefit from any of the alternatives compared to the No Action Alternative. Juvenile passage indices for these species for all proposed alternatives were generally less than 5 percent greater than those for the No Action Alternative. This is principally due to life history characteristics of NAS juveniles in which their out-migration occurs at times when the RBDD gates are not in operation. In the case of juvenile winter-run chinook salmon, large numbers begin to occur near RBDD during the later portion of the gates-in operations but predator species have correspondingly dispersed. Therefore, numerically small benefits in the juvenile passage index were shown for that species.

Other Native Anadromous Species

Adult green sturgeon did not measurably benefit from Alternatives 1A and 1B. However, gates-out operations for Alternatives 2A and 2B provided conditions for unimpeded passage through RBDD and Lake Red Bluff. Due to adult green sturgeons' life history and passage timing at RBDD, the additional period of gates-out for the Gates-out Alternative provided no additional passage benefit beyond that afforded from Alternatives 2A and 2B.

Passage for adult river lamprey and Pacific lamprey measurably benefited from Alternatives 2A, 2B, and 3. For both species, approximately 20 percent improvement in passage occurred with the Gates-out Alternative.

Passage of green sturgeon juveniles and river lamprey transformers measurably improved for the 2-month Alternative. Passage conditions (as reflected in the passage index) for juvenile green sturgeon greatly improved with a gates-out operation due to this species' life history pattern of presence near RBDD in July and August. River lamprey transformers also measurably benefited for the Gates-out Alternative, but not to the extent that green sturgeon juveniles did.

Resident Native Species

Rainbow trout was the only resident native species analyzed using the Fishtastic! tool. The results of the analyses of passage for this species indicated that all alternatives provided some additional increase in passage for adults of this species. However, only Alternatives 2A, 2B, and 3 had passage indices that were measurably greater than the No Action Alternative. Of these alternatives, the Gates-out Alternative provided a large measure of improvement over that for the No Action Alternative. The biological importance of these improvements are unclear as adults of this species, during the months of RBDD operation, are not obligated to migrate upstream of RBDD as are adult salmon or steelhead. Except for periods when summer water temperatures could exceed lethal thresholds, adult rainbow trout would not be adversely affected by delay or blockage currently created by operations of RBDD.

Juvenile passage of rainbow trout was not measurably different for any of the proposed alternatives compared to the No Action Alternative. This is principally due to life history characteristics of the species in that they generally pass RBDD during periods when RBDD gates are out or during periods when predation is potentially reduced (August and September).

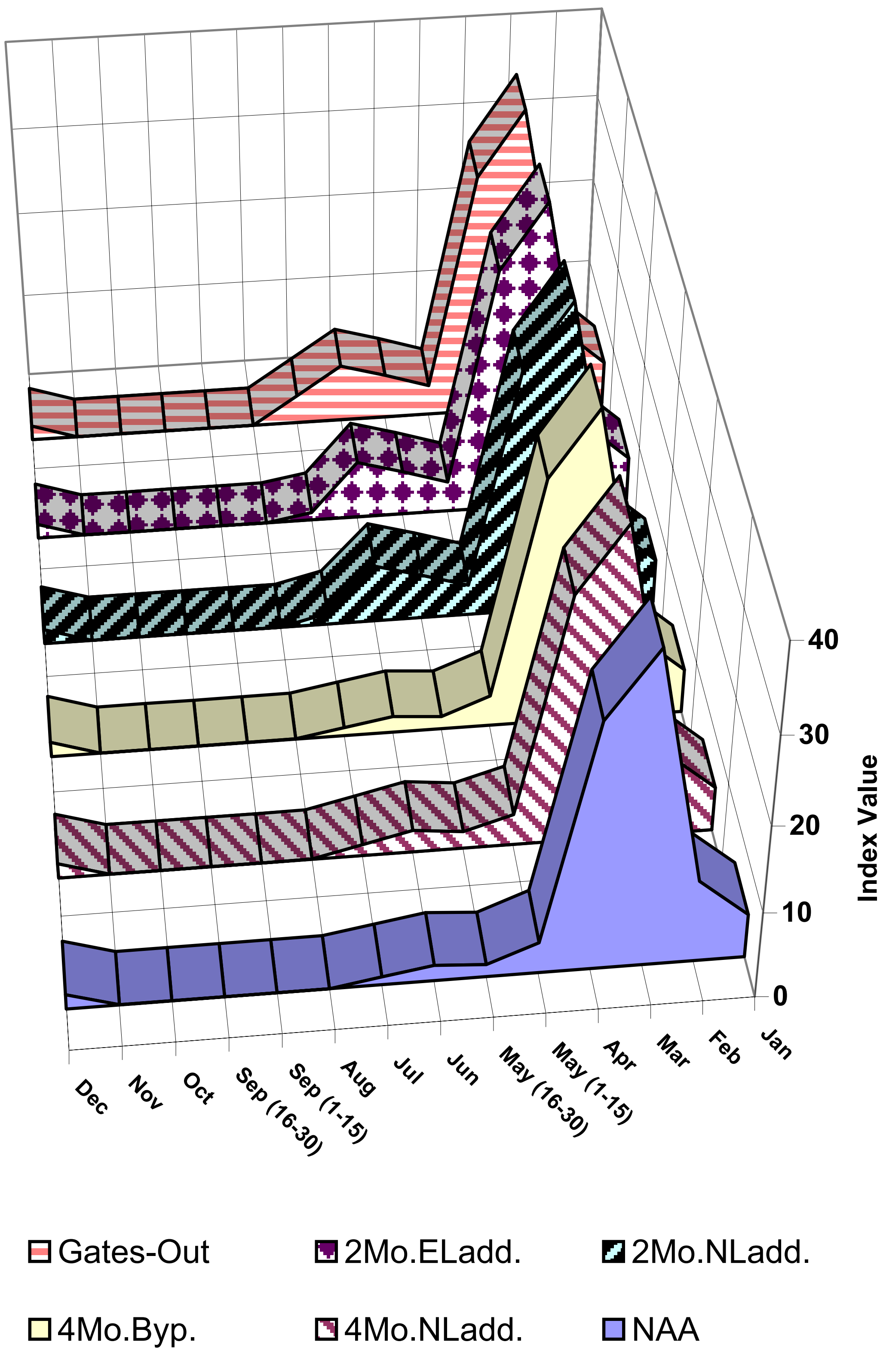
Key to Figures

The figure legends reference the alternatives differently than previous text. A key is provided below.

Alternatives

Referenced on Figure as:	Referenced in Text as:
NAA	No Action
4Mo.NLadd.	1A or 4-month Improved Ladder
4Mo.Byp.	1B or 4-month Bypass
2Mo.NLadd.	2A or 2-month Improved Ladder
2Mo.ELadd.	2B or 2-month with Existing Ladders
Gates-Out	3 or Gates-out
4 Mo.	1 or 4-month Gates-in
2 Mo.	2 or 2-month Gates-in

Figure 1a. Adult Winter-run Chinook Salmon Passage Indices



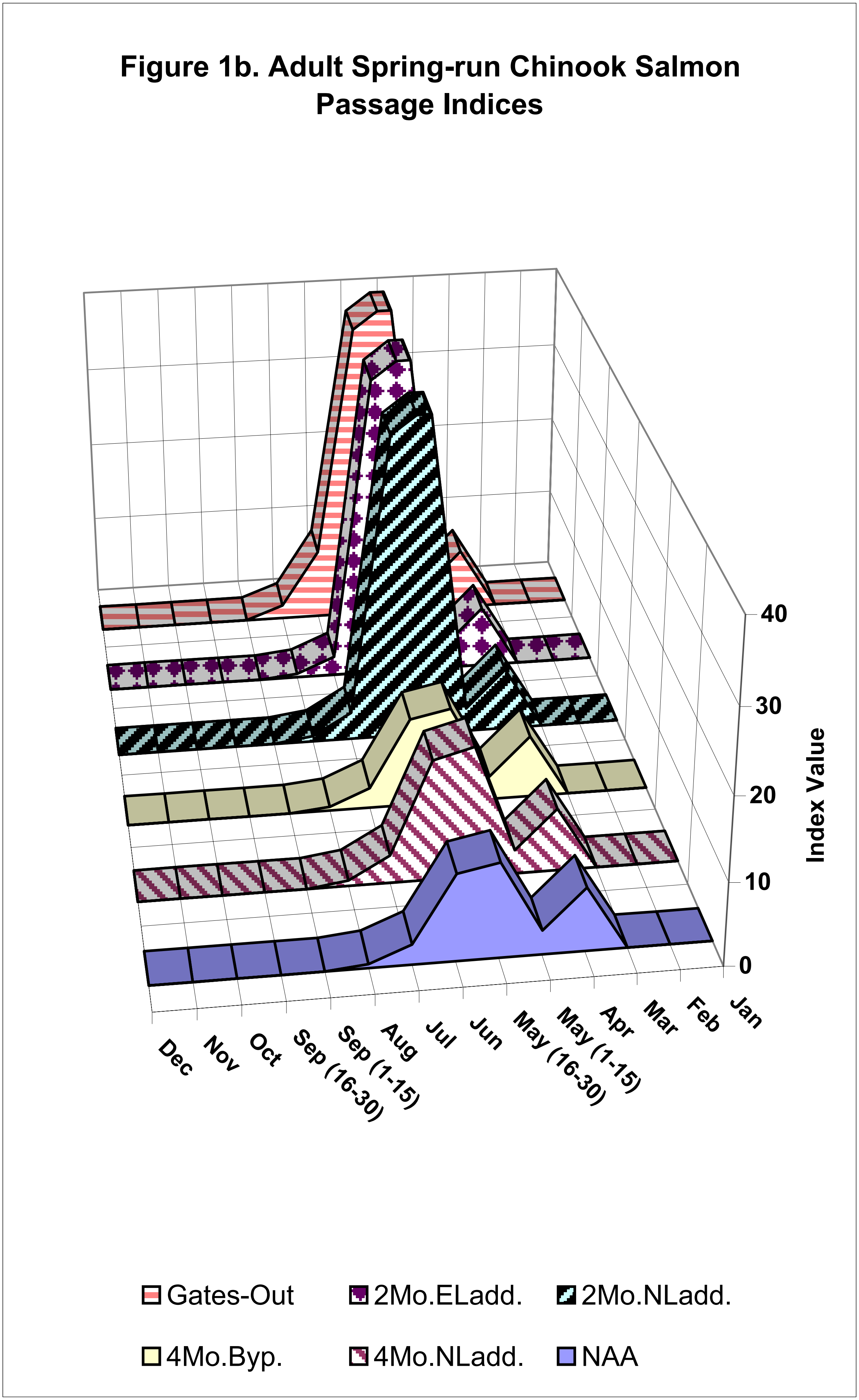


Figure 1b. Adult Spring-run Chinook Salmon
Passage Indices
40
30
20
10
0
Index Value
Dec
Nov
Oct
Sep (16-30)
Sep (1-15)
Aug
Jul
Jun
May (16-30)
May (1-15)
Apr
Mar
Feb
Jan
Gates-Out
2Mo.ELadd.
2Mo.NLadd.
4Mo.Byp.
4Mo.NLadd.
NAA

Figure 1c. Adult Fall-run Chinook Salmon Passage Indices

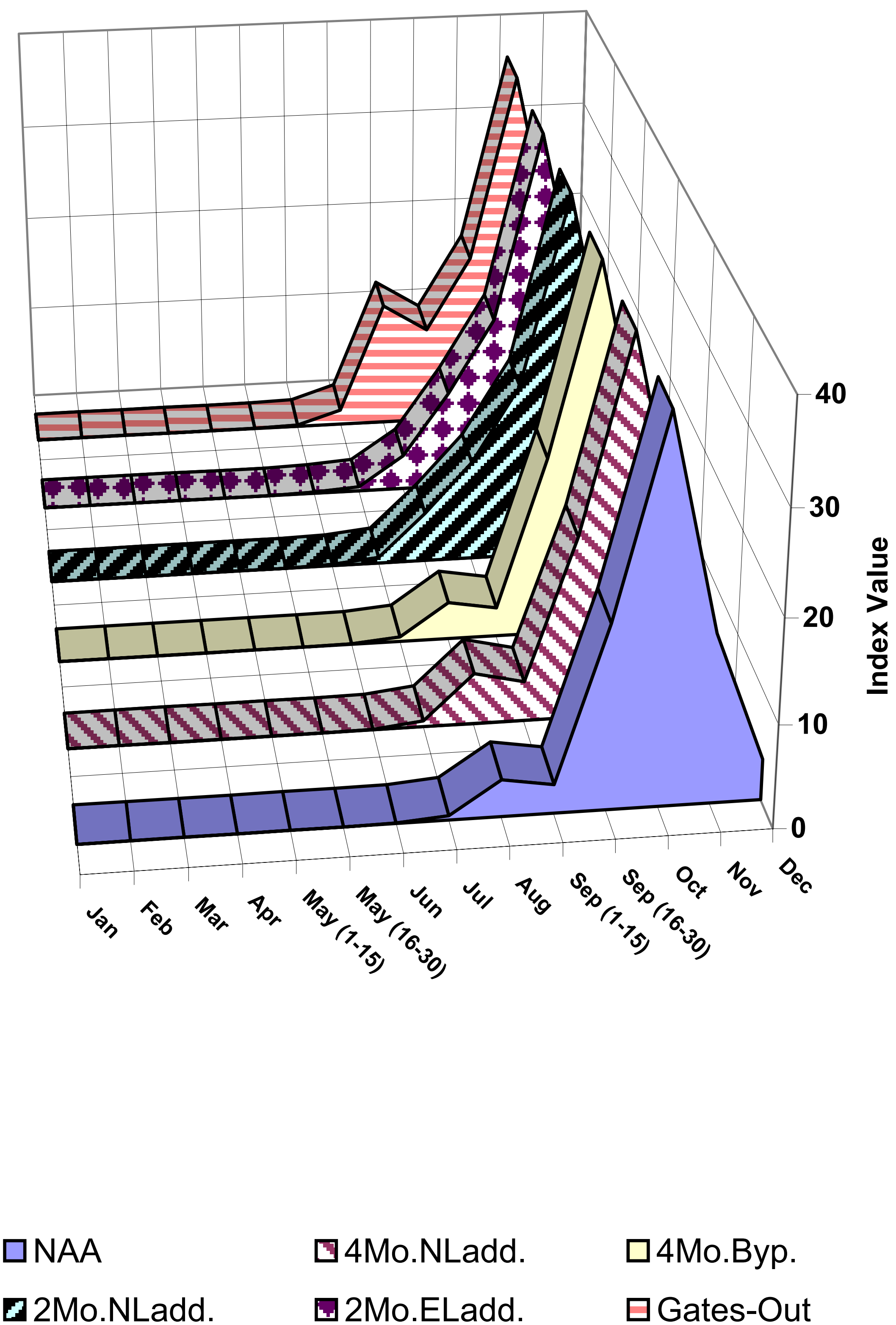


Figure 1d. Adult Late-fall-run Chinook Salmon Passage Indices

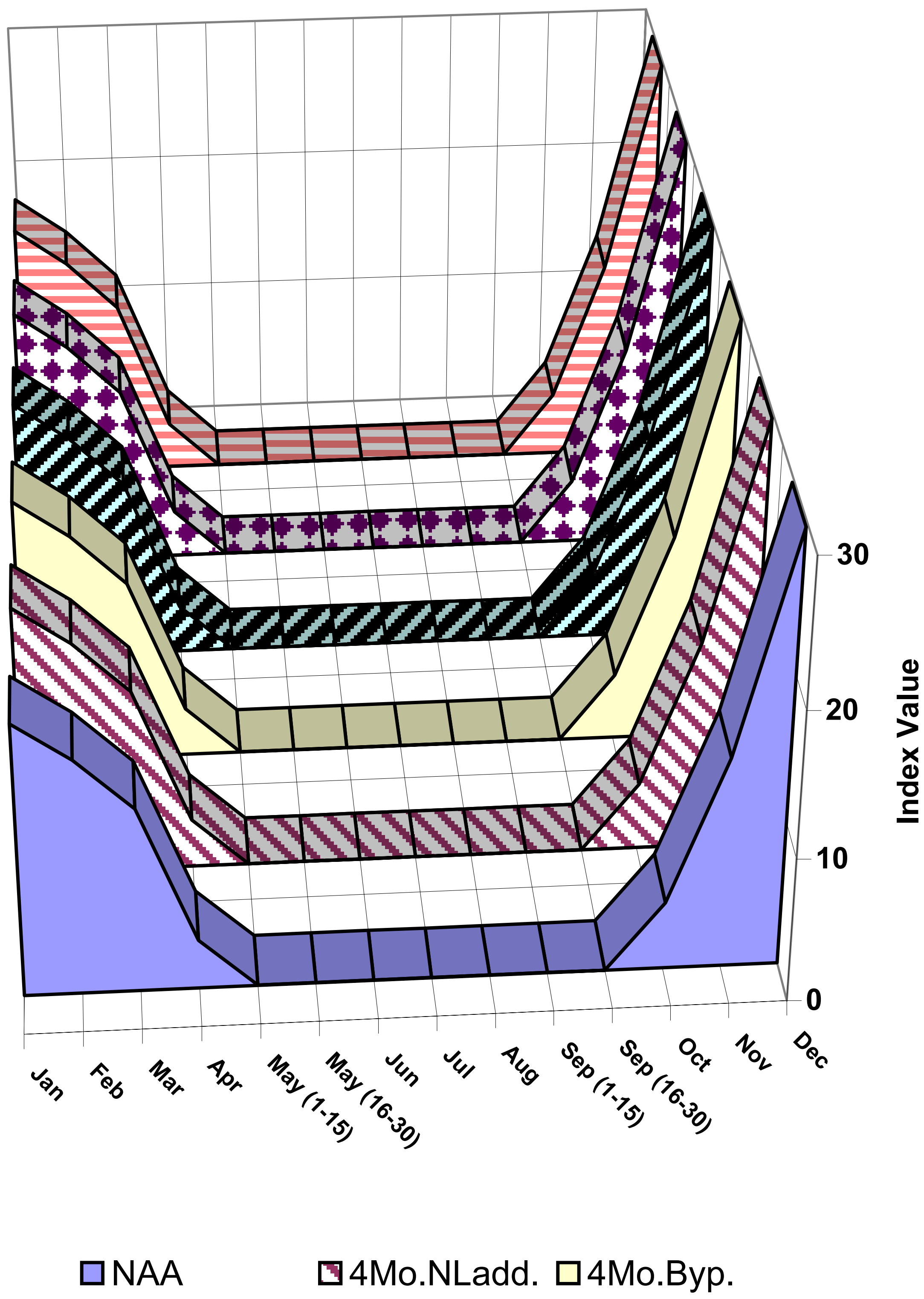


Figure 1e. Adult Steelhead Passage Indices

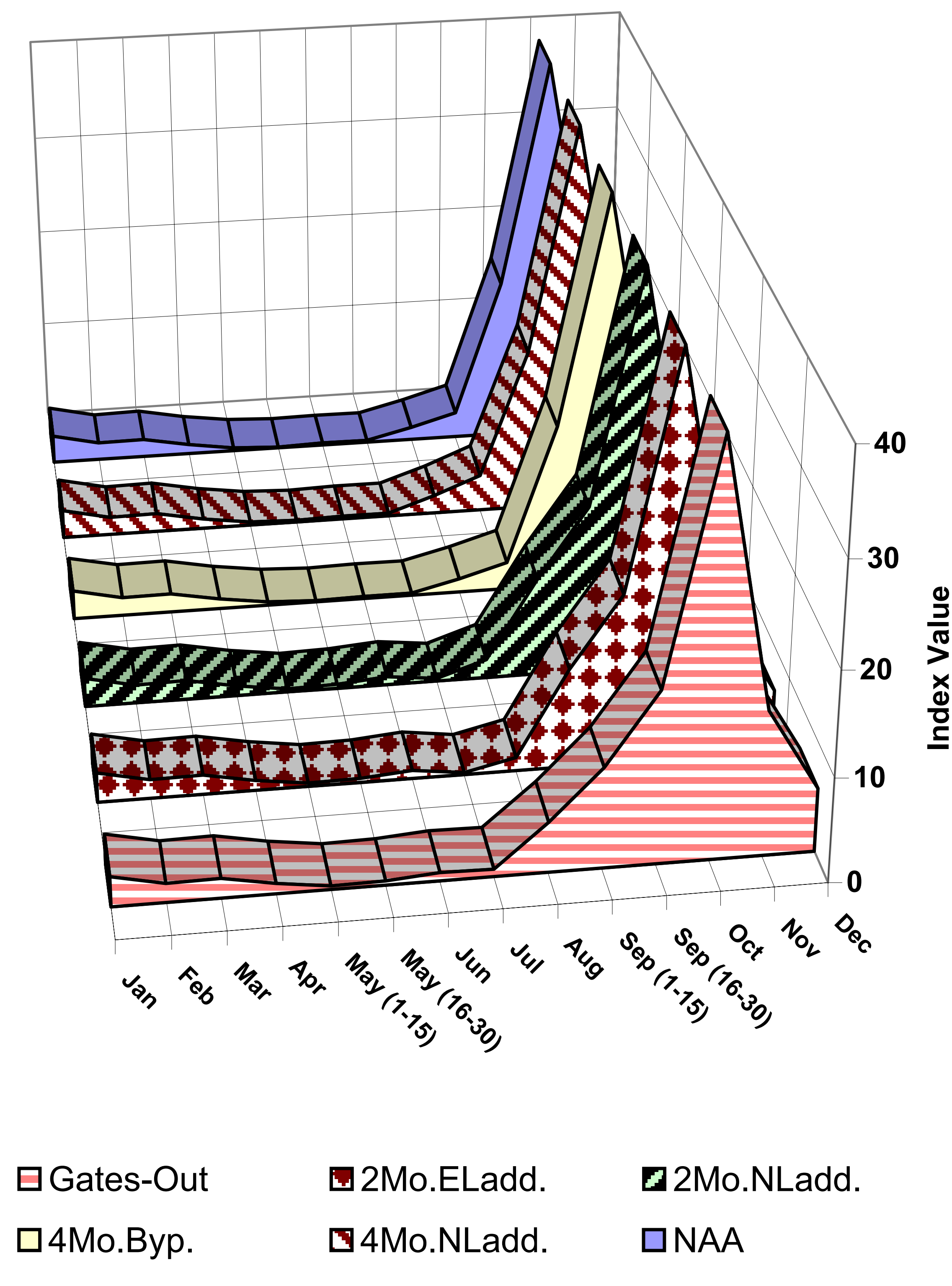
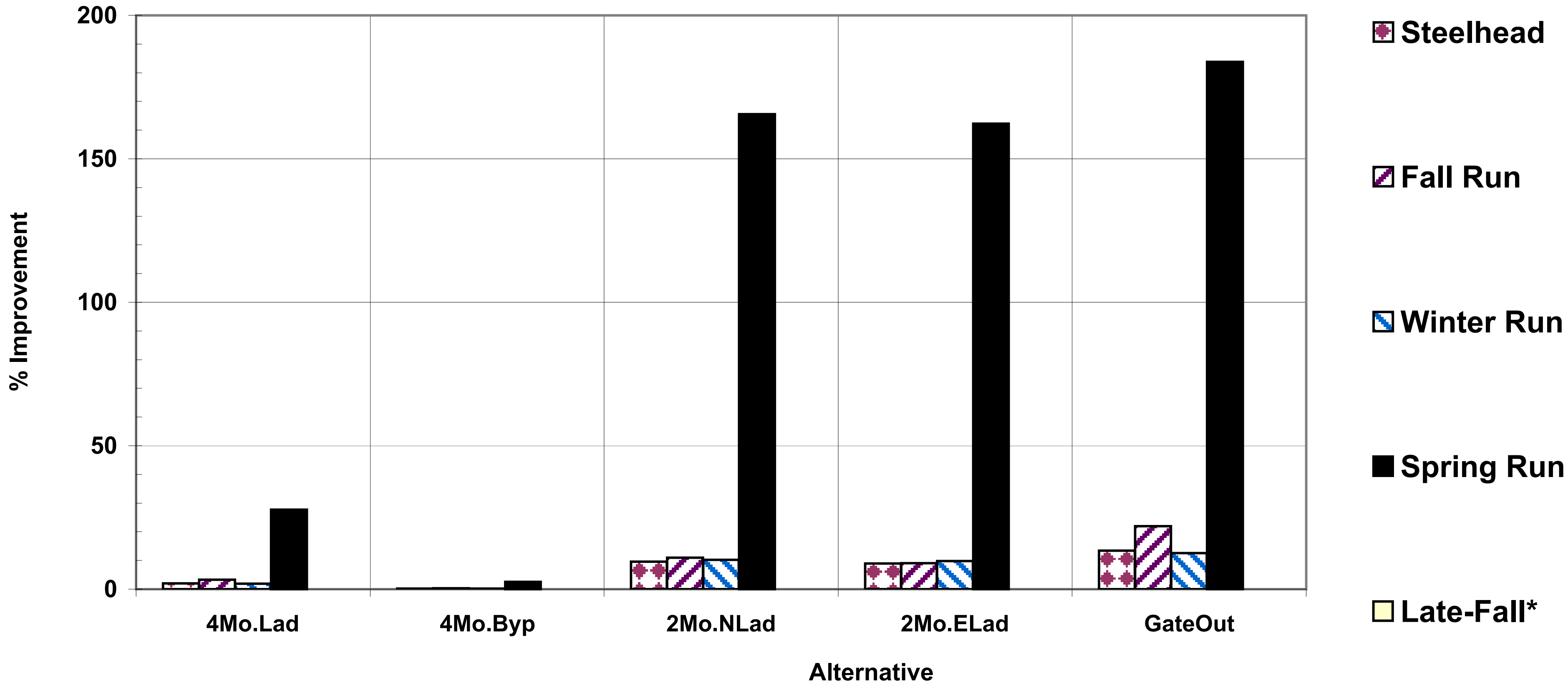


Figure 2. Relative Adult Passage Index Improvement from No Action for the Entire Year



** No impairment to the species and no change compared to No Action.*

Figure 3a. Juvenile Winter-run Chinook Salmon Passage Indices

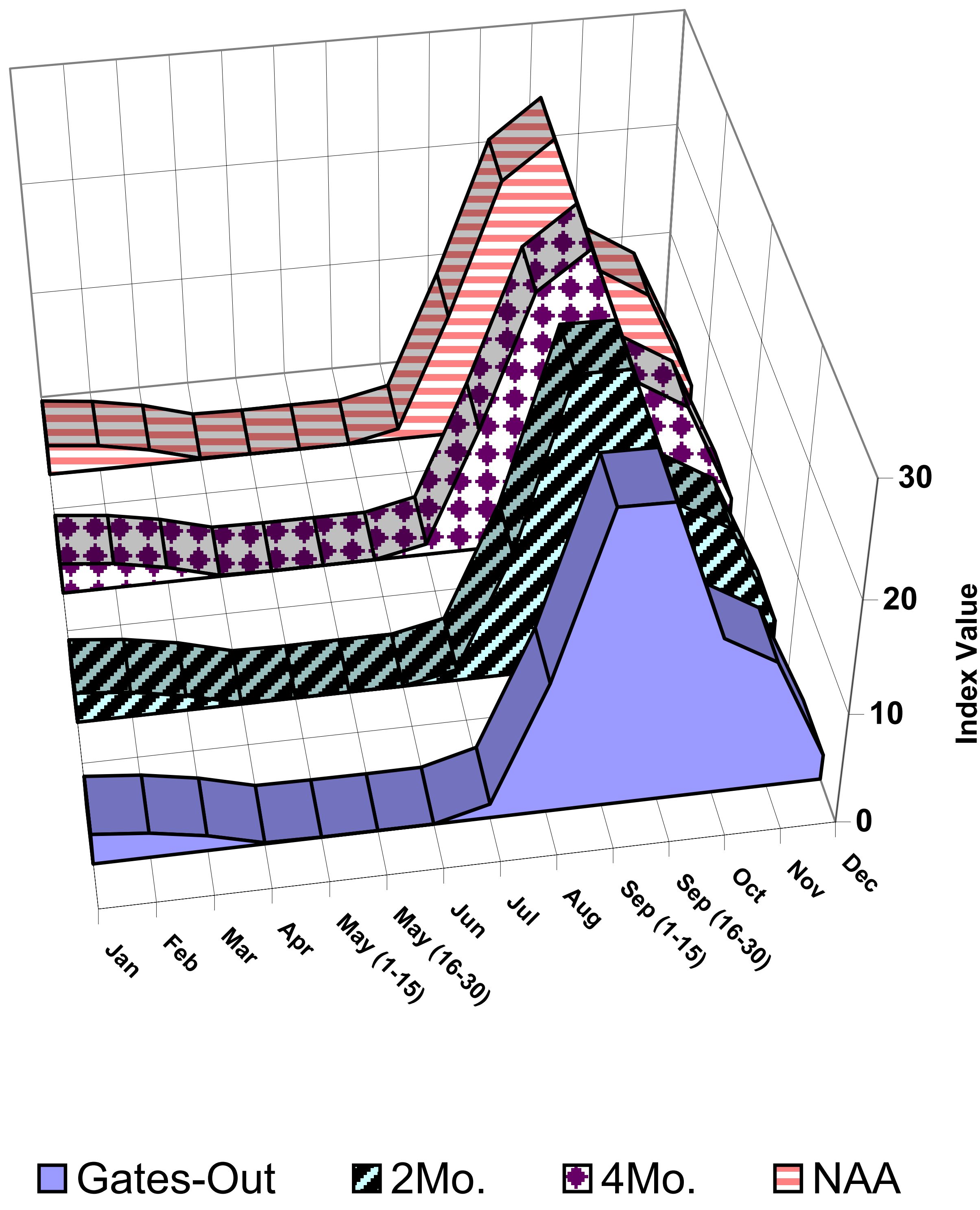


Figure 3b. Juvenile Spring-run Chinook Salmon Passage Indices

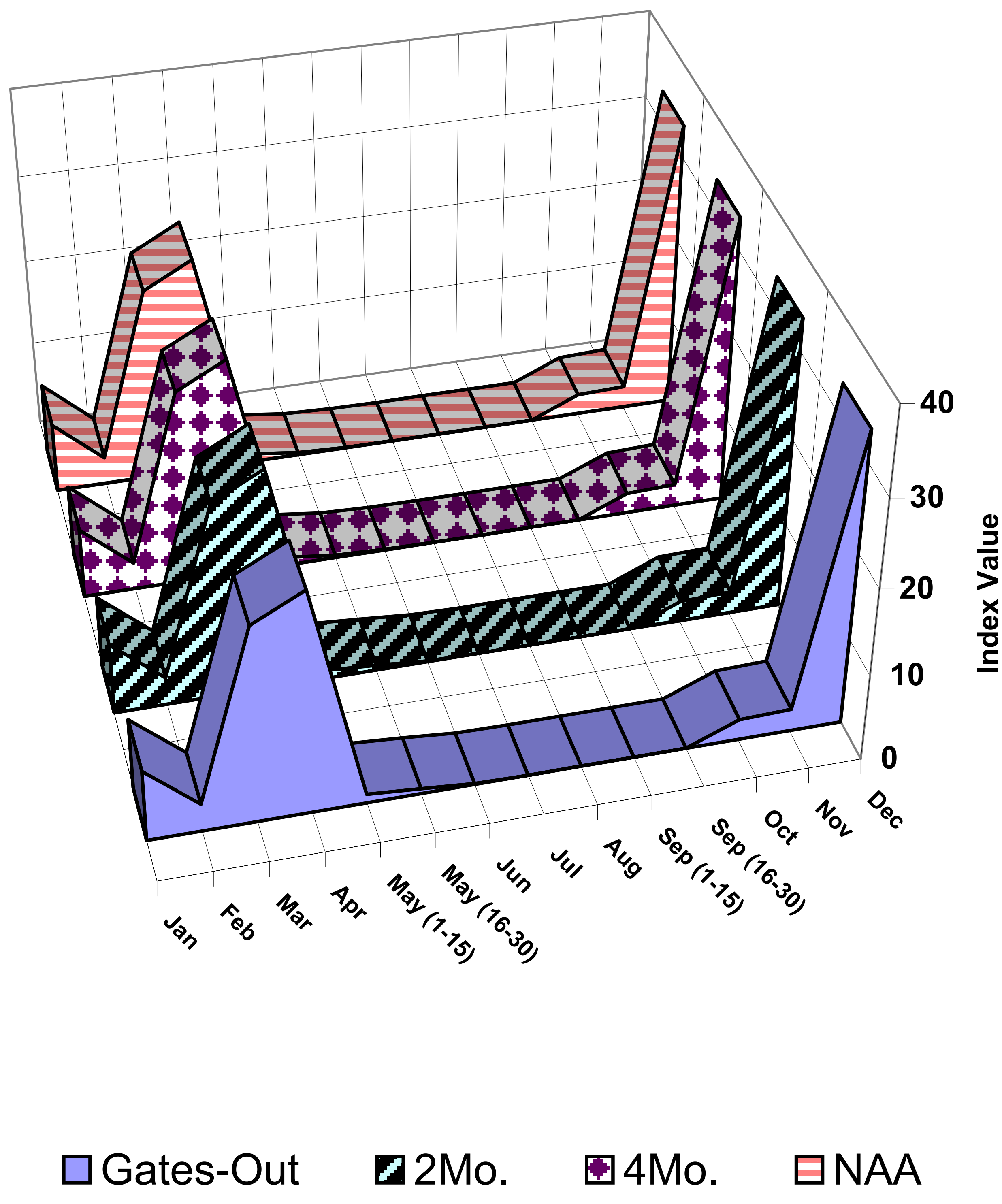


Figure 3c. Juvenile Fall-run Chinook Salmon Passage Indices

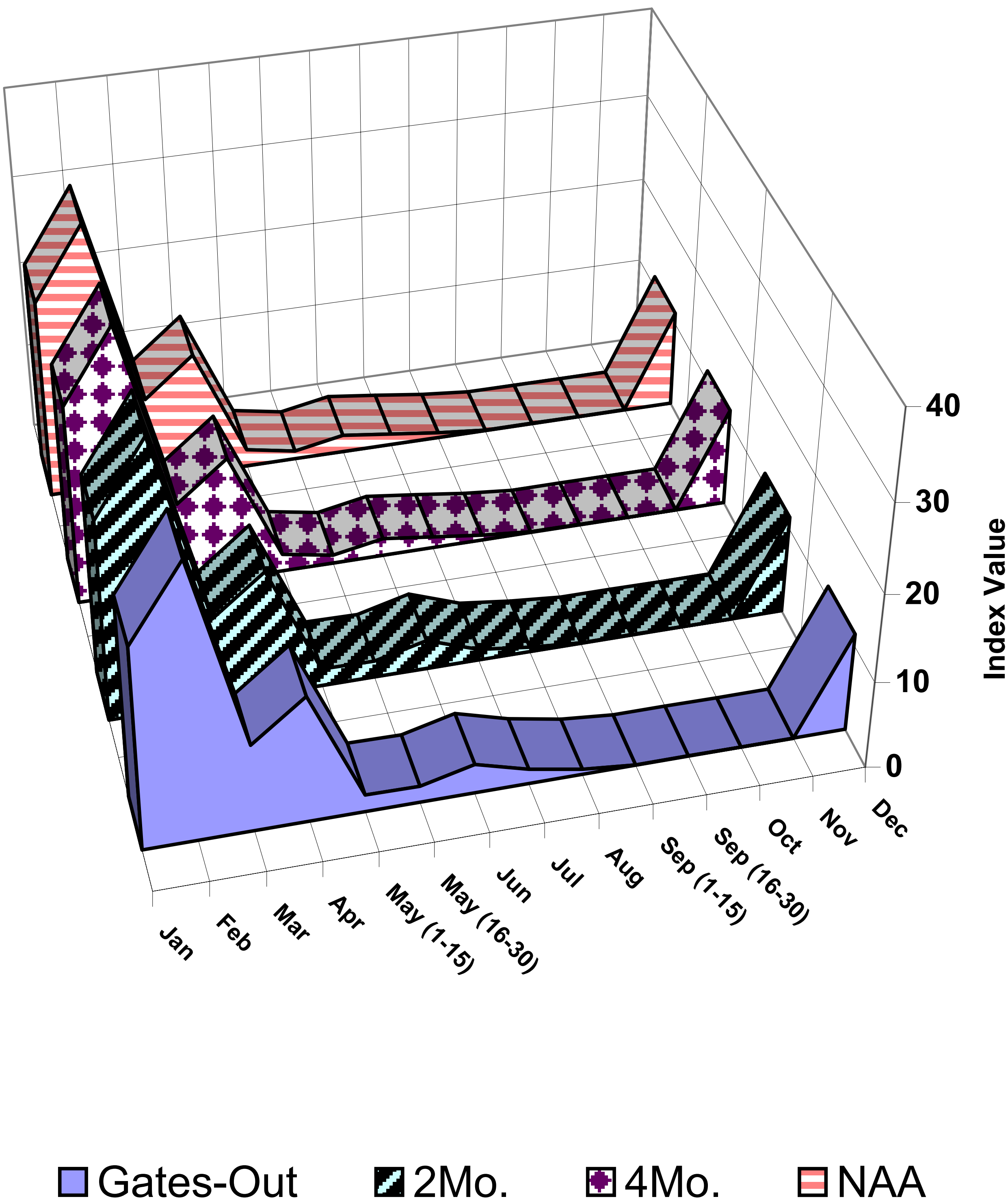


Figure 3d. Juvenile Late-fall-run Chinook Salmon Passage Indices

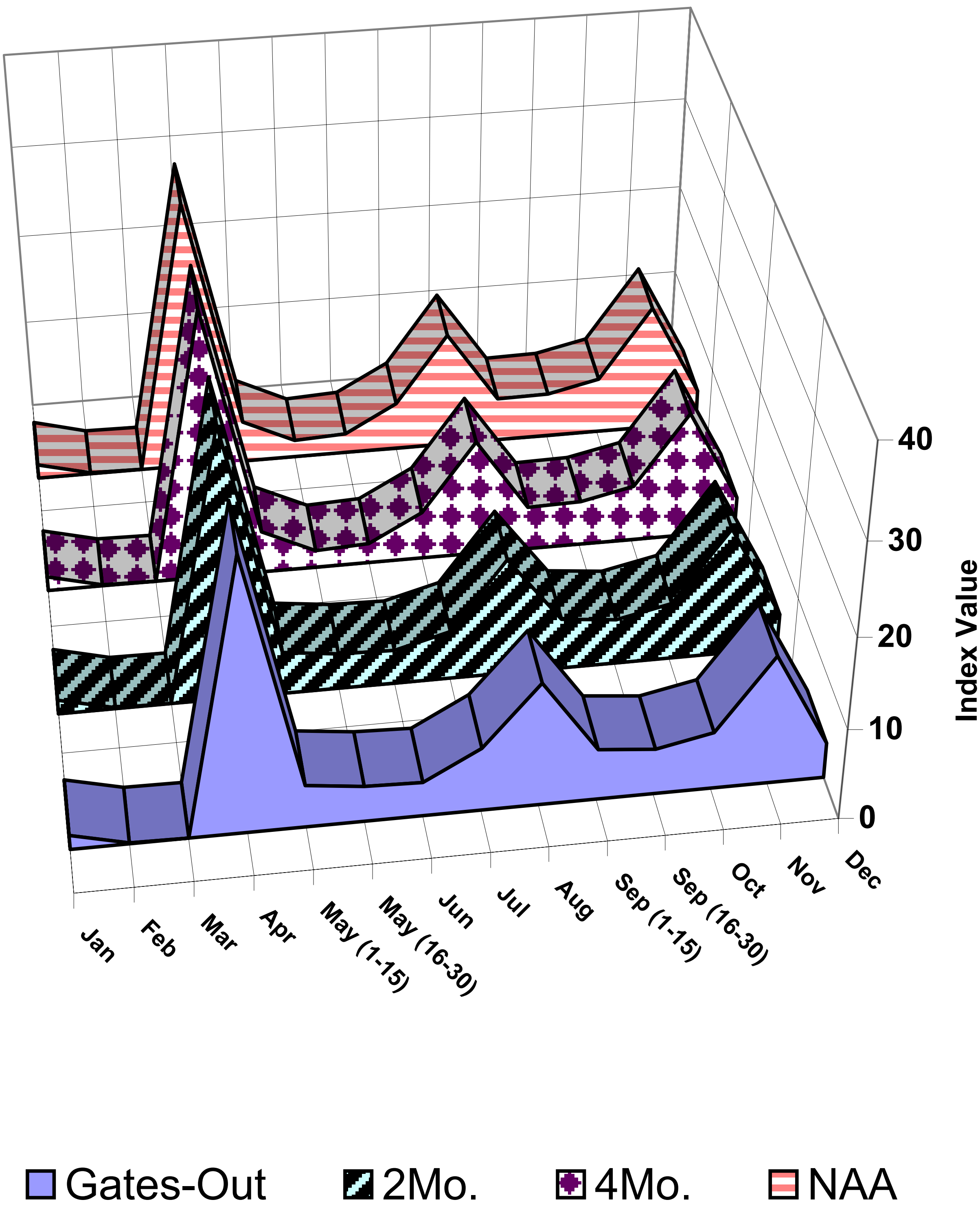
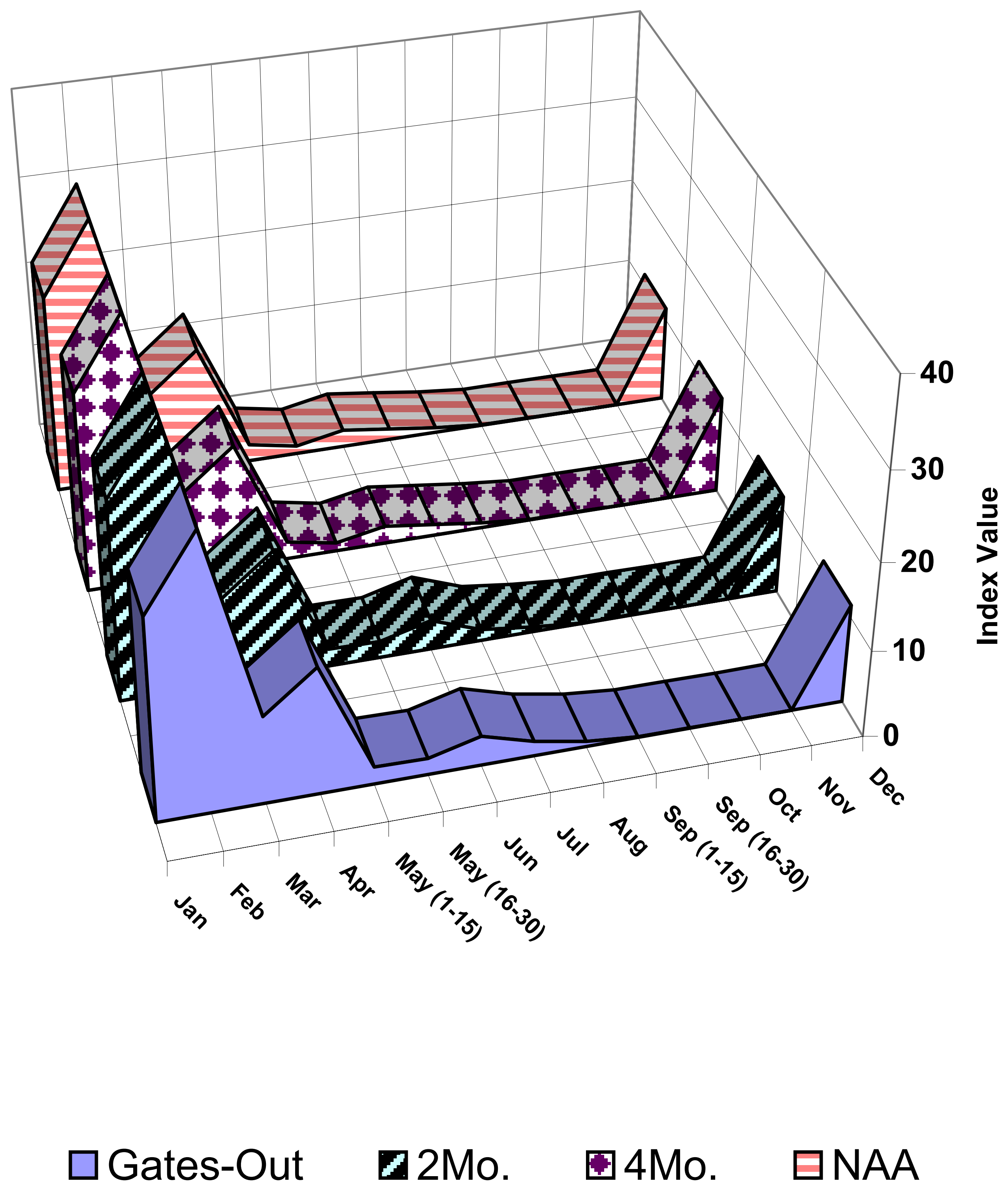


Figure 3e. Juvenile Steelhead Passage Indices



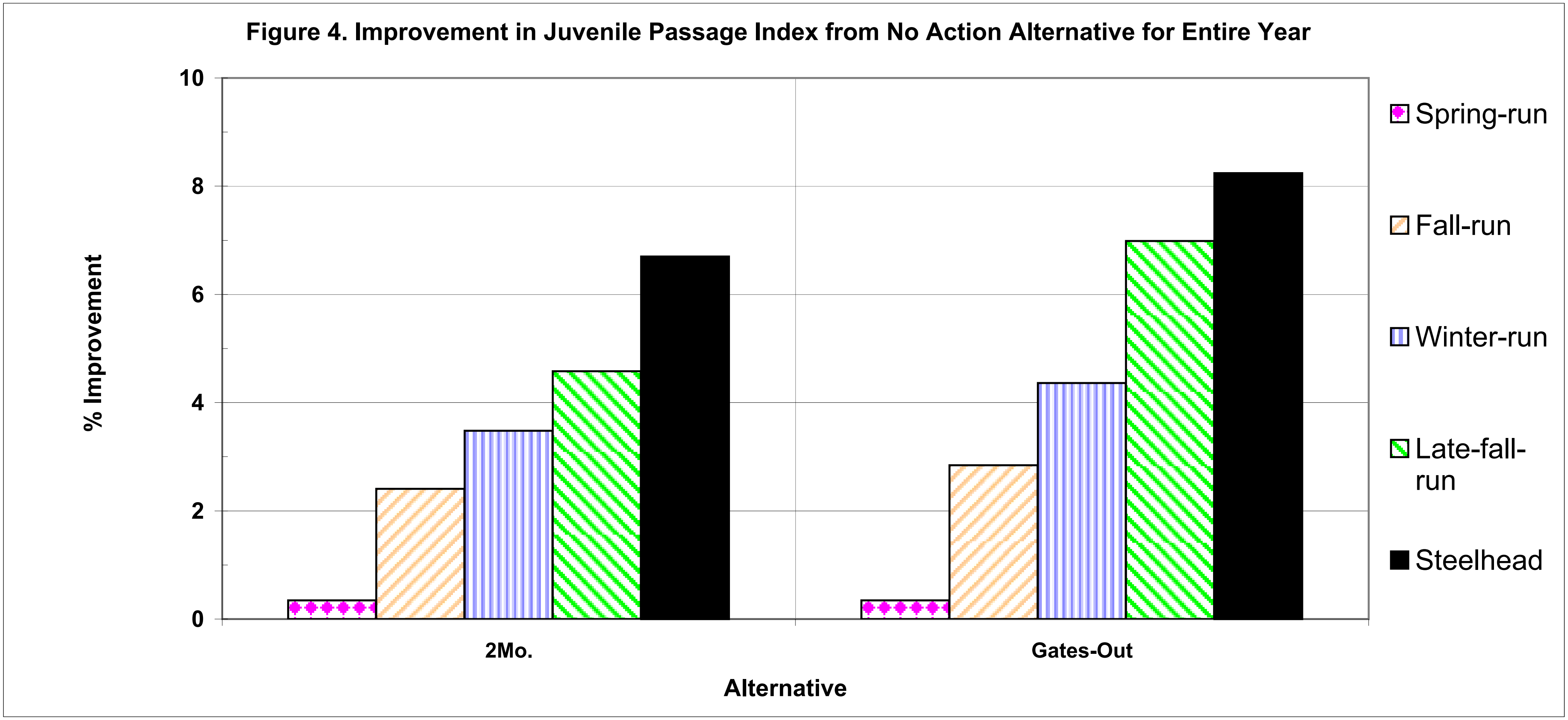


Figure 4. Improvement in Juvenile Passage Index from No Action Alternative for Entire Year
% Improvement
10
8
6
4
2
0
2Mo.
Gates-Out
Alternative
Spring-run
Fall-run
Winter-run
Late-fall-run
Steelhead

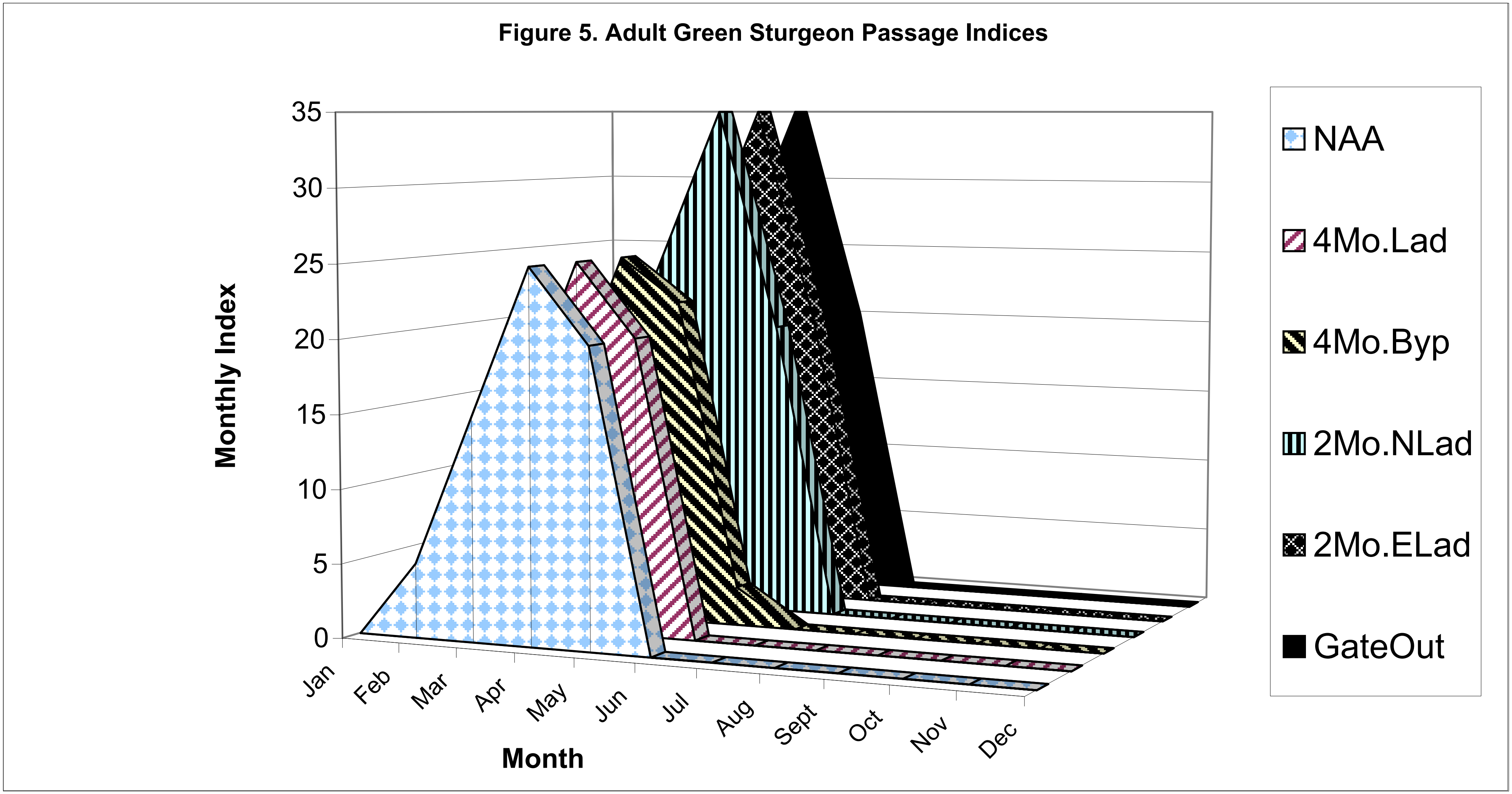
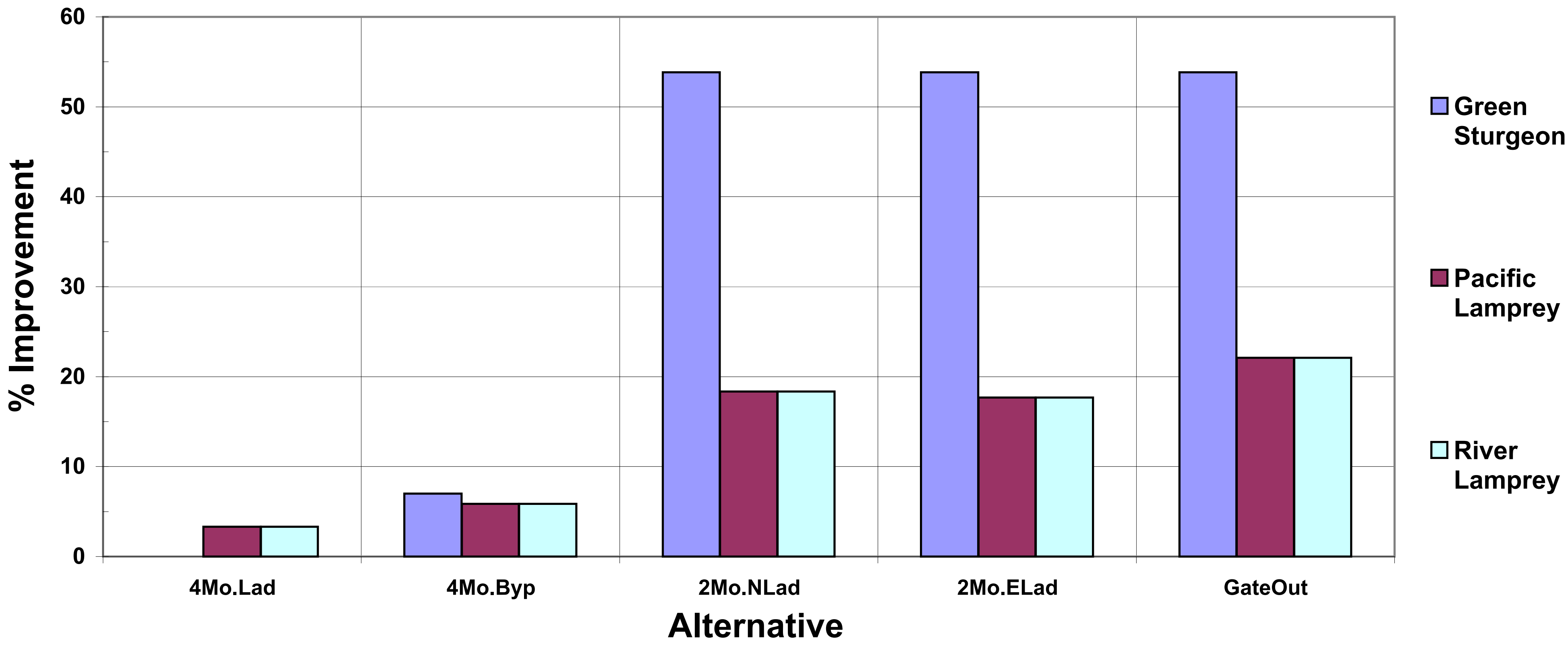


Figure 5. Adult Green Sturgeon Passage Indices
Monthly Index
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov
Dec
Month
NAA
4Mo.Lad
4Mo.Byp
2Mo.NLad
2Mo.ELad
GateOut

Figure 6. Relative Adult Passage Index Improvement from No Action Alternative for the Entire Year



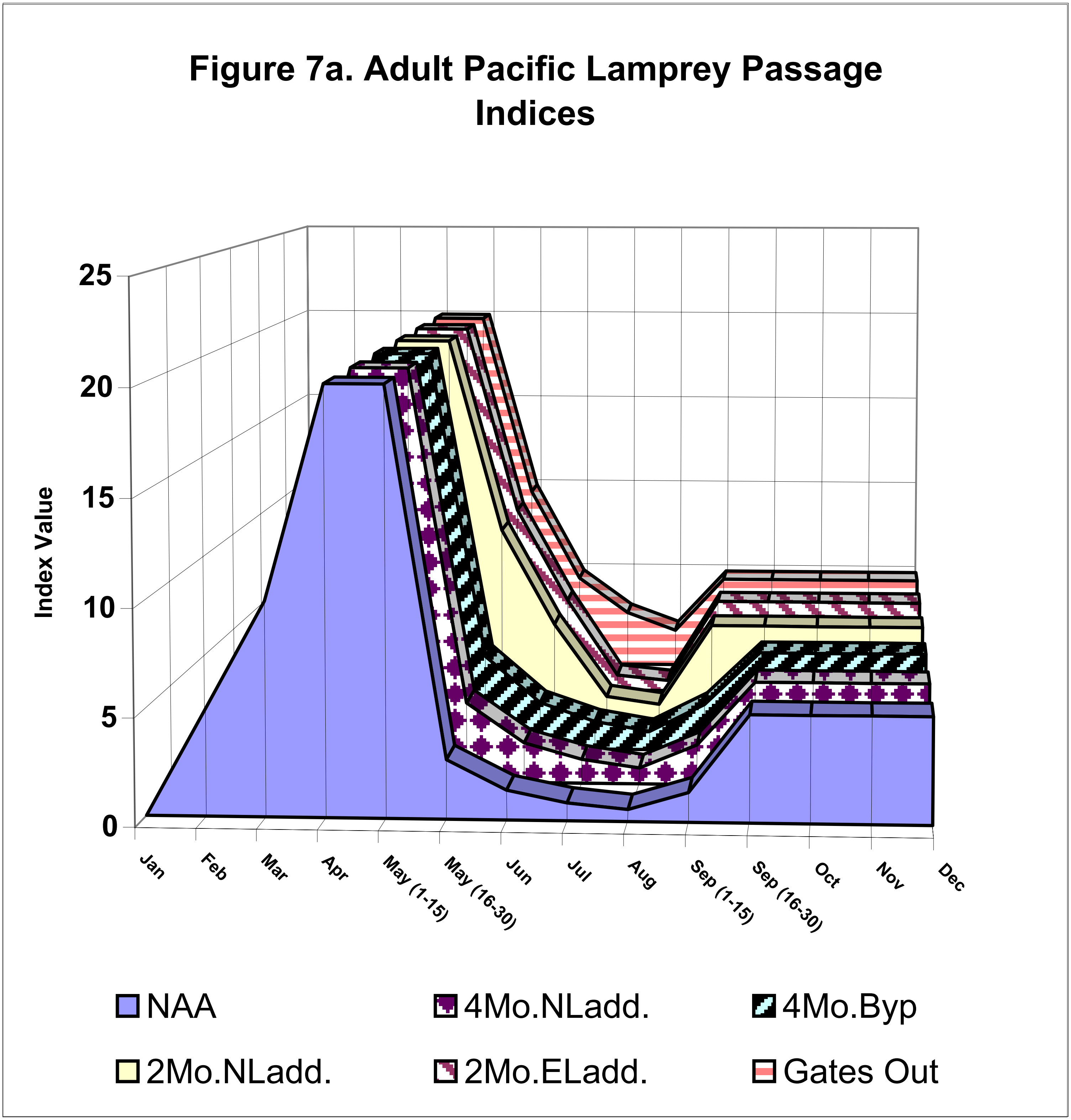


Figure 7a. Adult Pacific Lamprey Passage Indices
Index Value
0
5
10
15
20
25
Jan
Feb
Mar
Apr
May (1-15)
May (16-30)
Jun
Jul
Aug
Sep (1-15)
Sep (16-30)
Oct
Nov
Dec
NAA
4Mo.NLadd.
4Mo.Byp
2Mo.NLadd.
2Mo.ELadd.
Gates Out

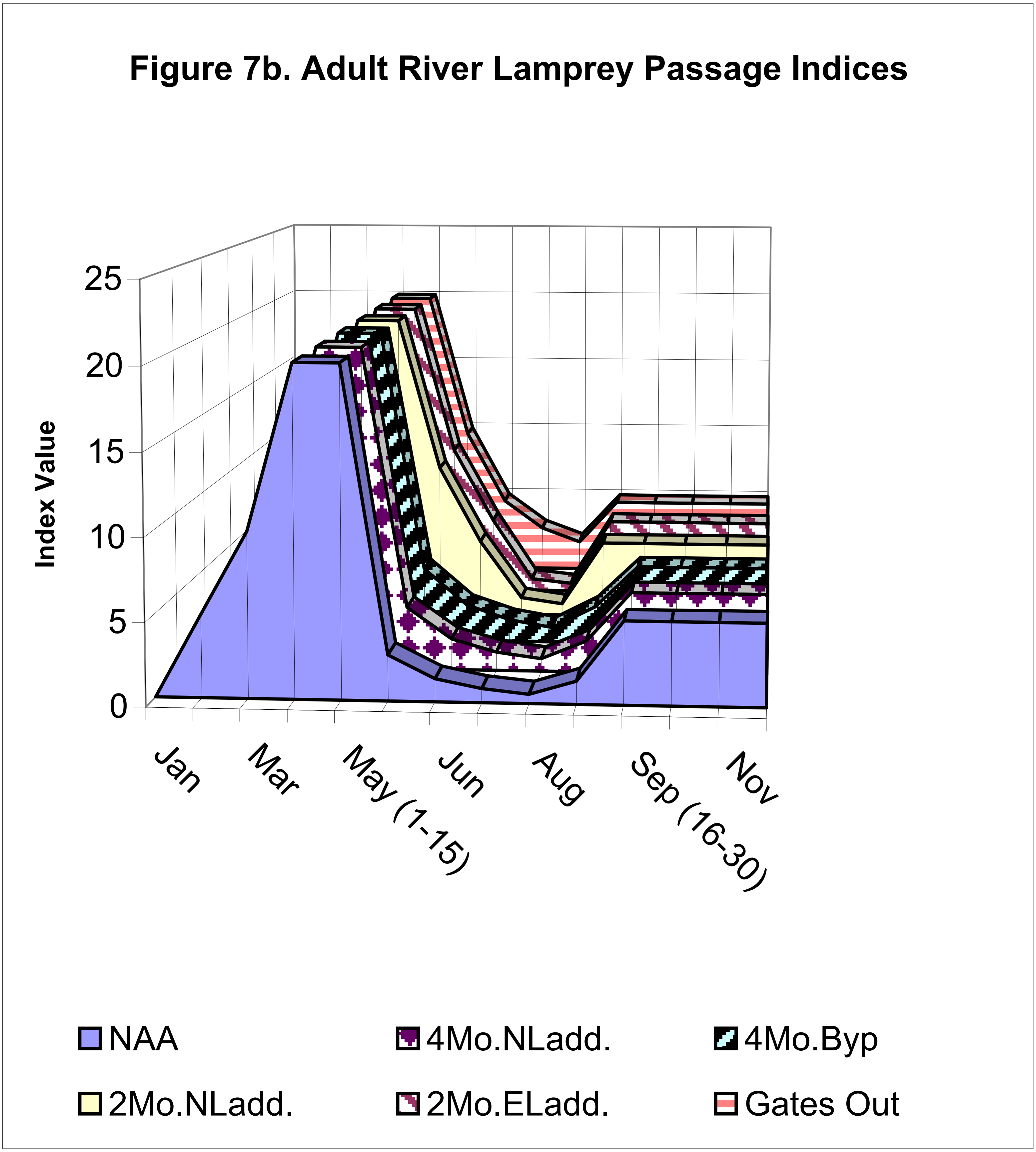
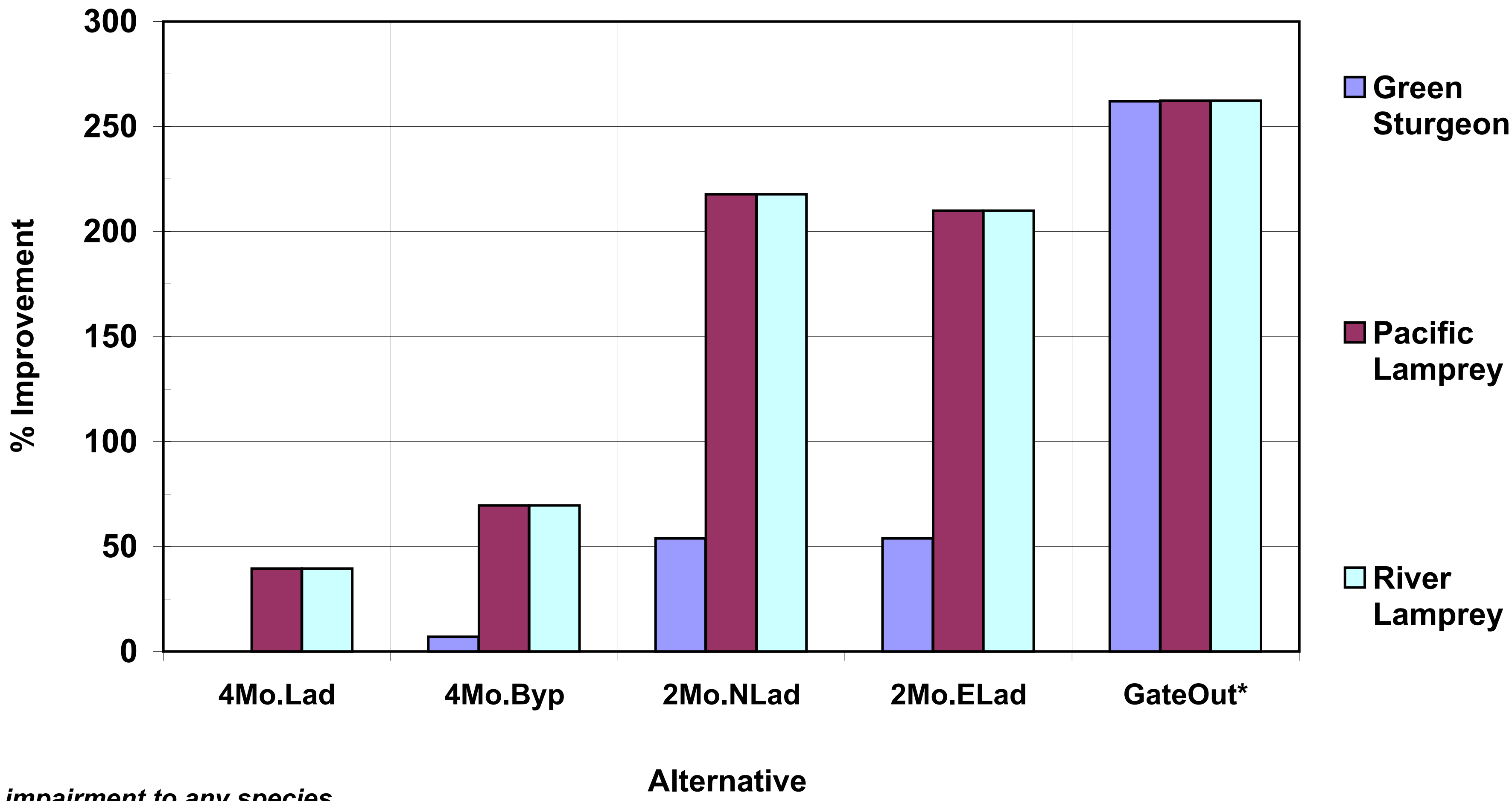


Figure 7b. Adult River Lamprey Passage Indices
Index Value
0
5
10
15
20
25
Jan
Mar
May (1-15)
Jun
Aug
Sep (16-30)
Nov
NAA
4Mo.NLadd.
4Mo.Byp
2Mo.NLadd.
2Mo.ELadd.
Gates Out

Figure 8. Relative Improvement in Adult Passage Index from No Action Alternative from mid-May through mid-September



** = No impairment to any species*

Figure 9. Improvement in Passage Indices for Pacific and River Lamprey Transformers and Juvenile Green Sturgeon (entire year)

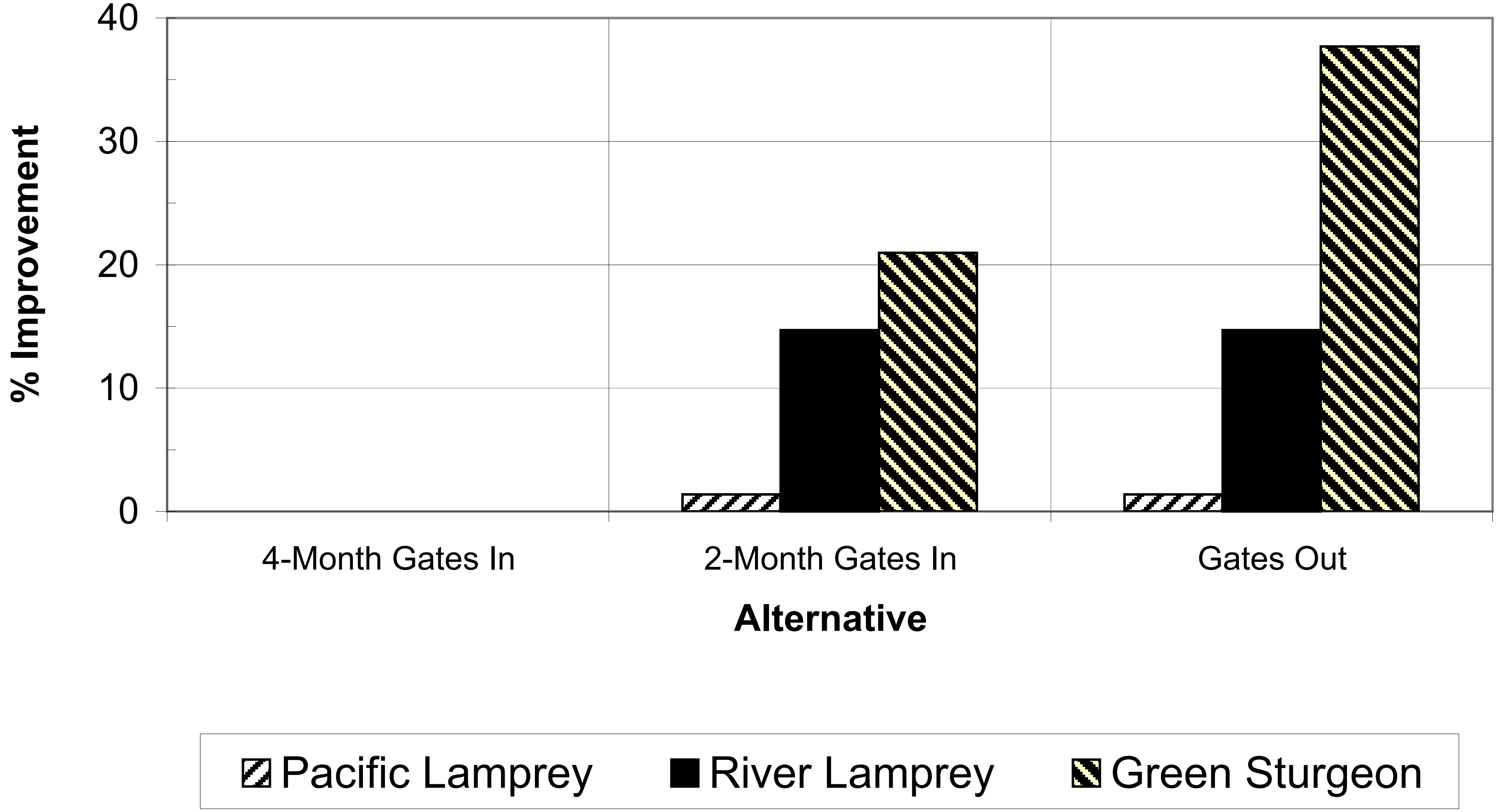
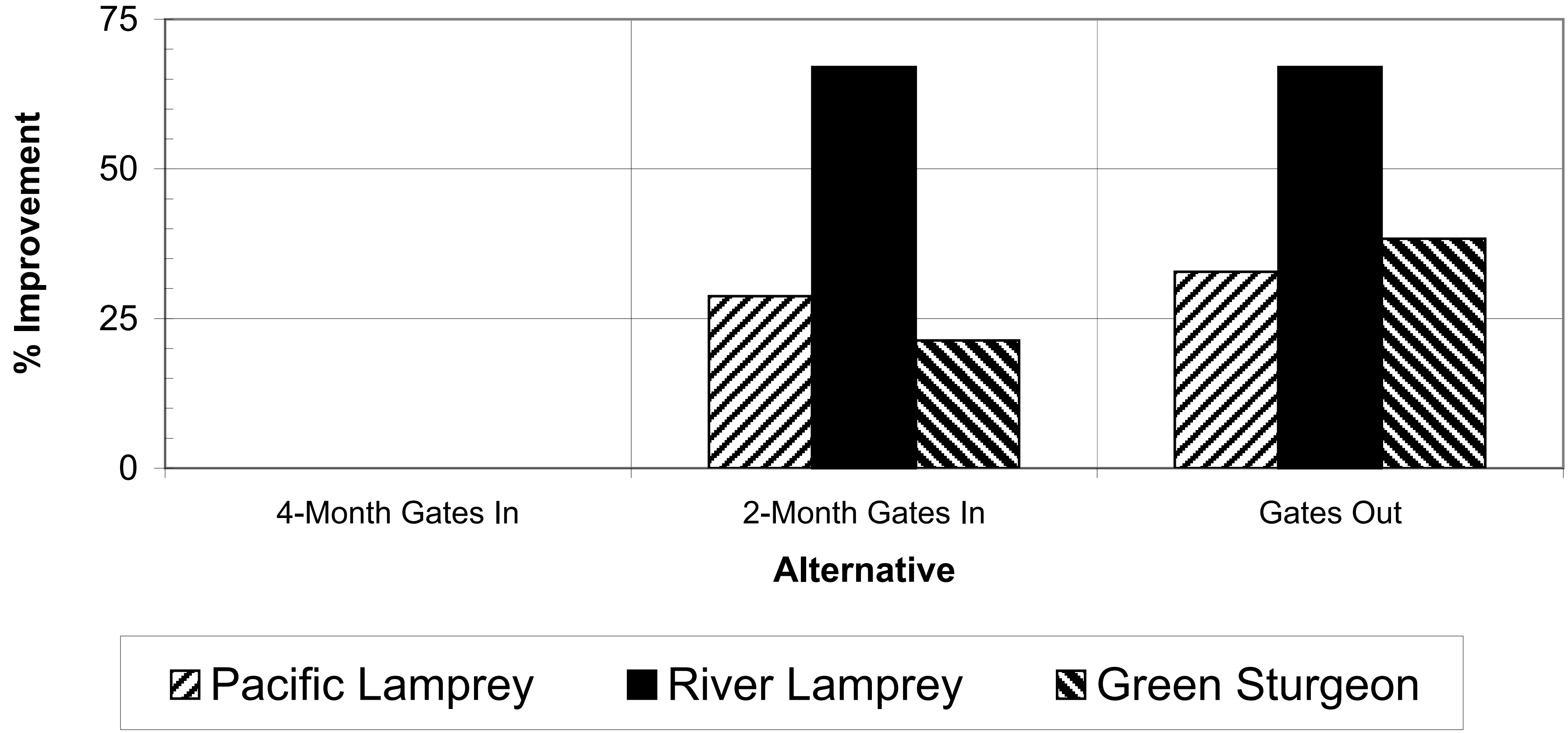


Figure 10. Improvement in Passage Indices for Pacific and River Lamprey Transformers and Juvenile Green Sturgeon (mid-May to mid-September)



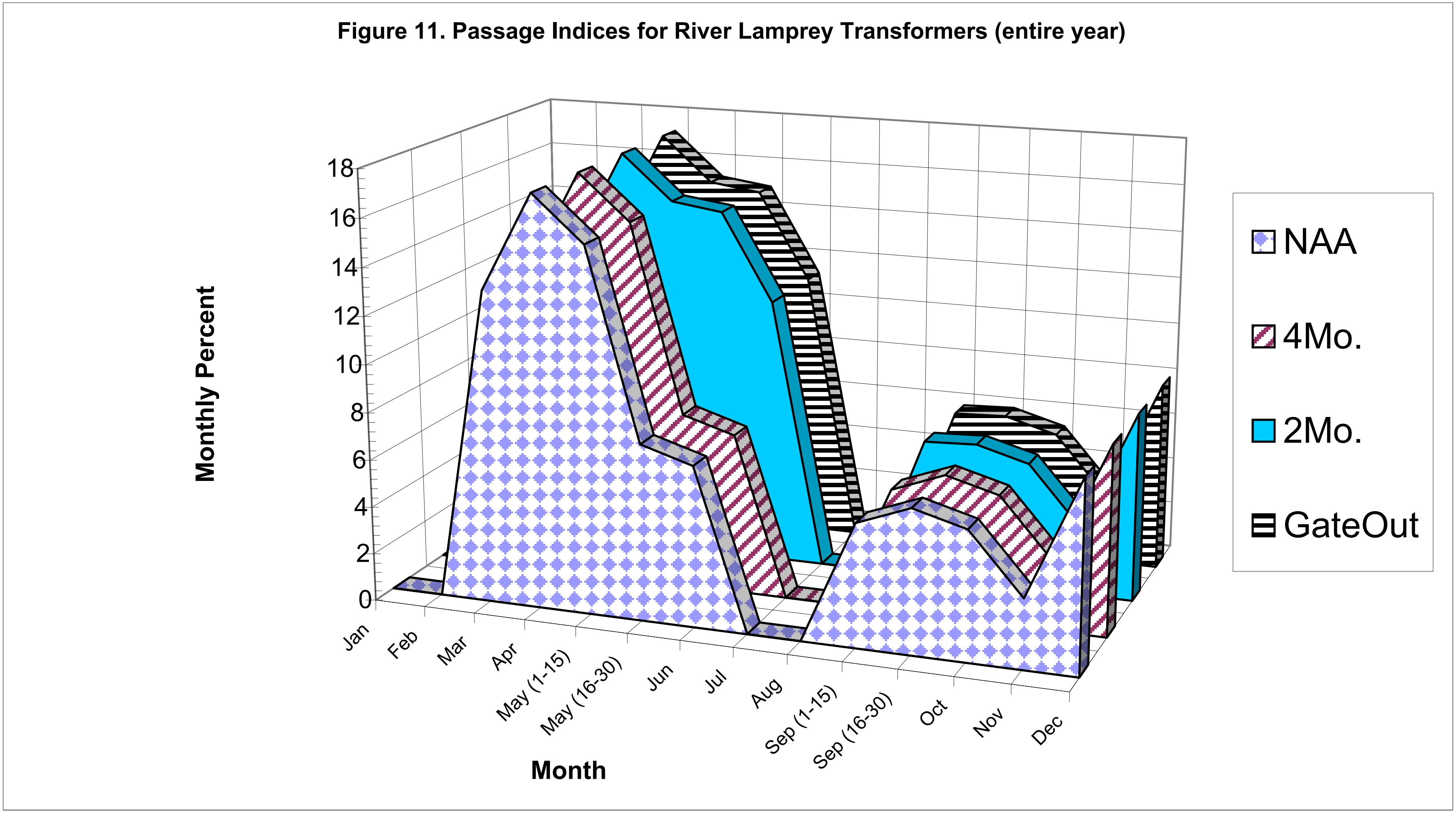


Figure 11. Passage Indices for River Lamprey Transformers (entire year)
Monthly Percent
18
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May (1-15)
May (16-30)
Jun
Jul
Aug
Sep (1-15)
Sep (16-30)
Oct
Nov
Dec
Month
NAA
4Mo.
2Mo.
GateOut

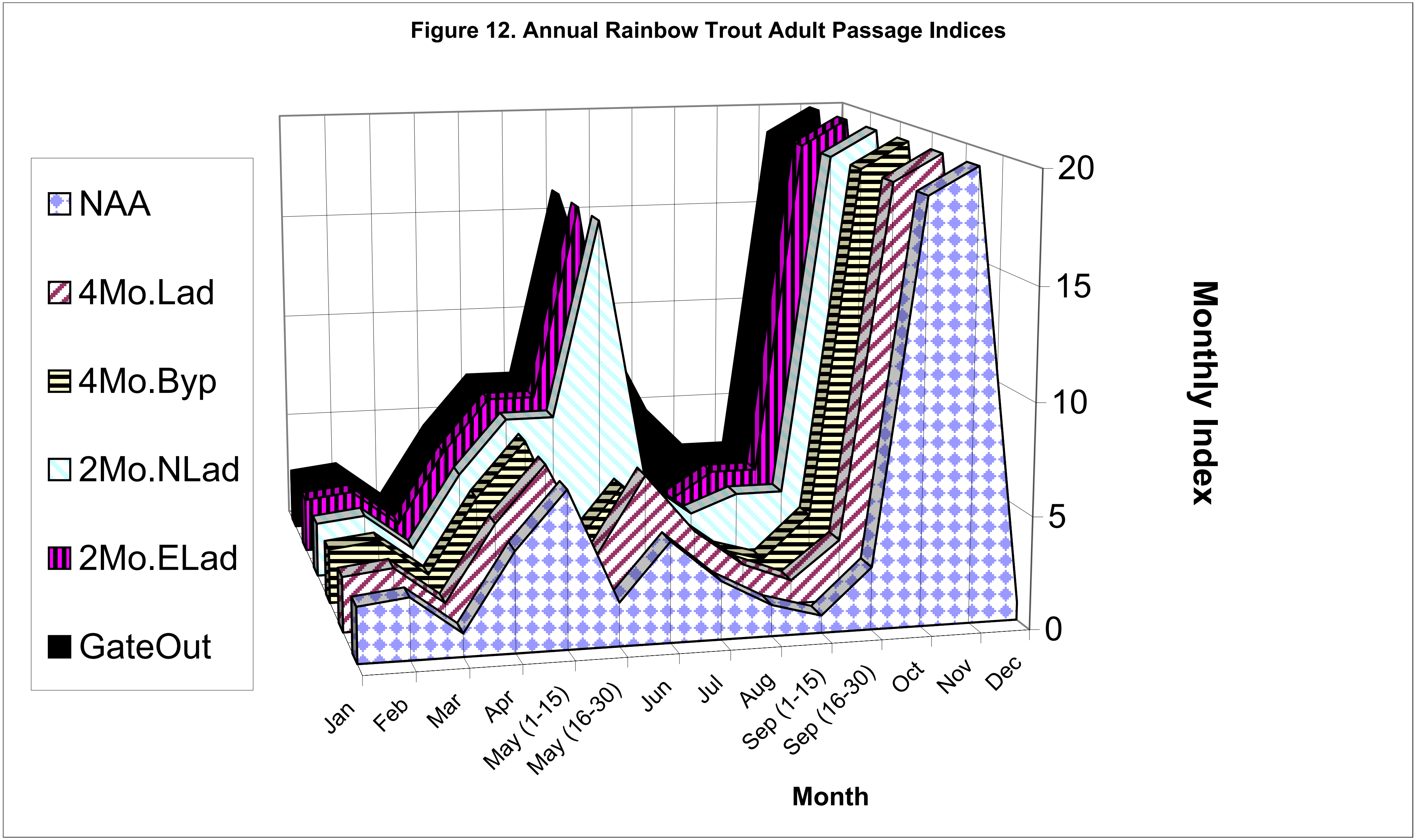
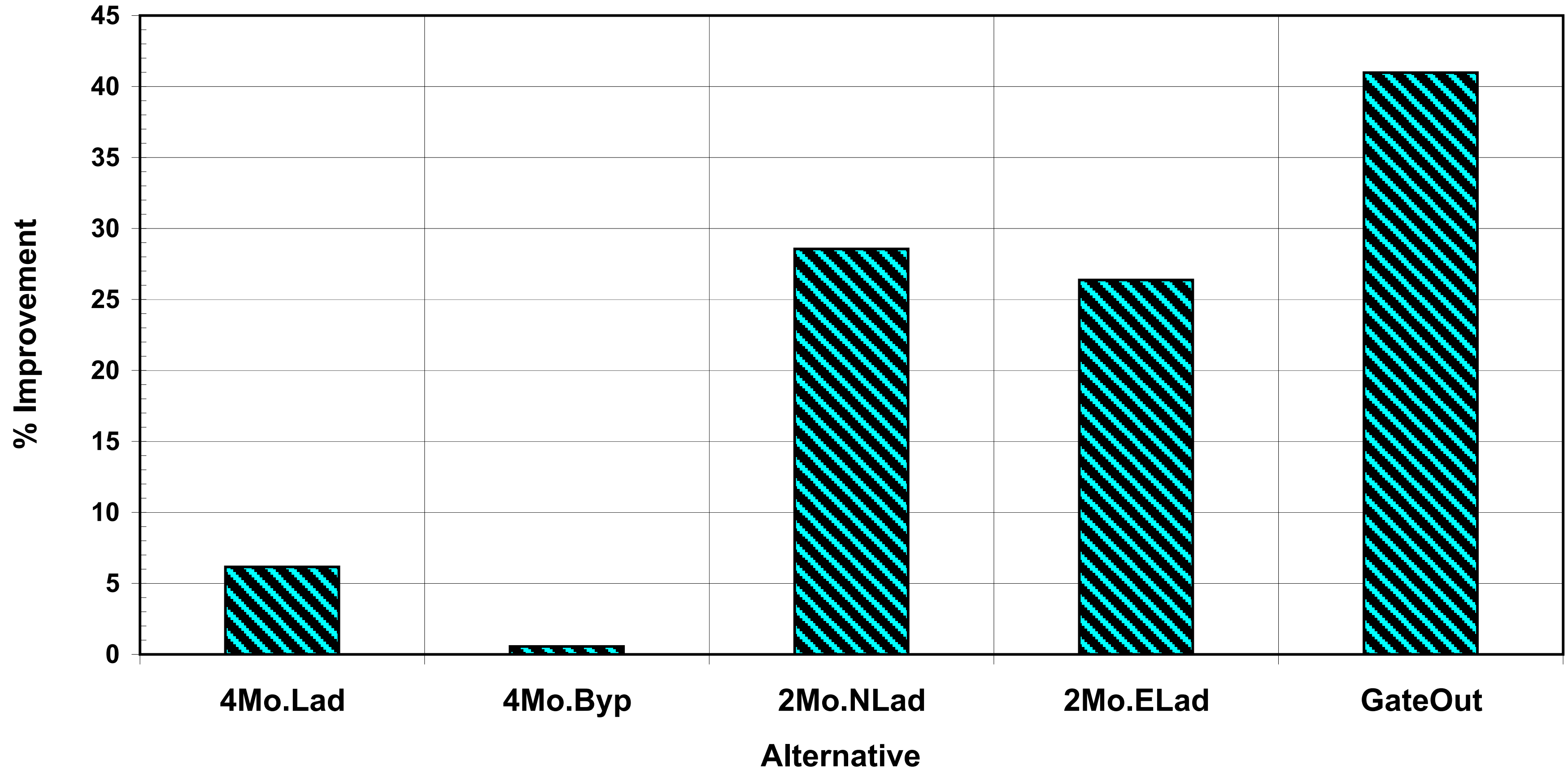


Figure 12. Annual Rainbow Trout Adult Passage Indices
NAA
4Mo.Lad
4Mo.Byp
2Mo.NLad
2Mo.ELad
GateOut
0
5
10
15
20
Monthly Index
Jan
Feb
Mar
Apr
May (1-15)
May (16-30)
Jun
Jul
Aug
Sep (1-15)
Sep (16-30)
Oct
Nov
Dec
Month

Figure 13. Relative Improvement in Adult Rainbow Trout Passage Indices from No Action Alternative (entire year)



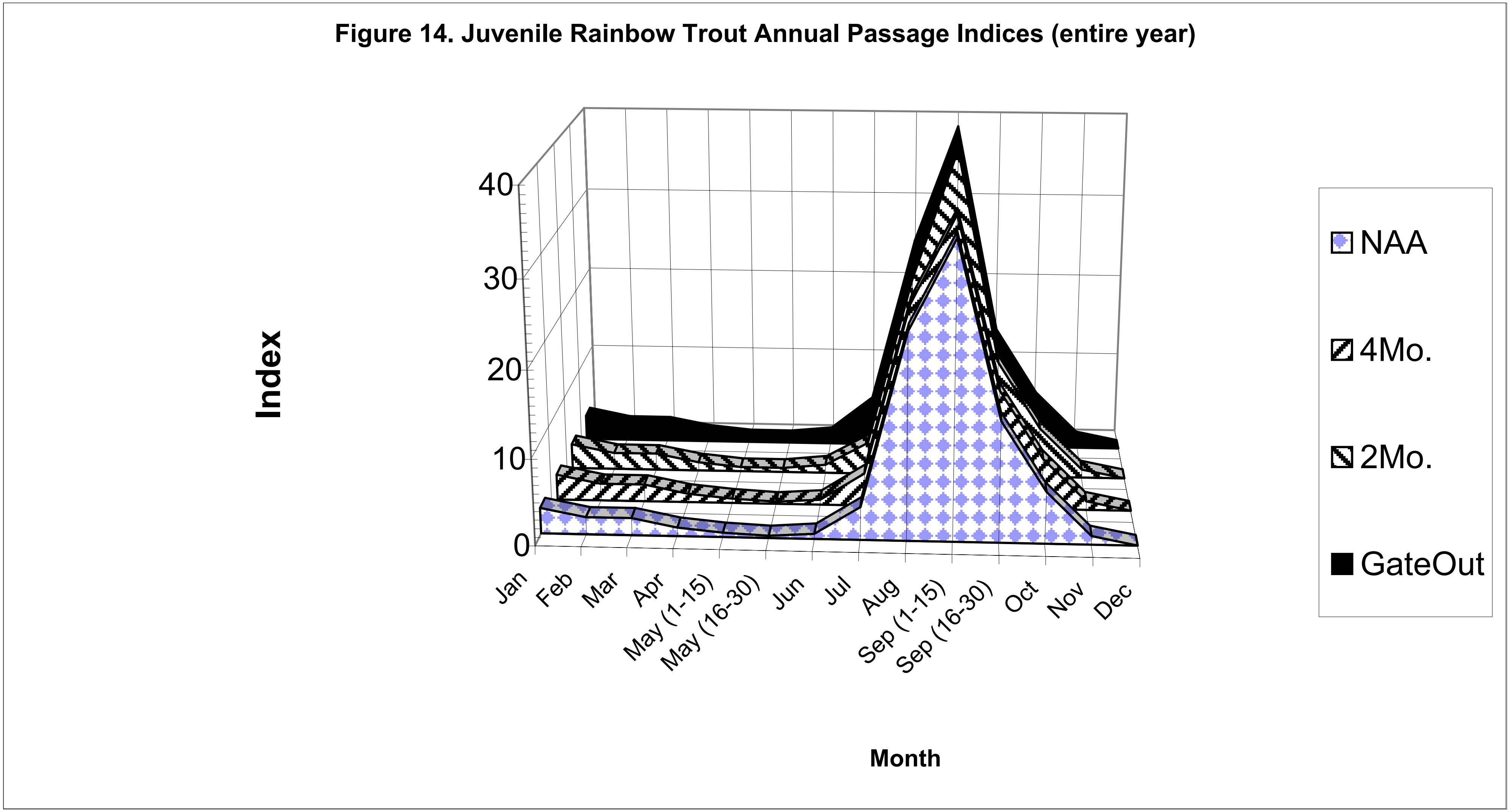
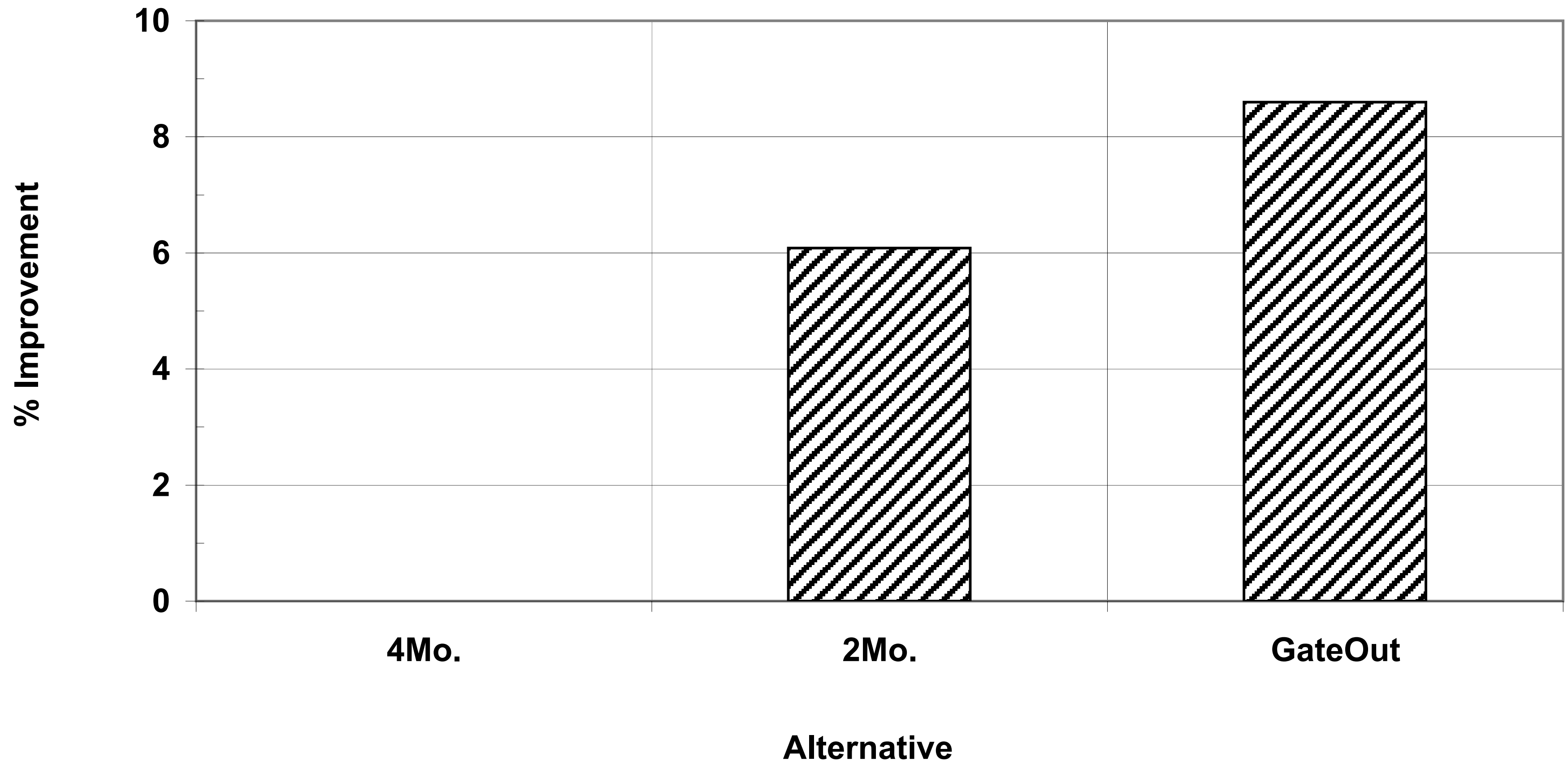


Figure 14. Juvenile Rainbow Trout Annual Passage Indices (entire year)
Index
40
30
20
10
0
Jan
Feb
Mar
Apr
May (1-15)
May (16-30)
Jun
Jul
Aug
Sep (1-15)
Sep (16-30)
Oct
Nov
Dec
Month
NAA
4Mo.
2Mo.
GateOut

Figure 15. Improvement in Juvenile Rainbow Trout Passage Index from No Action Alternative (entire year)



Appendix C
U.S. Fish and Wildlife Service Species List

ENCLOSURE A

Endangered and Threatened Species that May Occur in

or be Affected by Projects in the Selected Quads Listed Below

Reference File No. 00-SP-0217

Red Bluff Diversion Dam

November 7, 2000

QUAD : 610B RED BLUFF EAST

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC) long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

western burrowing owl, *Athene cunicularia hypugea* (SC)

Swainson's hawk, *Buteo Swainsoni* (CA)

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

bank swallow, *Riparia riparia* (CA)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

river lamprey, *Lampetra ayresi* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

silky cryptantha, *Cryptantha crinita* (SC)

adobe lily, *Fritillaria pluriflora* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
(MB)	*Migratory Bird*	Migratory bird
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
(*)	*Extirpated*	Possibly extirpated from this quad.
(**)	*Extinct*	Possibly extinct
	Critical Habitat	Area essential to the conservation of a species.

ENCLOSURE A

Endangered and Threatened Species that May Occur in or be Affected by

PROJECTS IN TEHAMA COUNTY

Reference File No. 00-SP-0217

November 7, 2000

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Critical habitat, northern spotted owl, *Strix occidentalis caurina* (T)

northern spotted owl, *Strix occidentalis caurina* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

Conservancy fairy shrimp, *Branchinecta conservatio* (E)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Plants

hairy Orcutt grass, *Orcuttia pilosa* (E)

Greene's tuctoria, *Tuctoria greenei* (E)

Hoover's spurge, *Chamaesyce hooveri* (T)

slender Orcutt grass, *Orcuttia tenuis* (T)

Candidate Species

Fish

Klamath Mts. Province steelhead, *Oncorhynchus mykiss* (C)

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

California wolverine, *Gulo gulo luteus* (CA)

Sierra Nevada red fox, *Vulpes vulpes necator* (CA)

pale Townsend's big eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

Sierra Nevada snowshoe hare, *Lepus americanus tahoensis* (SC)

Pacific fisher, *Martes pennanti pacifica* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

Swainson's hawk, *Buteo Swainsoni* (CA)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

greater sandhill crane, *Grus canadensis tabida* (CA)

bank swallow, *Riparia riparia* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

Black Crowned Night Heron, *Nycticorax nycticorax* (MB)

northern goshawk, *Accipiter gentilis* (SC)

tricolored blackbird, *Agelaius tricolor* (SC)

grasshopper sparrow, *Ammodramus savannarum* (SC)

Bell's sage sparrow, *Amphispiza belli belli* (SC)

short-eared owl, *Asio flammeus* (SC)

western burrowing owl, *Athene cunicularia hypugea* (SC)

American bittern, *Botaurus lentiginosus* (SC)

ferruginous hawk, *Buteo regalis* (SC)

Lawrence's goldfinch, *Carduelis lawrencei* (SC)

Vaux's swift, *Chaetura vauxi* (SC)

black tern, *Chlidonias niger* (SC)

lark sparrow, *Chondestes grammacus* (SC)

black swift, *Cypseloides niger* (SC)

hermit warbler, *Dendroica occidentalis* (SC)

white-tailed (=black shouldered) kite, *Elanus leucurus* (SC) loggerhead shrike, *Lanius ludovicianus* (SC)

Lewis' woodpecker, *Melanerpes lewis* (SC)

long-billed curlew, *Numenius americanus* (SC)

white-faced ibis, *Plegadis chihi* (SC)

rufous hummingbird, *Selasphorus rufus* (SC)

Brewer's sparrow, *Spizella breweri* (SC)

California spotted owl, *Strix occidentalis occidentalis* (SC)

Bewick's wren, *Thryomanes bewickii* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

tailed frog, *Ascaphus truei* (SC)

foothill yellow-legged frog, *Rana boylii* (SC)

mountain yellow-legged frog, *Rana muscosa* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

river lamprey, *Lampetra ayresi* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

Leech's skyline diving beetle, *Hydroporus leechi* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

Indian Valley brodiaea, *Brodiaea coronaria ssp. rosea* (CA)

upswept moonwort, *Botrychium ascendens* (SC)

scalloped moonwort, *Botrychium crenulatum* (SC)

Wilkins' harebell, *Campanula wilkinsiana* (SC)

silky cryptantha, *Cryptantha crinita* (SC)

clustered lady's-slipper, *Cypripedium fasciculatum* (SC)

Oregon fireweed, *Epilobium oreganum* (SC)

Brandegee's woolly star, *Eriastrum brandegeae* (SC)

Butte fritillary, *Fritillaria eastwoodiae* (SC)

adobe lily, *Fritillaria pluriflora* (SC)

Tehama dwarf-flax, *Hesperolinon tehamense* (SC) legenere, *Legenere limosa* (SC)

Mt. Tedoc linanthus, *Linanthus nuttallii ssp. howellii* (SC)

red flowered lotus, *Lotus rubriflorus* (SC)

Anthony Peak lupine, *Lupinus antoninus* (SC)

Stebbins' madia, *Madia stebbinsii* (SC)

The Lassics sandwort, *Minuartia decumbens* (SC)

Ahart's whitlow wort, *Paronychia ahartii* (SC)

valley sagittaria, *Sagittaria sanfordii* (SC)

Tracy's sanicle, *Sanicula tracyi* (SC)

Butte County (western) catchfly, *Silene occidentalis ssp. longistipitata* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	Other species of concern to the Service.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
*	*Extirpated*	Possibly extirpated from the area.
**	*Extinct*	Possibly extinct
	Critical Habitat	Area essential to the conservation of a species.

Federal Endangered and Threatened Species that may be Affected by Projects in the RED BLUFF EAST 7 1/2 Minute Quad

Database Last Updated: June 17, 2002

Today's Date is: June 26, 2002

Listed Species

Invertebrates

Branchinecta lynchi - vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus - valley elderberry longhorn beetle (T)

Lepidurus packardi - vernal pool tadpole shrimp (E)

Fish

Hypomesus transpacificus - delta smelt (T)

Oncorhynchus mykiss - Central Valley steelhead (T) (NMFS)

Oncorhynchus tshawytscha - Central Valley spring run chinook salmon (T) (NMFS)

Pogonichthys macrolepidotus - Sacramento splittail (T)

Amphibians

Rana aurora draytonii - California red-legged frog (T)

Reptiles

Thamnophis gigas - giant garter snake (T)

Birds

Haliaeetus leucocephalus - bald eagle (T)

Candidate Species

Fish

Oncorhynchus tshawytscha - Central Valley fall/late fall run chinook salmon (C) (NMFS)

Birds

Coccyzus americanus occidentalis - Western yellow-billed cuckoo (C)

Species of Concern

Invertebrates

Anthicus antiochensis - Antioch Dunes anthicid beetle (SC)

Anthicus sacramento - Sacramento anthicid beetle (SC)

Linderiella occidentalis - California linderiella fairy shrimp (SC)

Fish

Acipenser medirostris - green sturgeon (SC)

Lampetra ayresi - river lamprey (SC)

Spirinchus thaleichthys - longfin smelt (SC)

Amphibians

Rana boylii - foothill yellow-legged frog (SC)

Spea hammondii - western spadefoot toad (SC)

Reptiles

Clemmys marmorata marmorata - northwestern pond turtle (SC)

Birds

Agelaius tricolor - tricolored blackbird (SC)

Ammodramus savannarum - grasshopper sparrow (SC)

Asio flammeus - short-eared owl (SC)

Athene cunicularia hypugaea - western burrowing owl (SC)

Baeolophus inornatus - oak titmouse (SLC)

Branta canadensis leucopareia - Aleutian Canada goose (D)

Buteo regalis - ferruginous hawk (SC)

Buteo Swainsoni - Swainson's hawk (CA)

Carduelis lawrencei - Lawrence's goldfinch (SC)

Chaetura vauxi - Vaux's swift (SC)

Chlidonias niger - black tern (SC)

Elanus leucurus - white-tailed (=black shouldered) kite (SC)
Empidonax traillii brewsteri - little willow flycatcher (CA)
Falco peregrinus anatum - American peregrine falcon (D)
Lanius ludovicianus - loggerhead shrike (SC)
Melanerpes lewis - Lewis' woodpecker (SC)
Numenius americanus - long-billed curlew (SC)
Picoides nuttallii - Nuttall's woodpecker (SLC)
Plegadis chihi - white-faced ibis (SC)
Riparia riparia - bank swallow (CA)
Selasphorus rufus - rufous hummingbird (SC)

Mammals

Corynorhinus (=Plecotus) townsendii pallescens - pale Townsend's big-eared bat (SC)
Corynorhinus (=Plecotus) townsendii townsendii - Pacific western big-eared bat (SC)
Euderma maculatum - spotted bat (SC)
Myotis ciliolabrum - small-footed myotis bat (SC)
Myotis evotis - long-eared myotis bat (SC)
Myotis thysanodes - fringed myotis bat (SC)
Myotis volans - long-legged myotis bat (SC)
Myotis yumanensis - Yuma myotis bat (SC)
Perognathus inornatus - San Joaquin pocket mouse (SC)

Plants

Cryptantha crinita - silky cryptantha (SC)
Fritillaria pluriflora - adobe lily (SC)
Juncus leiospermus var. leiospermus - Red Bluff (dwarf) rush (SC)

Species with Critical Habitat Proposed or Designated in this Quad

Central Valley fall/late fall-run chinook (C)
Central Valley spring-run chinook (T)
winter-run chinook salmon (E)

Key:
(E) Endangered - Listed (in the Federal Register) as being in danger of extinction.
(T) Threatened - Listed as likely to become endangered within the foreseeable future.
(P) Proposed - Officially proposed (in the Federal Register) for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.
(C) Candidate - Candidate to become a proposed species.
(CA) Listed by the State of California but not by the Fish & Wildlife Service.
(D) Delisted - Species will be monitored for 5 years.
(SC) Species of Concern/(SLC) Species of Local Concern - Other species of concern to the Sacramento Fish & Wildlife Office.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

This is *not* an official list for formal consultation under the Endangered Species Act. *However, it may be used to update official lists.*

If you have a project that may affect endangered species, please contact the Endangered Species Division, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service

Federal Endangered and Threatened Species that may be affected by projects in Tehama County

Database Last Updated: June 17, 2002
Today's Date is: June 26, 2002

Listed Species

Invertebrates
Branchinecta conservatio - Conservancy fairy shrimp (E)
Branchinecta lynchi - vernal pool fairy shrimp (T)
Desmocerus californicus dimorphus - valley elderberry longhorn beetle (T)
Lepidurus packardi - vernal pool tadpole shrimp (E)

Fish
Hypomesus transpacificus - delta smelt (T)
Oncorhynchus mykiss - Central Valley steelhead (T) (NMFS)
Oncorhynchus tshawytscha - winter-run chinook salmon (E) (NMFS)
Pogonichthys macrolepidotus - Sacramento splittail (T)

Amphibians
Rana aurora draytonii - California red-legged frog (T)

Reptiles
Thamnophis gigas - giant garter snake (T)

Birds
Haliaeetus leucocephalus - bald eagle (T)
Strix occidentalis caurina - northern spotted owl (T)

Plants
Chamaesyce hooveri - Hoover's spurge (T)
Orcuttia pilosa - hairy Orcutt grass (E)
Orcuttia tenuis - slender Orcutt grass (T)
Tuctoria greenei - Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Fish
Oncorhynchus tshawytscha - Central Valley fall/late fall-run chinook salmon (C) (NMFS)

Birds
Coccyzus americanus occidentalis - Western yellow-billed cuckoo (C)

Species of Concern

Invertebrates
Anthicus antiochensis - Antioch Dunes anthicid beetle (SC)
Anthicus sacramento - Sacramento anthicid beetle (SC)
Hydroporus leechi - Leech's skyline diving beetle (SC)
Linderiella occidentalis - California linderiella fairy shrimp (SC)

Fish
Acipenser medirostris - green sturgeon (SC)
Lampetra ayresi - river lamprey (SC)
Spirinchus thaleichthys - longfin smelt (SC)

Amphibians
Ascaphus truei - tailed frog (SC)
Rana boylii - foothill yellow-legged frog (SC)
Rana muscosa - mountain yellow-legged frog (SC)
Spea hammondii - western spadefoot toad (SC)

Reptiles
Clemmys marmorata marmorata - northwestern pond turtle (SC)
Phrynosoma coronatum frontale - California horned lizard (SC)

Birds

Accipiter gentilis - northern goshawk (SC)
Agelaius tricolor - tricolored blackbird (SC)
Ammodramus savannarum - grasshopper sparrow (SC)
Amphispiza belli belli - Bell's sage sparrow (SC)
Asio flammeus - short-eared owl (SC)
Athene cunicularia hypugaea - western burrowing owl (SC)
Baeolophus inornatus - oak titmouse (SLC)
Botaurus lentiginosus - American bittern (SC)
Branta canadensis leucopareia - Aleutian Canada goose (D)
Buteo regalis - ferruginous hawk (SC)
Buteo Swainsoni - Swainson's hawk (CA)
Carduelis lawrencei - Lawrence's goldfinch (SC)
Chaetura vauxi - Vaux's swift (SC)
Chlidonias niger - black tern (SC)
Cypseloides niger - black swift (SC)
Dendroica occidentalis - hermit warbler (SC)
Egretta thula - Snowy Egret (MB)
Elanus leucurus - white-tailed (=black shouldered) kite (SC)
Empidonax traillii brewsteri - little willow flycatcher (CA)
Falco peregrinus anatum - American peregrine falcon (D)
Gavia immer - common loon (SC)
Grus canadensis tabida - greater sandhill crane (CA)
Lanius ludovicianus - loggerhead shrike (SC)
Melanerpes lewis - Lewis' woodpecker (SC)
Numenius americanus - long-billed curlew (SC)
Picoides nuttallii - Nuttall's woodpecker (SLC)
Plegadis chihi - white-faced ibis (SC)
Riparia riparia - bank swallow (CA)
Selasphorus rufus - rufous hummingbird (SC)
Strix occidentalis occidentalis - California spotted owl (SC)
Toxostoma redivivum - California thrasher (SC)

Mammals

Corynorhinus (=Plecotus) townsendii pallescens - pale Townsend's big-eared bat (SC)
Corynorhinus (=Plecotus) townsendii townsendii - Pacific western big-eared bat (SC)
Euderma maculatum - spotted bat (SC)
Gulo gulo luteus - California wolverine (CA)
Lepus americanus tahoensis - Sierra Nevada snowshoe hare (SC)
Martes pennanti pacifica - Pacific fisher (SC)
Myotis ciliolabrum - small-footed myotis bat (SC)
Myotis evotis - long-eared myotis bat (SC)
Myotis thysanodes - fringed myotis bat (SC)
Myotis volans - long-legged myotis bat (SC)
Myotis yumanensis - Yuma myotis bat (SC)
Perognathus inornatus - San Joaquin pocket mouse (SC)
Vulpes vulpes necator - Sierra Nevada red fox (CA)

Plants

Agrostis hendersonii - Henderson's bent grass (SC)
Arctostaphylos canescens ssp sonomensis - Sonoma manzanita (SLC)
Astragalus rattanii var jepsonianus - Jepson's milk-vetch (SLC)
Balsamorhiza macrolepis var macrolepis - big-scale (=California) balsamroot (SLC)
Botrychium ascendens - upswept moonwort (SC)
Botrychium crenulatum - scalloped moonwort (SC)
Brodiaea coronaria ssp. rosea - Indian Valley brodiaea (CA)
Calystegia atriplicifolia ssp. buttensis - Butte County morning-glory (SC)
Campanula wilkinsiana - Wilkin's harebell (SC)
Chamaesyce ocellata ssp. rattanii - Stony Creek spurge (SLC)

Chlorogalum pomeridianum var. minus - dwarf soaproot (= wavyleaf soap plant) (SLC)
Clarkia gracilis ssp. albicaulis - white-stemmed (= whitestem) clarkia (SLC)
Cryptantha crinita - silky cryptantha (SC)
Cypripedium fasciculatum - clustered lady's-slipper (SC)
Epilobium oreganum - Oregon fireweed (SC)
Eriastrum brandegeae - Brandegee's woolly-star (= eriastrum) (SC)
Eriogonum libertini - Dubakella Mountain buckwheat (SLC)
Fritillaria eastwoodiae - Butte fritillary (SC)
Fritillaria pluriflora - adobe lily (SC)
Gratiola heterosepala - Boggs Lake hedge-hyssop (CA)
Hesperolinon tehamense - Tehama dwarf-flax (SC)
Iliamna bakeri - Baker's globe mallow (= Baker's wild hollyhock) (SLC)
Juncus leiospermus var. leiospermus - Red Bluff (dwarf) rush (SC)
Layia septentrionalis - Colusa layia (= Colusa tidytips) (SLC)
Legenere limosa - legenere (SC)
Linanthus nuttallii ssp. howellii - Mt. Tedoc linanthus (SLC)
Lotus rubriflorus - red-flowered lotus (SC)
Lupinus antoninus - Anthony Peak lupine (SC)
Madia stebbinsii (= Harmonia stebbinsii) - Stebbins's madia (= Stebbins's harmonia) (SC)
Navarretia leucocephala ssp. bakeri - Baker's navarretia (SC)
Oreostemma elatum - tall alpine aster (= Plumas alpine aster) (SLC)
Paronychia ahartii - Ahart's whitlow-wort (= Ahart's paronychia) (SC)
Rupertia hallii - Hall's rupertia (= Hall's California tea) (SLC)
Sagittaria sanfordii - valley sagittaria (= Sanford's arrowhead) (SC)
Silene campanulata ssp. campanulata - Red Mountain catchfly (= campion) (CA)
Silene occidentalis ssp. longistipitata - Butte County catchfly (= long-stiped campion) (SC)

Species with Critical Habitat Proposed or Designated in this County

Central Valley fall/late fall-run chinook (C)
Central Valley spring-run chinook (T)
Central Valley steelhead (T)
northern spotted owl (T)
winter-run chinook salmon (E)

Key:
(E) Endangered - Listed (in the Federal Register) as being in danger of extinction.
(T) Threatened - Listed as likely to become endangered within the foreseeable future.
(P) Proposed - Officially proposed (in the Federal Register) for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.
(C) Candidate - Candidate to become a proposed species.
(CA) Listed by the State of California but not by the Fish & Wildlife Service.
(D) Delisted - Species will be monitored for 5 years.
(SC) Species of Concern/(SLC) Species of Local Concern - Other species of concern to the Sacramento Fish & Wildlife Office.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

This is not an official list for formal consultation under the Endangered Species Act. *However, it may be used to update official lists.*

If you have a project that may affect endangered species, please contact the Endangered Species Division, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service.

Appendix C
U.S. Fish and Wildlife Service Species List

ENCLOSURE A

Endangered and Threatened Species that May Occur in
or be Affected by Projects in the Selected Quads Listed Below
Reference File No. 00-SP-0217
Red Bluff Diversion Dam
November 7, 2000

QUAD : 610B RED BLUFF EAST

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

Candidate Species

Fish

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

pale Townsend's big-eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC) long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

western burrowing owl, *Athene cunicularia hypugea* (SC)

Swainson's hawk, *Buteo Swainsoni* (CA)

ferruginous hawk, *Buteo regalis* (SC)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

white-faced ibis, *Plegadis chihi* (SC)

bank swallow, *Riparia riparia* (CA)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

Amphibians

foothill yellow-legged frog, *Rana boylii* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

river lamprey, *Lampetra ayresi* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

silky cryptantha, *Cryptantha crinita* (SC)

adobe lily, *Fritillaria pluriflora* (SC)

KEY:

(E)	*Endangered*	Listed (in the Federal Register) as being in danger of extinction.
(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	May be endangered or threatened. Not enough biological information has been gathered to support listing at this time.
(MB)	*Migratory Bird*	Migratory bird
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
(*)	*Extirpated*	Possibly extirpated from this quad.
(**)	*Extinct*	Possibly extinct
	Critical Habitat	Area essential to the conservation of a species.

ENCLOSURE A

Endangered and Threatened Species that May Occur in or be Affected by

PROJECTS IN TEHAMA COUNTY

Reference File No. 00-SP-0217

November 7, 2000

Listed Species

Birds

Aleutian Canada goose, *Branta canadensis leucopareia* (T)

bald eagle, *Haliaeetus leucocephalus* (T)

Critical habitat, northern spotted owl, *Strix occidentalis caurina* (T)

northern spotted owl, *Strix occidentalis caurina* (T)

Reptiles

giant garter snake, *Thamnophis gigas* (T)

Amphibians

California red-legged frog, *Rana aurora draytonii* (T)

Fish

Critical habitat, winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

winter-run chinook salmon, *Oncorhynchus tshawytscha* (E)

delta smelt, *Hypomesus transpacificus* (T)

Central Valley steelhead, *Oncorhynchus mykiss* (T)

Central Valley spring-run chinook salmon, *Oncorhynchus tshawytscha* (T)

Critical Habitat, Central Valley spring-run chinook, *Oncorhynchus tshawytscha* (T)

Sacramento splittail, *Pogonichthys macrolepidotus* (T)

Invertebrates

Conservancy fairy shrimp, *Branchinecta conservatio* (E)

vernal pool tadpole shrimp, *Lepidurus packardi* (E)

vernal pool fairy shrimp, *Branchinecta lynchi* (T)

valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (T)

Plants

hairy Orcutt grass, *Orcuttia pilosa* (E)

Greene's tuctoria, *Tuctoria greenei* (E)

Hoover's spurge, *Chamaesyce hooveri* (T)

slender Orcutt grass, *Orcuttia tenuis* (T)

Candidate Species

Fish

Klamath Mts. Province steelhead, *Oncorhynchus mykiss* (C)

Central Valley fall/late fall-run chinook salmon, *Oncorhynchus tshawytscha* (C)

Species of Concern

Mammals

California wolverine, *Gulo gulo luteus* (CA)

Sierra Nevada red fox, *Vulpes vulpes necator* (CA)

pale Townsend's big eared bat, *Corynorhinus (=Plecotus) townsendii pallescens* (SC)

Pacific western big-eared bat, *Corynorhinus (=Plecotus) townsendii townsendii* (SC)

spotted bat, *Euderma maculatum* (SC)

Sierra Nevada snowshoe hare, *Lepus americanus tahoensis* (SC)

Pacific fisher, *Martes pennanti pacifica* (SC)

small-footed myotis bat, *Myotis ciliolabrum* (SC)

long-eared myotis bat, *Myotis evotis* (SC)

fringed myotis bat, *Myotis thysanodes* (SC)

long-legged myotis bat, *Myotis volans* (SC)

Yuma myotis bat, *Myotis yumanensis* (SC)

San Joaquin pocket mouse, *Perognathus inornatus* (SC)

Birds

Swainson's hawk, *Buteo Swainsoni* (CA)

little willow flycatcher, *Empidonax traillii brewsteri* (CA)

greater sandhill crane, *Grus canadensis tabida* (CA)

bank swallow, *Riparia riparia* (CA)

American peregrine falcon, *Falco peregrinus anatum* (D)

Black Crowned Night Heron, *Nycticorax nycticorax* (MB)

northern goshawk, *Accipiter gentilis* (SC)

tricolored blackbird, *Agelaius tricolor* (SC)

grasshopper sparrow, *Ammodramus savannarum* (SC)

Bell's sage sparrow, *Amphispiza belli belli* (SC)

short-eared owl, *Asio flammeus* (SC)

western burrowing owl, *Athene cunicularia hypugea* (SC)

American bittern, *Botaurus lentiginosus* (SC)

ferruginous hawk, *Buteo regalis* (SC)

Lawrence's goldfinch, *Carduelis lawrencei* (SC)

Vaux's swift, *Chaetura vauxi* (SC)

black tern, *Chlidonias niger* (SC)

lark sparrow, *Chondestes grammacus* (SC)

black swift, *Cypseloides niger* (SC)

hermit warbler, *Dendroica occidentalis* (SC)

white-tailed (=black shouldered) kite, *Elanus leucurus* (SC) loggerhead shrike, *Lanius ludovicianus* (SC)

Lewis' woodpecker, *Melanerpes lewis* (SC)

long-billed curlew, *Numenius americanus* (SC)

white-faced ibis, *Plegadis chihi* (SC)

rufous hummingbird, *Selasphorus rufus* (SC)

Brewer's sparrow, *Spizella breweri* (SC)

California spotted owl, *Strix occidentalis occidentalis* (SC)

Bewick's wren, *Thryomanes bewickii* (SC)

Reptiles

northwestern pond turtle, *Clemmys marmorata marmorata* (SC)

California horned lizard, *Phrynosoma coronatum frontale* (SC)

Amphibians

tailed frog, *Ascaphus truei* (SC)

foothill yellow-legged frog, *Rana boylii* (SC)

mountain yellow-legged frog, *Rana muscosa* (SC)

western spadefoot toad, *Scaphiopus hammondii* (SC)

Fish

green sturgeon, *Acipenser medirostris* (SC)

river lamprey, *Lampetra ayresi* (SC)

longfin smelt, *Spirinchus thaleichthys* (SC)

Invertebrates

Antioch Dunes anthicid beetle, *Anthicus antiochensis* (SC)

Sacramento anthicid beetle, *Anthicus sacramento* (SC)

Leech's skyline diving beetle, *Hydroporus leechi* (SC)

California linderiella fairy shrimp, *Linderiella occidentalis* (SC)

Plants

Indian Valley brodiaea, *Brodiaea coronaria ssp. rosea* (CA)

upswept moonwort, *Botrychium ascendens* (SC)

scalloped moonwort, *Botrychium crenulatum* (SC)

Wilkins' harebell, *Campanula wilkinsiana* (SC)

silky cryptantha, *Cryptantha crinita* (SC)

clustered lady's-slipper, *Cypripedium fasciculatum* (SC)

Oregon fireweed, *Epilobium oreganum* (SC)

Brandegee's woolly star, *Eriastrum brandegeae* (SC)

Butte fritillary, *Fritillaria eastwoodiae* (SC)

adobe lily, *Fritillaria pluriflora* (SC)

Tehama dwarf-flax, *Hesperolinon tehamense* (SC) legenere, *Legenere limosa* (SC)

Mt. Tedoc linanthus, *Linanthus nuttallii ssp. howellii* (SC)

red flowered lotus, *Lotus rubriflorus* (SC)

Anthony Peak lupine, *Lupinus antoninus* (SC)

Stebbins' madia, *Madia stebbinsii* (SC)

The Lassics sandwort, *Minuartia decumbens* (SC)

Ahart's whitlow wort, *Paronychia ahartii* (SC)

valley sagittaria, *Sagittaria sanfordii* (SC)

Tracy's sanicle, *Sanicula tracyi* (SC)

Butte County (western) catchfly, *Silene occidentalis ssp. longistipitata* (SC)

KEY:

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(T)	*Threatened*	Listed as likely to become endangered within the foreseeable future.
(P)	*Proposed*	Officially proposed (in the Federal Register) for listing as endangered or threatened.
(PX)	*Proposed Critical Habitat*	Proposed as an area essential to the conservation of the species.
(C)	*Candidate*	Candidate to become a *proposed* species.
(SC)	*Species of Concern*	Other species of concern to the Service.
(D)	*Delisted*	Delisted. Status to be monitored for 5 years.
(CA)	*State-Listed*	Listed as threatened or endangered by the State of California.
*	*Extirpated*	Possibly extirpated from the area.
**	*Extinct*	Possibly extinct.
	Critical Habitat	Area essential to the conservation of a species.

Federal Endangered and Threatened Species that may be Affected by Projects in the RED BLUFF EAST 7 1/2 Minute Quad

Database Last Updated: June 17, 2002
Today's Date is: June 26, 2002

Listed Species

Invertebrates
Branchinecta lynchi - vernal pool fairy shrimp (T)
Desmocerus californicus dimorphus - valley elderberry longhorn beetle (T)
Lepidurus packardi - vernal pool tadpole shrimp (E)

Fish
Hypomesus transpacificus - delta smelt (T)
Oncorhynchus mykiss - Central Valley steelhead (T) (NMFS)
Oncorhynchus tshawytscha - Central Valley spring run chinook salmon (T) (NMFS)
Pogonichthys macrolepidotus - Sacramento splittail (T)

Amphibians
Rana aurora draytonii - California red-legged frog (T)

Reptiles
Thamnophis gigas - giant garter snake (T)

Birds
Haliaeetus leucocephalus - bald eagle (T)

Candidate Species

Fish
Oncorhynchus tshawytscha - Central Valley fall/late fall run chinook salmon (C) (NMFS)

Birds
Coccyzus americanus occidentalis - Western yellow-billed cuckoo (C)

Species of Concern

Invertebrates
Anthicus antiochensis - Antioch Dunes anthicid beetle (SC)
Anthicus sacramento - Sacramento anthicid beetle (SC)
Linderiella occidentalis - California linderiella fairy shrimp (SC)

Fish
Acipenser medirostris - green sturgeon (SC)
Lampetra ayresi - river lamprey (SC)
Spirinchus thaleichthys - longfin smelt (SC)

Amphibians
Rana boylii - foothill yellow-legged frog (SC)
Spea hammondii - western spadefoot toad (SC)

Reptiles
Clemmys marmorata marmorata - northwestern pond turtle (SC)

Birds
Agelaius tricolor - tricolored blackbird (SC)
Ammodramus savannarum - grasshopper sparrow (SC)
Asio flammeus - short-eared owl (SC)
Athene cunicularia hypugaea - western burrowing owl (SC)
Baeolophus inornatus - oak titmouse (SLC)
Branta canadensis leucopareia - Aleutian Canada goose (D)
Buteo regalis - ferruginous hawk (SC)
Buteo Swainsoni - Swainson's hawk (CA)
Carduelis lawrencei - Lawrence's goldfinch (SC)
Chaetura vauxi - Vaux's swift (SC)
Chlidonias niger - black tern (SC)

Elanus leucurus - white-tailed (=black shouldered) kite (SC)
Empidonax traillii brewsteri - little willow flycatcher (CA)
Falco peregrinus anatum - American peregrine falcon (D)
Lanius ludovicianus - loggerhead shrike (SC)
Melanerpes lewis - Lewis' woodpecker (SC)
Numenius americanus - long-billed curlew (SC)
Picoides nuttallii - Nuttall's woodpecker (SLC)
Plegadis chihi - white-faced ibis (SC)
Riparia riparia - bank swallow (CA)
Selasphorus rufus - rufous hummingbird (SC)
Mammals
Corynorhinus (=Plecotus) townsendii pallescens - pale Townsend's big-eared bat (SC)
Corynorhinus (=Plecotus) townsendii townsendii - Pacific western big-eared bat (SC)
Euderma maculatum - spotted bat (SC)
Myotis ciliolabrum - small-footed myotis bat (SC)
Myotis evotis - long-eared myotis bat (SC)
Myotis thysanodes - fringed myotis bat (SC)
Myotis volans - long-legged myotis bat (SC)
Myotis yumanensis - Yuma myotis bat (SC)
Perognathus inornatus - San Joaquin pocket mouse (SC)
Plants
Cryptantha crinita - silky cryptantha (SC)
Fritillaria pluriflora - adobe lily (SC)
Juncus leiospermus var. leiospermus - Red Bluff (dwarf) rush (SC)

Species with Critical Habitat Proposed or Designated in this Quad

Central Valley fall/late fall-run chinook (C)
Central Valley spring-run chinook (T)
winter-run chinook salmon (E)

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(T) **Threatened** - Listed as likely to become endangered within the foreseeable future.
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(C) Candidate - Candidate to become a proposed species.
(CA) Listed by the State of California but not by the Fish & Wildlife Service.
(D) Delisted - Species will be monitored for 5 years.
(SC) Species of Concern/(SLC) Species of Local Concern - Other species of concern to the Sacramento Fish & Wildlife Office.

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This is *not* an official list for formal consultation under the Endangered Species Act. *However, it may be used to update official lists.*

If you have a project that may affect endangered species, please contact the Endangered Species Division, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service

Federal Endangered and Threatened Species that may be affected by projects in Tehama County

Database Last Updated: June 17, 2002
Today's Date is: June 26, 2002

Listed Species

Invertebrates
Branchinecta conservatio - Conservancy fairy shrimp (E)
Branchinecta lynchi - vernal pool fairy shrimp (T)
Desmocerus californicus dimorphus - valley elderberry longhorn beetle (T)
Lepidurus packardi - vernal pool tadpole shrimp (E)

Fish
Hypomesus transpacificus - delta smelt (T)
Oncorhynchus mykiss - Central Valley steelhead (T) (NMFS)
Oncorhynchus tshawytscha - winter-run chinook salmon (E) (NMFS)
Pogonichthys macrolepidotus - Sacramento splittail (T)

Amphibians
Rana aurora draytonii - California red-legged frog (T)

Reptiles
Thamnophis gigas - giant garter snake (T)

Birds
Haliaeetus leucocephalus - bald eagle (T)
Strix occidentalis caurina - northern spotted owl (T)

Plants
Chamaesyce hooveri - Hoover's spurge (T)
Orcuttia pilosa - hairy Orcutt grass (E)
Orcuttia tenuis - slender Orcutt grass (T)
Tuctoria greenei - Greene's tuctoria (=Orcutt grass) (E)

Candidate Species

Fish
Oncorhynchus tshawytscha - Central Valley fall/late fall-run chinook salmon (C) (NMFS)

Birds
Coccyzus americanus occidentalis - Western yellow-billed cuckoo (C)

Species of Concern

Invertebrates
Anthicus antiochensis - Antioch Dunes anthicid beetle (SC)
Anthicus sacramento - Sacramento anthicid beetle (SC)
Hydroporus leechi - Leech's skyline diving beetle (SC)
Linderiella occidentalis - California linderiella fairy shrimp (SC)

Fish
Acipenser medirostris - green sturgeon (SC)
Lampetra ayresi - river lamprey (SC)
Spirinchus thaleichthys - longfin smelt (SC)

Amphibians
Ascaphus truei - tailed frog (SC)
Rana boylii - foothill yellow-legged frog (SC)
Rana muscosa - mountain yellow-legged frog (SC)
Spea hammondii - western spadefoot toad (SC)

Reptiles
Clemmys marmorata marmorata - northwestern pond turtle (SC)
Phrynosoma coronatum frontale - California horned lizard (SC)

Birds

Accipiter gentilis - northern goshawk (SC)
Agelaius tricolor - tricolored blackbird (SC)
Ammodramus savannarum - grasshopper sparrow (SC)
Amphispiza belli belli - Bell's sage sparrow (SC)
Asio flammeus - short-eared owl (SC)
Athene cunicularia hypugaea - western burrowing owl (SC)
Baeolophus inornatus - oak titmouse (SLC)
Botaurus lentiginosus - American bittern (SC)
Branta canadensis leucopareia - Aleutian Canada goose (D)
Buteo regalis - ferruginous hawk (SC)
Buteo Swainsoni - Swainson's hawk (CA)
Carduelis lawrencei - Lawrence's goldfinch (SC)
Chaetura vauxi - Vaux's swift (SC)
Chlidonias niger - black tern (SC)
Cypseloides niger - black swift (SC)
Dendroica occidentalis - hermit warbler (SC)
Egretta thula - Snowy Egret (MB)
Elanus leucurus - white-tailed (=black shouldered) kite (SC)
Empidonax traillii brewsteri - little willow flycatcher (CA)
Falco peregrinus anatum - American peregrine falcon (D)
Gavia immer - common loon (SC)
Grus canadensis tabida - greater sandhill crane (CA)
Lanius ludovicianus - loggerhead shrike (SC)
Melanerpes lewis - Lewis' woodpecker (SC)
Numenius americanus - long-billed curlew (SC)
Picoides nuttallii - Nuttall's woodpecker (SLC)
Plegadis chihi - white-faced ibis (SC)
Riparia riparia - bank swallow (CA)
Selasphorus rufus - rufous hummingbird (SC)
Strix occidentalis occidentalis - California spotted owl (SC)
Toxostoma redivivum - California thrasher (SC)

Mammals

Corynorhinus (=Plecotus) townsendii pallescens - pale Townsend's big-eared bat (SC)
Corynorhinus (=Plecotus) townsendii townsendii - Pacific western big-eared bat (SC)
Euderma maculatum - spotted bat (SC)
Gulo gulo luteus - California wolverine (CA)
Lepus americanus tahoensis - Sierra Nevada snowshoe hare (SC)
Martes pennanti pacifica - Pacific fisher (SC)
Myotis ciliolabrum - small-footed myotis bat (SC)
Myotis evotis - long-eared myotis bat (SC)
Myotis thysanodes - fringed myotis bat (SC)
Myotis volans - long-legged myotis bat (SC)
Myotis yumanensis - Yuma myotis bat (SC)
Perognathus inornatus - San Joaquin pocket mouse (SC)
Vulpes vulpes necator - Sierra Nevada red fox (CA)

Plants

Agrostis hendersonii - Henderson's bent grass (SC)
Arctostaphylos canescens ssp sonomensis - Sonoma manzanita (SLC)
Astragalus rattanii var jepsonianus - Jepson's milk-vetch (SLC)
Balsamorhiza macrolepis var macrolepis - big-scale (=California) balsamroot (SLC)
Botrychium ascendens - upswept moonwort (SC)
Botrychium crenulatum - scalloped moonwort (SC)
Brodiaea coronaria ssp. rosea - Indian Valley brodiaea (CA)
Calystegia atriplicifolia ssp. buttensis - Butte County morning-glory (SC)
Campanula wilkinsiana - Wilkin's harebell (SC)
Chamaesyce ocellata ssp. rattanii - Stony Creek spurge (SLC)

Chlorogalum pomeridianum var. minus - dwarf soaproot (= wavyleaf soap plant) (SLC)
Clarkia gracilis ssp. albicaulis - white-stemmed (= whitestem) clarkia (SLC)
Cryptantha crinita - silky cryptantha (SC)
Cypripedium fasciculatum - clustered lady's-slipper (SC)
Epilobium oreganum - Oregon fireweed (SC)
Eriastrum brandegeae - Brandegee's woolly-star (= eriastrum) (SC)
Eriogonum libertini - Dubakella Mountain buckwheat (SLC)
Fritillaria eastwoodiae - Butte fritillary (SC)
Fritillaria pluriflora - adobe lily (SC)
Gratiola heterosepala - Boggs Lake hedge-hyssop (CA)
Hesperolinon tehamense - Tehama dwarf-flax (SC)
Iliamna bakeri - Baker's globe mallow (= Baker's wild hollyhock) (SLC)
Juncus leiospermus var. leiospermus - Red Bluff (dwarf) rush (SC)
Layia septentrionalis - Colusa layia (= Colusa tidytips) (SLC)
Legenere limosa - legenere (SC)
Linanthus nuttallii ssp. howellii - Mt. Tedoc linanthus (SLC)
Lotus rubriflorus - red-flowered lotus (SC)
Lupinus antoninus - Anthony Peak lupine (SC)
Madia stebbinsii (= Harmonia stebbinsii) - Stebbins's madia (= Stebbins's harmonia) (SC)
Navarretia leucocephala ssp. bakeri - Baker's navarretia (SC)
Oreostemma elatum - tall alpine aster (= Plumas alpine aster) (SLC)
Paronychia ahartii - Ahart's whitlow-wort (= Ahart's paronychia) (SC)
Rupertia hallii - Hall's rupertia (= Hall's California tea) (SLC)
Sagittaria sanfordii - valley sagittaria (= Sanford's arrowhead) (SC)
Silene campanulata ssp. campanulata - Red Mountain catchfly (= campion) (CA)
Silene occidentalis ssp. longistipitata - Butte County catchfly (= long-stiped campion) (SC)

Species with Critical Habitat Proposed or Designated in this County

Central Valley fall/late fall-run chinook (C)
Central Valley spring-run chinook (T)
Central Valley steelhead (T)
northern spotted owl (T)
winter-run chinook salmon (E)

Key:
(E) Endangered - Listed (in the Federal Register) as being in danger of extinction.
(T) Threatened - Listed as likely to become endangered within the foreseeable future.
(P) Proposed - Officially proposed (in the Federal Register) for listing as endangered or threatened.
(NMFS) Species under the Jurisdiction of the National Marine Fisheries Service. Consult with them directly about these species.
Critical Habitat - Area essential to the conservation of a species.
(PX) Proposed Critical Habitat - The species is already listed. Critical habitat is being proposed for it.
(C) Candidate - Candidate to become a proposed species.
(CA) Listed by the State of California but not by the Fish & Wildlife Service.
(D) Delisted - Species will be monitored for 5 years.
(SC) Species of Concern/(SLC) Species of Local Concern - Other species of concern to the Sacramento Fish & Wildlife Office.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

This is not an official list for formal consultation under the Endangered Species Act. *However, it may be used to update official lists.*

If you have a project that may affect endangered species, please contact the Endangered Species Division, Sacramento Fish and Wildlife Office, U.S. Fish and Wildlife Service.

Appendix D
Sensitive Plant and Wildlife Species

APPENDIX D

Sensitive Plant and Wildlife Species

Sensitive plant and wildlife species with the potential to occur within the project area were determined from a records search of the California Natural Diversity Data Base (CNDDB) and consultation with the U.S. Fish and Wildlife Service (USFWS). The species that have the potential to occur within the project area are discussed below and potential impacts resulting from project activities are evaluated. Table D-1 (at the end of this appendix) summarizes status, habitat, season, and reported occurrences of those species.

Birds

American Bittern (Botaurus lentiginosus)

The American bittern is widely distributed throughout North America. Breeding range extends from the central U.S. northward into Canada. The breeding season extends from March to early May. Fall migration to wintering range in the southern U.S., Mexico, and central America begins in September and continues through November. Bitterns are non-migratory along the Pacific Coast from California to British Columbia. Nests sites are typically located in dense emergent vegetation in shallow-water wetlands. Foraging occurs at dawn and dusk with insects, amphibians, crayfish, small fish, and mammals as primary prey. Wetlands habitat loss is the primary factor responsible for the decline of this species as well as contaminants and pollution. This species has been observed on rare occasions near Red Bluff during breeding bird surveys. The American bittern is a Federal species of concern.

Black-crowned Night Heron (*Nycticorax nycticorax*)

The black-crowned night heron breeds throughout most of the U.S. and is a resident throughout most of California. The breeding season lasts from February to July. Nests are built in areas with dense foliage including trees, shrubs and wetlands. This species forages at night feeding on fish, crustaceans, insects, amphibians, reptiles, and mammals. Winter migration for non-resident species begins in July and continues through October. Wintering range includes areas in the southern U.S. to South America. Nest sites are generally built near aquatic habitats, as most foraging occurs in shallow waters such as swamps, ponds, marshes, lakes, and rice fields. Primary threats to this species include habitat loss, pesticides, and human disturbance of nest sites. The black-crowned night heron has been spotted only on rare occasions in the Red Bluff area during breeding bird surveys. The black-crowned night heron is a Federal species of concern.

White-faced Ibis (*Plegadis chihi*)

In the U.S., the breeding and wintering range of the white-faced ibis is concentrated in Southern California and the southern portion of the gulf states. Local breeding occurs in northern California and southern Oregon as well as areas in the Great Basin states and the Midwest. Large flocks gather in wintering habitats in the U.S. and Mexico. Fall migration begins in early August and continues through mid-September. Freshwater wetlands with dense emergent vegetation provide the primary habitat, but agricultural fields are often used for foraging. Breeding begins in April and continues through June. Nests are built in shallow wetlands areas with emergent vegetation such as cattails, bulrush, or low trees and shrubs or tamarisk over shallow water. The white-faced ibis feeds in wetlands and flooded fields where primary prey items include crayfish, insects, and earthworms. Habitat loss, illegal hunting, and pesticides pose the greatest threats to this species. No nest sites have been reported in the vicinity of the project area. The white-faced ibis is a State and Federal special-status species.

Aleutian Canada Goose (*Branta canadensis leucopareia*)

The breeding areas for the Aleutian Canada goose are restricted to the Aleutian and Semidi islands in the North Pacific, but they migrate to the northern Central Valley during the winter. Southern migration begins in mid-October, and the geese remain in California through early April. Flocks gather in agricultural fields and feed on the remaining post-harvest grains during the day and roost in areas with shallow water at night. Introduced predators, overhunting, and disease resulted in dramatic population declines; however, protection and conservation measures have allowed the population to increase in recent years. There are no specific reports for this subspecies in the vicinity of the project area; however, 1999 Audubon Christmas bird counts for Red Bluff reported over 170 Canada geese (subspecies not determined), thus there is potential for this subspecies to occur near the project area. The Aleutian Canada goose was delisted in 2001.

Cooper's Hawk (*Accipiter cooperii*)

Cooper's hawks are widely distributed residents throughout North America. They can be found in a variety of habitats including woodlands, riparian forests, wetlands, grasslands, and agricultural fields. Breeding season begins in March and continues through June. Nests are built in large trees, generally near streams or open water. Small birds are the primary prey for Cooper's hawks, but small mammals are also important prey items. Historical population declines resulted from pesticides and loss of suitable nesting sites. While generally uncommon, the populations in the West are presumably stable (Rosenfield and Bielefeldt, 1993). Breeding bird surveys and 1999 Audubon Christmas bird counts in the Red Bluff area have reported Cooper's hawks present in the area. Cooper's hawks are a State species of special concern.

Sharp-shinned Hawk (*Accipiter cooperii*)

Sharp-shinned hawks are widely distributed throughout North America, with the breeding range largely in the northern parts of the continent and wintering areas in the southern half of the U.S. into Mexico and Central America. In California there is a small resident population, but the population increases from mid-September to mid-April during the winter migration (Small, 1994). During winter migration, a variety of habitats are used; however, wetlands and grasslands are rarely used, as plucking perches are required for sharp-shinned hawks. Breeding begins in April with nest sites in open woodlands and conifer forests. Small birds are the primary prey as well as small mammals, reptiles, amphibians, and insects. Habitat loss and pesticides are the principle factors responsible for population declines of this species. Breeding bird surveys and 1999 Audubon Christmas bird counts in the Red Bluff area have reported sharp-shinned hawks present in the area. The sharp-shinned hawk is a State species of special concern.

Northern Goshawk (*Accipiter gentilis*)

The northern goshawk is a widespread resident throughout the western U.S. and Canada. They are typically associated with montane conifer forests but may migrate to lower elevations in the winter to forage. Northern goshawks are the largest of the North American accipters and are well adapted for hunting in forests but may also forage in open areas. Breeding season occurs between March and April, with nests built in either conifer, deciduous, or mixed forests with suitable large trees. In California, most nesting occurs in old-growth ponderosa pine forests with high canopy closure. Relative to other areas throughout its range, the Sierra Nevada montane conifer forests are an important nesting area for northern goshawks (Squires and Reynolds, 1997). Prey includes a variety of birds and small mammals. Habitat loss resulting from timber harvest and pesticides have been responsible for historical population declines. Goshawks are uncommon in the lower areas of the State, but have been observed on rare occasions during breeding bird surveys in the Red Bluff area. The goshawk is a State species of special concern.

Golden Eagle (*Aquila chrysaetos*)

Golden eagles are widespread throughout most of North America and are resident species in California. They occupy primarily mountain and canyon habitats, usually avoiding dense forested areas where hunting is difficult because of their large wingspan. Breeding occurs between March and April. Nests are constructed on cliff ledges, high rocky outcrops, in large trees, and on top of telephone poles. Golden eagles hunt in a variety of habitat types including grasslands, oak savannah, meadows, open woodland, chaparral, and wetlands. Prey include hares, marmots, rodents, snakes, birds, and carrion. Habitat loss and pesticides have led to reduced population levels throughout its range. There are an estimated 500 breeding pairs in California (California Department of Fish and Game [CDFG], 1987). This species has been observed on rare occasions during breeding bird surveys near Red Bluff, and one golden eagle was noted in the 1999 Red Bluff Audubon Christmas bird count. Golden eagles are a State species of special concern and are a California fully protected species.

Ferruginous Hawks *(Buteo regalis)*

Ferruginous hawks are uncommon winter migrants in northern California where they forage in open grasslands and agricultural areas between September and April. Small mammals are the primary prey, but birds, reptiles, and amphibians are also taken. Ferruginous hawks will roost in scattered trees and on utility poles. Pesticides, shooting, agricultural conversion, and rodent control programs have led to historical declines in the population; however, current populations appear to be stable (Bechard and Schmutz, 1995). Non-nesting ferruginous hawks have been observed in the Red Bluff area during 1999 Audubon Christmas bird counts. Ferruginous hawks are California State and Federal special-status species.

Sawinson's Hawk (*Buteo Swainsoni*)

Swainson's hawks are widespread throughout much of central and western North America; during the winter, large flocks of Swainson's hawks migrate to South America. Although this species was historically widespread throughout California, most of the populations are now restricted to the Central Valley and Great Basin areas of the State. Breeding season begins in late March, and fall migration begins in August. Insects are an important prey, especially during the nonbreeding season, and large flocks of Swainson's hawks often congregate in fields to forage. During the breeding season, small mammals, birds, lizards, and amphibians are taken. Nest sites occur in mature riparian forests, oak groves, or in large trees adjacent to grasslands or agricultural fields. Loss of nesting habitat throughout California and pesticide use throughout the wintering range are the two most significant factors in the decline of this species. One nesting pair was observed in 1993 north of the project site along Salt Creek. Swainson's hawks are listed as threatened in California.

Northern Harrier (*Circus cyaneus*)

Northern harriers are widespread throughout North America. In California, they are common winter migrants and occasional residents in the Central Valley. Harriers are generally found in open habitats such as grasslands, rangelands, agricultural fields, marshes, and open woodlands and conifer forests. Northern harriers construct nests on the ground in areas of tall, dense vegetation, usually near water such as rivers, lakes, and marshes, but may also nest in grasslands and agricultural fields. Breeding occurs between April and September. Small mammals and birds are the primary prey, but reptiles and frogs are also taken. Habitat loss and degradation as well as pesticides are the most significant threats to this species. While the overall population appears to be declining, they remain locally abundant in California (Zeiner et al., 1990). Few northern harriers have been observed during breeding bird surveys in the Red Bluff area, but they were relatively common during 1999 Audubon Christmas bird counts. Northern harriers are a California species of special concern.

White-tailed Kite (*Elanus leucrus*)

White-tailed kites have a disjunct distribution throughout much of North America, and in California are uncommon to common residents in coastal areas and valley lowlands. They nest in a variety of habitats including oak woodlands, savannas, and riparian areas in tall trees and shrubs in and near open foraging grounds. Breeding season lasts from February through August with a peak between March and May. Voles are the principle prey, but other small mammals, birds, reptiles, and amphibians are also taken. Kites are often found foraging in agricultural areas as well as grasslands and wetlands. Although the population has historically declined, this species has become well adapted to human-modified landscapes, and the population appears to be increasing (Zeiner et al., 1990). This species in known to nest in riparian areas near Gerber and has been observed on rare occasions during breeding bird surveys and 1999 Audubon Christmas bird counts in the Red Bluff area. White-tailed kites are listed as State and Federal special-status species.

Bald Eagle (*Haliaectus leucocephalus*)

In western North America bald eagles are resident species from northern California to Alaska. Breeding populations in California are restricted to the northeast part of the State with half of the wintering population found in the Klamath Basin (Zeiner et al., 1990). Nests are constructed in large old-growth trees with open canopies, often in ponderosa pines. Nesting begins in November, and breeding season extends from February through July. Nest sites are built close to water such as lakes, rivers, and estuaries as fish are a significant part of bald eagle's diet. Eagles are sensitive to nest site disturbance and will not nest around human activity. Eagles will also take small mammals, birds, reptiles, and carrion. Human activity such as logging and off-road vehicle traffic can result in nest abandonment. Pesticides, habitat loss, and illegal shooting have led to population declines, but protection measures have resulted in an increase in the population in recent decades. Bald eagles are only rare breeders in Tehama County and occasional migrants through the area. Eagles are not known to nest in the project area and have been observed only rarely during breeding bird surveys in the Red Bluff area. However, they may be somewhat more common during the winter as they have been recently observed in Red Bluff 1999 Audubon Christmas bird surveys. Bald eagles are a California State endangered and Federal-listed threatened species.

Osprey (*Pandion haliaetus*)

The osprey is a widespread species and has an extensive breeding range throughout northern California. During the winter, osprey migrate to more southern latitudes of California, the Gulf Coast, and Central and South America. Large trees, snags, and utility poles are used as nest sites. Osprey feed predominately on fish, and nest sites are generally located close to open water. The breeding season begins in late March and continues through April. Fall migration may begin as soon as September and continue through mid-November, but the peak migration period occurs between late September and early October. Pesticides resulted in dramatic population declines; however, since the ban on DDT, populations have been increasing. However, pesticide use in the winter range stills poses a threat to this species. Two nesting pair were observed within the project area near the confluence of Red Bank Creek and the Sacramento River. Osprey are a California State species of concern.

Prairie Falcon (*Falco mexicanus*)

Prairie falcons occur throughout the western half of North America, breeding as far north as southern Canada and wintering in Mexico and Central America. In California they are residents throughout much of the Sierra Nevada and Coast Range, with the exception of the northwest part of the State. Winter migrants are also common throughout the Central Valley. Nests are built on cliffs, bluffs, and rock outcrops with sheltered ledges overlooking large open areas. Breeding season occurs from mid-February through September, with a peak between April and August. Small mammals are the primary prey, with occasional small birds and reptiles also included in the diet. Foraging occurs in open habitats including annual grasslands, savannas, rangelands, and agricultural fields. Pesticides have resulted in historical population declines of this species. This species has not been observed nesting in the vicinity of the project area, but has been observed in the Red Bluff area during 1999 Audubon Christmas bird counts and has been observed on rare occasions during breeding bird surveys in the area. The prairie falcon is a State species of special concern.

Peregrine Falcon (*Falco peregrinus anatum*)

The American peregrine falcon, which is the most southerly subspecies of peregrine falcon in North America, breeds south of the Arctic Tundra of Canada and Alaska to Mexico. In winter and during migration, the American peregrine falcon extends its range southward to the Caribbean and parts of South America. In California it is a resident species throughout the Coast Range and Sierra Nevada, and a winter migrant throughout the Central Valley. Breeding season occurs between March and August, with nests located on ledges, human-made structures, trees, snags, or in old raptor nests in forests and woodlands near wetlands, lakes, and rivers. Riparian areas and wetlands are particularly important habitats for this species (Zeiner et al., 1990). Peregrine falcons prey mostly on birds, but will also take small mammals, fish, and insects. This species is not known to nest in the vicinity of the project area, but has been observed in the Red Bluff area during 1999 Audubon Christmas bird counts and observed on rare occasions during breeding bird surveys in the area. Habitat loss and pesticides led to dramatic population declines, but the population has made a significant recovery in recent decades and has been delisted by USFWS. Peregrine falcons remain listed as endangered by the State of California.

Black Tern (*Chlidonias niger*)

The current breeding range of the black tern includes the northern U.S. and southern Canada, and its winter range includes the southern U.S., Mexico, and Central America. In California, it was historically a common spring and summer migrant, but populations have declined throughout its range, especially in the Central Valley as a result of habitat loss and pesticides. Spring migration begins in April, and fall migration begins as early as June and lasts through September; however, some birds may remain throughout the season (Zeiner et al., 1990). Breeding occurs between May and August in freshwater wetlands with extensive emergent vegetation and areas of open water. Nests are built on mats of floating vegetation or on the ground near water. Black terns forage on insects and fish but will also take tadpoles, frogs, crustaceans, and worms. Foraging habitats include wetlands, wet meadows, rice fields, irrigated agricultural crops, and riparian areas They have been observed only rarely during breeding bird surveys in the Red Bluff area. Black terns are State and Federal special-status species.

Western Yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)

Historically, the yellow-billed cuckoo was widespread throughout the western U.S.; however, the extensive loss of mature riparian forest has resulted in dramatic declines of this species. In California it is now an uncommon to rare summer resident in scattered locations of its former range. Fall migration to South America begins in August and continues through September. Cuckoos maintain large territories, and suitable habitat of at least 25 acres may be required for breeding to occur. Breeding season begins in late June in the Sacramento River Valley. Dense cottonwood-willow stands are used by the yellow-billed cuckoo for nesting sites. Cuckoos are primarily insectivores, but will occasionally consume small reptiles and amphibians. This species has historically nested at Todd and Mooney islands, several miles to the southeast of the project area, but there are no recent observations in the vicinity of the project area. The western yellow-billed cuckoo is a California State endangered species and a candidate for Federal listing.

Short-eared Owl (*Asio flammeus*)

Short-eared owls occur throughout North America and historically breed throughout much of California, but breeding populations are now largely restricted to the northeastern portion of the State. They are more common and widespread winter migrants, especially in the Central Valley between September and April. Breeding season is between March and July. Nesting occurs in open habitats with dense vegetation such as grasslands and upland areas in marshes. Voles are the principal prey item, but other rodents, small mammals, birds, reptiles, amphibians, and arthropods are also taken. Foraging occurs in open habitats including grasslands, pastures, agriculture fields, and wetlands. Fence posts and small mounds are often used as perch sites. Agricultural conversion and urban development have significantly diminished suitable breeding habitat throughout much of the State, and the historical range and populations in California have been greatly reduced (Zeiner et al., 1990). This species has been observed only rarely in the Red Bluff area. The short-eared owl is a State and Federal special-status species.

Burrowing Owl (*Athene cunicularia hypougea*)

Burrowing owls occur in western North America from southern Canada to central Mexico. The species is generally non-migratory; however, owls in the northern parts of the range migrate south during the winter months. They are residents throughout much of California excluding the mesic coastal forests in the northwest and the high sierras. Breeding season starts in late March and continues through April. Burrowing owls generally forage on large arthropods, but will also consume small mammals, birds, reptiles, and amphibians. Burrows created by other animals, most commonly the California ground squirrel, are used as nest sites. Nests are generally located in dry, open areas such as grasslands, pastures, and agricultural fields; but burrowing owls will also nest in road embankments and near open urban areas. Population declines have resulted from extensive habitat loss, rodent control programs, pesticides, predators, and collisions with vehicles. There is one reported occurrence located several miles to the northeast of the project area along Little Salt Creek, and they have been observed on rare occasions during breeding bird surveys in the Red Bluff area. The burrowing owl is a State and Federal special-status species.

Vaux’s Swift (*Chaetura vauxi*)

Vaux’s swift breeds in western North America and winters in Mexico and Central America. In California, they primarily nest in the Coast Range south to Monterey County, but are also likely to breed in low densities in Lake, Butte, Tehama, Plumas, and other interior California counties. Breeding season is between May and August. They nest in conifer forests along the central and northern California coast, and mixed oaks and conifers in the interior mountain ranges. Nests are typically built in hollow trees or snags, especially those charred by fire. Migrating birds may be common throughout the State in the spring, between April and May, and again in the fall between August and September. Foraging occurs above the forest canopy and at lower levels in meadows, over lakes, rivers, ponds, and above burned areas. Vaux’s swifts feed exclusively on insects captured in flight (Zeiner et al., 1990). Significant population declines of the Vaux's swift have been documented in Oregon and Washington, and most populations are believed to be declining throughout the species’ range. The removal of large broken-top trees and large hollow snags, most of which are found in late-seral stage forests, has been suggested as contributing to population declines. This species has only been observed on rare occasions during breeding bird surveys in the Red Bluff area. Vaux's swift is a State and Federal special-status species.

Black Swift (*Cypseloides niger*)

The black swift occurs in western North America, breeding very locally from southeastern Alaska, through western Canada and the U.S. and into Mexico. The winter range is poorly known but it may be found in northern South America and in the West Indies (DeGraaf and Rappole, 1995). In California, black swifts breed very locally in the Sierra Nevada and Cascade Range, the San Gabriel, San Bernardino, and San Jacinto mountains, and in coastal bluffs and mountains from San Mateo County south probably to San Luis Obispo County. Black swifts are present in California between May and September, and breeding occurs from June to August. Nests are built on cliffs, often in deep canyons behind waterfalls or on coastal bluffs. Foraging occurs over a wide variety of habitats where insects are captured in flight. Common prey items include wasps, flies, mayflies, caddisflies, beetles, leafhoppers, and beetles. The current status of black swifts is uncertain. Kaufman (1996) characterized the population as probably stable, but DeGraaf and Rappole (1995) consider the species to be experiencing a long-term decline. They have been observed only on rare occasions in the vicinity of Red Bluff and seldom occur outside of their breeding range (Zeiner et al., 1990). The black swift is a State and Federal special-status species.

Rufous Hummingbird (*Selasphorus rufus*)

The rufous hummingbird breeds from northwestern California in the Trinity Mountains to southeastern Alaska, and winters in the Southern U.S., Mexico- and Central America. In California it is an uncommon breeder, but a fairly common migrant species. Spring migration through the lowlands and foothills of California occurs between February and May, where riparian areas, open woodlands, chaparral, orchards, and gardens provide migrational habitats. Breeding is thought to occur only in montane conifer forests in the Trinity Mountains in California between April and July. Nests are constructed in berry tangles, shrubs, and conifers. Fall migration occurs between June and July, but is generally restricted to the higher elevation areas in the Coast Range and Sierra Nevada where nectar-producing flowers are abundant. While nectar is the principal food item, they will also glean insects from flowers and foliage and forage on tree sap. In general, the population appears to be stable, and no significant threats have been identified for this species. This species has been only rarely observed during breeding bird surveys in the Red Bluff area. Migrating populations may use the riparian area along Red Bank Creek. It is a California watch list species and a Federal species of concern.

Lewis' Woodpecker (*Melanerpes lewis*)

The Lewis' woodpecker occurs in localized populations throughout the U.S. west of the Great Plains. It is a resident throughout much of California and southern Oregon. They can be found in a variety of habitats depending on the season. Open conifer forests, especially burned-over pine forests appear to be preferred summer habitats at higher elevations, and oak woodlands are used extensively in the winter. Other habitats such as cottonwood riparian forests and fruit and nut orchards are also commonly used by this species. Nests are constructed in snags, generally in well-decayed dead trees, and breeding occurs between April and May. During the breeding season they forage primarily on insects, switching to acorns and other nuts during the winter. This species is generally uncommon throughout its range, and the population has declined dramatically since the 1960s (Tobalske, 1997). Principal threats include loss of habitat, pesticides, and competition from European starlings for nest sites. In the Red Bluff area, this species is rarely observed during the summer, but is a common winter resident according to 1999 Audubon Christmas bird counts, which recorded 34 sightings in 1999. The Lewis' woodpecker is a Federal species of concern.

Olive-sided Flycatcher (*Contopus borealis*)

The olive-sided flycatcher breeds from Alaska to southern California west into the Rocky Mountains and throughout most of Canada and the Northeastern U.S., and winters in South America. In California it is an uncommon to common summer resident between April and October. Breeding occurs in montane conifer forests where tall conifers are used for nest and perch sites. Olive-sided flycatchers forage on insects above the forest canopy, in meadows, clearings, and over chaparral-covered slopes. They are uncommon transients in low-elevation woodlands (Zeiner et al., 1990). Early breeding bird surveys indicated that this species was declining throughout much of its range, but populations in California appeared to be relatively stable (Robbins, et al., 1986). While the olive-sided flycatcher is benefited in the short term by clear-cutting, dense stands of even-aged timber are not used by this species. This species has been reported only rarely in breeding bird surveys in the Red Bluff area and is unlikely to occur within the vicinity of the project site. The olive-sided flycatcher is a California State and Federal watch list species.

Little Willow Flycatcher (*Empidonax traillii brewsteri*)

The little willow flycatcher is a rare to uncommon summer resident in California from May through September, migrating to South America during the winter months. Migrational habitats include narrow riparian corridors as well as shrubs and trees in parks and gardens. They require extensive dense stands of willows for nesting and roost sites. Preferred breeding habitats include willow thickets along the margins of wet montane meadows, ponds and back waters, and montane riparian areas. During the spring (May to June) and fall (August to September) migrations they are more common at lower elevations and less selective of habitat type. They forage primarily on insects, and less on berries and seeds, by making short forays from perches within the shrub thicket. Habitat loss and degradation, along with extensive nest parasitism by brown-headed cowbirds, has led to dramatic declines in the population in recent decades. Reports of this species during breeding bird surveys are rare in the Red Bluff area, and it is expected to occur only as a spring and fall migrant. The little willow flycatcher is a California State endangered species.

California Horned Lark (*Eremophila alpestris actia*)

While horned larks are generally widespread and common residents throughout the U.S., this subspecies has a restricted distribution from the North Coast Range in California south to Mexico and are relatively uncommon. The breeding season extends from March through July with a peak in May. Horned larks are ground nesters, preferring areas with low, sparse vegetation in grassland and open woodland habitats. They forage on the ground for insects and seeds, often in large flocks after the breeding season. Habitat loss, predation, and nest disturbances are the most significant threats to this subspecies. Horned larks are abundant in the Red Bluff area, but surveys have not distinguished between subspecies. The California horned lark is a California species of special concern.

Purple Martin (*Progne subis*)

The purple martin breeds west of the Cascade Range and Sierra Nevada from southwestern British Columbia south to Baja California and Arizona as well as areas east of the Rocky Mountains. In fall, it migrates to South America. Old woodpecker nests in tall, mature trees along rivers, estuaries, and other large water bodies are preferred nest sites, but they will occasionally nest in more urban areas (Zeiner et al., 1990). They arrive in California in late March, and breeding begins April and lasts through August, followed by fall migration in September. Purple martins forage by capturing insects in flight and occasionally on the ground. Foraging can occur over any habitat types where insects are abundant. A variety of habitats are used during migration including grasslands, wet meadows, wetlands, woodlands, and riparian areas. Significant declines in purple martins have been reported in California as a result of nest site competition with the introduced European starlings and the loss of suitable nest and roost trees, and loss of wetlands and riparian habitat. This species has been reported on rare occasions during breeding bird surveys in the Red Bluff area. The purple martin is a California State species of special concern.

Bank Swallow (*Riparia riparia*)

Bank swallows are neotropical migrants ranging throughout much of the U.S. and Canada. The largest breeding populations in California occur along the Sacramento and Feather rivers and their associated tributaries. Bank swallows are coloniel breeders, building nests in the friable soils of vertical streambanks between April and September. Vegetation and adjacent land use are highly variable and less important than soil type, slope, and bank height in determining nesting location. Bank swallows forage primarily over open riparian areas, but will also forage over agricultural fields, grasslands, and chaparral. They feed primarily on flying insects but will occasionally feed on terrestrial and aquatic insects. During the breeding season, foraging occurs within 650 feet of the nest sites. The population in California has declined largely as a result of flood control measures and bank stabilization projects. Nesting sites have been reported (1987) approximately a mile upriver from the Red Bluff Diversion Dam and at Blackberry Island, located several miles to the southwest of the project area. The bank swallow is a California State threatened species.

Bewick's Wren (*Thryomanes bewickii*)

Bewick's wren is a widespread resident species throughout the central and southern U.S. It is a widespread resident throughout most of California, with the exception of high elevations in the Sierra Nevada range and the Sonoran Desert. Breeding season lasts from mid-February through August with peak activity occurring between May and June. They prefer to nest in natural cavities and rock crevices in chaparral, woodlands, conifer forests, and riparian areas. They are associated with dense, shrubby vegetation where they glean insects from the foliage and branches. Populations east of the Mississippi have declined dramatically, and many populations have been extirpated; however, populations west of the Mississippi appear to be stable. The reason for the dramatic declines in the East are uncertain, but may have to do with competition from the house wren. The California populations do not appear to be threatened. Bewick's wrens have been observed in the Red Bluff area during breeding bird surveys and

1999 Audubon Christmas bird counts. Because of the steady decline of this species in the East, the Bewick's wren has been listed as a Federal species of concern.

Loggerhead Shrike (*Lanius ludovicianus*)

Loggerhead shrikes formerly nested throughout much of North America, from Canada south through the Great Basin, along the Gulf Coast, and south to Florida and Mexico; but their current range is more restricted, encompassing mainly the southern portions of the historical range. Loggerhead shrikes prefer open country such as grasslands, meadows, scrublands, deserts, pastures, and certain ruderal or agricultural lands with scattered shrubs, trees, fences, or other perch sites. They require dense shrubs or small trees in sparse riparian woodlands, foothill woodlands, and mixed conifer forests. Breeding occurs from February to July. Shrikes are carnivorous, eating a variety of prey including mice, small birds, reptiles, insects, and spiders, which are hunted from perches. Thorny trees and bushes, barbed wire and crevices are used to impale and store prey. The primary reason loggerhead shrikes are thought to have declined is loss and degradation of breeding habitat. Other causes of decline that have been suggested include possible adverse effects from pesticides (Cade and Woods, 1997). Despite general population declines, populations in the Pacific states appear to have remained relatively stable (Ziener et al., 1990). During 1999 Audubon Christmas bird counts, five loggerhead shrikes were observed in the Red Bluff area. The loggerhead shrike is a State and Federal special-status species.

Tri-colored Blackbird (*Agelaius tricolor*)

Tri-colored blackbirds are resident species primarily in California's Central Valley and coastal districts from Sonoma County south. In northeastern California, where the species is present only during summer, it occurs regularly only at Tule Lake; but breeding pairs have been observed in some years as far south as Honey Lake. Tri-colored blackbirds roost and nest in large flocks in areas with emergent wetland vegetation, especially cattails and tules, and in trees and shrubs adjacent to wetland areas. Breeding season is between April and July. Nests are usually located a few feet over, or near, fresh water or may be hidden on the ground among low vegetation. This species is highly colonial, often nesting in a minimum colony of about 50 pairs. They forage on the ground in croplands, grassy fields, flooded lands, and along edges of ponds feeding on insects, spiders, seeds, and cultivated grains, such as rice and oats. Tri-colored blackbirds are uncommon, but have been reported in 1999 breeding bird surveys and Audubon Christmas bird counts in the Red Bluff area. Tri-colored blackbird populations have declined in recent decades because of habitat loss and are California State and Federal special-status species.

Grasshopper Sparrow (*Ammodramus savannarum*)

Grasshopper sparrows are widespread in North America, occurring in a variety of grassland habitats including native prairie, hayfields, pastures, and grassy fallow fields. In California, they are uncommon local summer residents west of the Sierra Nevada and along the coast between March and September. They are ground nesting species, breeding between April and mid-July. Nest sites are generally constructed in dense grasslands with occasional shrubs for singing perches. They forage on the ground for insects and seeds, and other than singing males, are highly secretive. Recent population declines have occurred throughout its range primarily because of habitat loss and degradation. This species has been observed on rare occasions during breeding bird surveys in the Red Bluff area. The grasshopper sparrow is a Federal species of concern.

Lark Sparrow (Chondestes grammacus)

The breeding range of the lark sparrow includes most of the U.S.; it also migrates south into Mexico and Central America during the winter. In much of California, however, the lark sparrow is a non-migratory resident. It is commonly found in foothill woodlands, mixed conifer-hardwood forests, chaparral, and savannas along the margins of the Central Valley. Breeding begins in April, and nests are built on the ground in dense herbaceous cover or under shrubs. Lark sparrows forage on the ground or occasionally in small trees and shrubs, often in large flocks. Primary food items include insects, grains, and seeds. The national trend for this species is one of decline; however, California populations appear to be stable. This species is common in the Red Bluff area with as many as 184 observed in 1999 Audubon Christmas bird counts. The lark sparrow is a Federal species of concern.

Hermit Warbler (*Denroica occidentalis*)

The hermit warbler breeds in coastal Oregon and Washington as well as in the North Coast Range and Sierra Nevada in California. Generally, spring and fall migrations are in mountain areas, but occasionally, this species can be found in lowlands. Spring migration is between April and May, and breeding occurs from April to July with a peak in June. Nests are built in mature conifers in montane forests. Hermit warblers forage in the mid to upper canopy of hardwoods and conifers where they glean insects and spiders from the foliage. Fall migration to wintering habitats in Central America occurs between August and early September. Habitat destruction by logging and development of breeding grounds as well as brood parasitism by brown-headed cowbirds have led to population declines. This species has been observed on rare occasions during breeding bird surveys in the Red Bluff area. There is no suitable breeding habitat within the project area, and project activity is not expected to have any significant impacts on occasional migrants passing through the area. The hermit warbler is a Federal species of concern.

Yellow Warbler (*Dendroicia petechia brewsteri*)

The yellow warbler is a neotropical migrant with a wide distribution throughout North America and is locally common throughout central and northern California. Yellow warblers nest in riparian habitats with willows and other small trees and shrubs. Breeding season starts in April and early May, and fall migration begins in August and continues through September. Breeding occurs in a variety of habitats including chaparral and conifer forests with multi-layered canopies, but prefers to nest in riparian woodlands. Nests are usually built in deciduous saplings or shrubs. Breeding populations in the Sacramento River valley have presumably been extirpated due to the loss of suitable breeding habitat; however, areas are still heavily used by migrating birds, especially during May and late July through October. Yellow warblers are predominantly insectivores and forage in riparian areas, but will also feed on fruits and seeds. In addition to breeding-ground habitat loss, nest parasitism by brown-headed cowbirds in North America as well as pesticide use and habitat loss in wintering grounds continue to threaten this species Yellow warblers historically nested at Todd Island, along the Sacramento River, several miles south of the project area, and have been observed on rare occasions during breeding bird surveys in the Red bluff area. The yellow warbler is a California State species of special concern.

Yellow-breasted Chat (*Icteria virens*)

The yellow-breasted chat is widespread throughout the western U.S. and northern Mexico. Breeding season starts in mid-May and continues through mid-June. Well-developed riparian areas with dense shrub thickets provide suitable nesting habitat. Fall migration to southern Mexico and Central America begins in mid-August. During the spring, yellow-breasted chats are primarily insectivores, but fruits and berries become an important food item later in the summer. Loss of suitable nesting habitat and nest parasitism by brown-headed cowbirds are the main factors for the population declines of this species, with habitat loss in wintering range also an important factor. Nesting pairs have been reported at Mooney and Todd islands along the Sacramento River, several miles to the southeast of the project area, and they have been observed on rare occasions during breeding bird surveys in the Red Bluff area. The yellow-breasted chat is a California State species of concern.

Lawrence's Goldfinch (*Carduelis lawrencei*)

Lawrence's goldfinch breeds in the foothills surrounding California's Central Valley and in the slopes of the south Coast Range. In northern California, they are present from March through September where they inhabit foothill woodlands. Breeding season extends from late March through April. They prefer to nest in oaks with dense foliage near water. Migration south begins in September, to wintering grounds in southern California, Arizona, and Mexico. They forage on seeds from common forbs including pigweed, fiddleneck, and yellow starthistle, but will occasionally eat insects. This species has been observed on rare occasions during breeding bird surveys in the Red Bluff area. Lawrence's goldfinch is a Federal species of concern.

Reptiles

Northwestern Pond Turtle (*Clemmys marmorata marmorata*)

The northwestern pond turtle ranges from the San Francisco Bay north to Washington. It occurs in a variety of aquatic habitats including ponds, marshes, rivers, streams, and irrigation ditches. They require basking sites such as partially submerged logs, rocks, mats of floating vegetation, or muddy open banks. Pond turtles are omnivorous, eating a variety of aquatic plants, invertebrates, fishes, frogs, and carrion. Breeding season occurs between April and May, after which time females will build a nest in adjacent uplands, occasionally several hundred feet from the water. Nests are constructed in a variety of soil types between July and August. Predation of hatchlings and juveniles by introduced bullfrogs along with habitat loss and degradation have led to declines in pond turtle populations in recent decades. No occurrences of this species have been reported in the project area. The northwest pond turtle is a California State and Federal special-status species.

Giant Garter Snake (*Thamnophis gigas*)

The giant garter snake is a California endemic species that inhabits a variety of freshwater habitats including marshes, sloughs, seasonal pools, irrigation ditches, and rice fields. Historically, its range extended throughout the Central Valley from Butte County south to

Bakersfield in Kern County. Because of habitat loss, this species has been extirpated throughout much of its former range, including all areas north of Chico and most areas in the San Joaquin Valley. The largest remaining intact habitat is found in the American River Basin in Sacramento County. Giant garter snakes are diurnal, foraging along streams where a variety of fish and amphibians are the primary prey. Occasionally, small mammals and invertebrates such as leaches and earthworms may be eaten. Garter snakes are vivaparous, giving birth to active young between July and August. In addition to habitat loss, pesticides may have also been responsible for decline of this species (Zeiner et al., 1988). There are no reports of this species in the vicinity of the project area. The giant garter snake is a California State- and Federal-listed threatened species.

California Horned Lizard (*Phrynosoma coronatum frontale*)

The California horned lizard is an endemic species that ranges from southern Tehama County to the desert regions of southern California. It can be found in a variety of habitat types including grasslands, chaparral, and riparian areas. Horned lizards construct shallow burrows in loose soil or used mammal burrows and spaces under logs and rocks to escape predators and to hibernate. This species typically occurs in open areas with low rocks for basking and sandy soils, including washes and floodplains. Breeding season is between May and June. Horned lizards are diurnal and forage on a variety of insects including ants, beetles, grasshoppers, and flies. Threats to this species include habitat loss from agricultural conversion and urban development. This species is also collected for distribution as pets because of its unique appearance. There are no reports of this species in the vicinity of the project area. The California horned lizard is a State and Federal special-status species.

Amphibians

Western Spadefoot Toad (*Scaphiopus hammodii*)

The western spadefoot toad ranges throughout the Central Valley and adjacent foothills. They are found in grasslands and woodlands often associated with washes, floodplains, alluvial fans, and playas, but have also been reported to use orchards and vineyards on occasion (Zeiner et al., 1988). Spadefoot toads are nocturnal, foraging on a variety of insects and other invertebrates such as worms and spend the day in deep burrows. Breeding occurs between February and March, usually in shallow temporary pools. Habitat loss due to land development poses the greatest threat to the spadefoot toad. There are no reported occurrences of this species in the project area. The spadefoot toad is a is a State and Federal special-status species.

California Red-legged Frog (*Rana aurora draytonii*)

The red-legged frog was once widely distributed throughout western California but has been extirpated from approximately 70 percent of its former range (USFWS, 1996). The red-legged frog is the largest native frog in California and can be found in a variety of habitats including streams, marshes, ponds, and quiet pools. They require areas with dense shoreline vegetation such as willow thickets and deep pools. They feed on a variety of prey including aquatic insects, crustaceans, snails, worms, small fish, tadpoles, and smaller frogs. Breeding season occurs from March through July. Habitat loss and degradation along with the introduction of bullfrogs have lead to dramatic population declines. There are no reported occurrences in the vicinity of the project site. The red-legged frog is a California species of special concern and a Federal-listed threatened species.

Foothill Yellow-legged Frog (*Rana boylii*)

The foothill yellow-legged frog occurs throughout northwestern California, along the Coast Range south to Los Angeles County, and along the western foothills of the Sierras south to Kern County. This species inhabits rocky streams in hardwood, conifer, and riparian forests as well as coastal scrub and wet meadow habitats. They are diurnal and feed on a variety of aquatic and terrestrial invertebrates. Breeding occurs between March and May in open areas with slow-moving water with rocks and gravel bars. Predation of eggs by centrachid fish and introduced bullfrogs have negatively impacted this species as well as habitat loss and modification. There are no reported occurrence of this species in the vicinity of the project area. The foothill yellow-legged frog is a California State and Federal special status-species.

Invertebrates

Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)

The valley elderberry longhorn beetle is entirely dependent on its host plant, elderberry (*Sambucus* spp.) for food and reproduction. Mating occurs on the plants, and eggs are laid in the cracks and crevices of the bark. Upon emergence, the larva bore into the plant and remain in the spongy pith of the plant for the majority of their lifetime. The developing beetle remain inside of the plant for up to 2 years, after which time the adults emerge and reproduce. Adults emerge in March and feed on foliage and flowers until late June. Because elderberry plants are vital to the continued existence and recovery of this species, any reduction in shrubs or habitat quality is considered to have an adverse impact on this species. There are several know occurrences along the Sacramento River in the vicinity of the project area. The valley elderberry longhorn beetle is a Federal-listed threatened species.

Sacramento Anthicid Beetle (*Anthicus sacramento*) and Antioch Dunes Anthicid Beetle (*Anthicus antiochensis*)

These two small beetles, approximately 3.5 millimeters long are found in sandy habitats in the San Joaquin and Sacramento Delta and at numerous sandy habitats along the Sacramento River, including sandy and eroded banks, sandbars, and sandy beaches. They are also known to inhabit sandy dredge spoils that have been deposited some distance from water sources; loose sand appears to be an essential habitat requirement (Davis, 1991). Anthicid beetles are nocturnal and forage on the surface of the sand for organic debris and detritus. During the day, they remain burrowed under the sand. Adults oviposite in the spring, and new adults emerge in the summer (Hagen, 1986). They are active throughout the year and presumably have excellent dispersal ability as they are often found in areas subject to frequent inundation (Davis, 1991). Habitat loss from urban expansion, industrial development, and off-road vehicles pose the most significant threats to these species. These species are known to occur in Tehama County along the Sacramento River and are a California State species of special concern.

Leech's Skyline Diving Beetle (*Hydroporus leechii*)

Leech's skyline diving beetle is a medium-sized freshwater beetle that inhabits springs, creeks, ponds, and pools in drying streams. Nothing is known about the life history of this particular species. It was originally described as originating from San Mateo County, but this population has presumably been extirpated. Recent studies have found Leech's skyline diving beetle to be more widely distributed throughout the West than originally thought (Hafernik, 1989). In California, it occurs from the Owens Valley to the Oregon border. In southwest Tehama County it has been reported 2 miles southwest of Government Camp. It is a Federal species of concern.

Vernal Pool Fairy Shrimp (*Branchinecta lynchi*)

Vernal pool fairy shrimp inhabit small ephemeral freshwater wetlands that are commonly found in grassland areas. Vernal pool fairy shrimp are wide ranging occurring from Tulare County, California, to Jackson County in southwestern Oregon; however, within a given vernal pool complex they are often sparsely distributed. These shallow pools fill with water during the wet winter months but soon dry as the rains decrease during the spring. Adult fairy shrimp may be found in pools from December to May. Their eggs, deposited on the bottom of the pool, are capable of withstanding long periods of desiccation and high soil temperatures. As the pools fill with water, some of the eggs hatch and quickly develop into adults and reproduce. Extensive losses in vernal pool habitat as a result of agricultural and urban development have led to significant reductions in vernal pool fairy shrimp populations. Vernal pool fairy shrimp have been reported to occur in Tehama County along the PG&E pipeline 4 mile east of the Black Butte Dam north of Stony Creek. The vernal pool fairy shrimp is a Federal-threatened species.

Mammals

Townsend's Big-eared Bat (*Corynorhinus townsendii*)

The Townsend's big-eared bat occurs in a variety of habitat types including woodlands, grasslands, riparian communities, and active agricultural areas. Roost sites are in cavernicolous spaces in caves, mines, tunnels, and less often in buildings and bridges. Sometimes rock crevices and hollow trees are used as roosts. The Townsend's big-eared bat is extremely sensitive to disturbance and may abandon a roost if disturbed. During the reproductive period in spring and summer, roost abandonment may cause mortality of the young. Foraging associations include edge habitats along streams and areas adjacent to and within a variety of wooded habitats. Suitable habitat for this species occurs in the project area, but no evidence was found during preliminary roost searches conducted in 2002. The Townsend's big-eared bat is a State and Federal special-status species.

Spotted Bat (*Euderma maculatum*)

The spotted bat occurs in a variety of habitat types including woodlands, riparian communities, and conifer forests, but is closely associated with rock-faced cliff roosting habitat. It roosts in crevices in rocky cliffs but will also use caves and buildings. The spotted bat may roost singly but with a number of individuals at the same site. Foraging associations include forest meadows, woodlands, and large riverine/riparian habitats. This species is not likely to be found in the project area because of a lack of suitable roosting habitat. The spotted bat is a State and Federal special-status species considered to be rare in California.

Pallid Bat (*Antrozous pallidus*)

The pallid bat is characteristically a species of arid and semiarid lowland habitats such as oak woodlands, grasslands, active agricultural areas, and desert scrub. Roost sites include crevices and cavities in cliffs, rocks, trees, caves, bridges, buildings, and mines. Foraging habitat includes grasslands and woodlands. Reproductive colonies are formed in spring and summer and are highly vulnerable to disturbance. This species was confirmed to be occupying the project area during a survey conducted in 2002. The pallid bat is a State species of special concern.

Red Bat (Lasiurus blossevillii)

The red bat is characteristically found in riparian habitat, especially Central Valley cottonwood, sycamore, and willow riverine galleries. Roost sites are in the foliage of trees and shrubs, and possibly in leaf litter on the ground. Reproductive females and young are especially vulnerable to habitat loss in spring and summer. Suitable habitat for this species occurs in the project area. The red bat is a State and Federal special-status species.

Yuma Myotis (*Myotis yumanensis*)

The Yuma myotis occurs throughout the State and is closely associated with foraging areas at water sources such as reservoirs, rivers, streams, and ponds. Roost sites include buildings, bridges, mines, and caves. Reproductive colonies are highly vulnerable in spring and summer. This species is highly likely to be among the myotid bats (*Myotis* spp.) present in the project area during a preliminary survey conducted in 2002. The Yuma myotis is relatively common in California but is a Federal species of concern.

Long-legged Myotis (*Myotis volans*)

The long-legged myotis occurs throughout the State primarily in conifer forests, but also seasonally in riparian and desert habitats. Roost sites include crevices and cavities in trees, rocks, caves, mines, and buildings. It often feeds around the forest canopy. This species is not likely to be found in the project area but may occur in the surrounding higher elevation conifer forests. The long-legged myotis is a Federal species of concern.

Fringed Myotis (*Myotis thysanodes*)

The fringed myotis occurs in a wide range of habitats from low-desert scrub to high-elevation coniferous forest. This species appears to be most common in xeric woodlands (oak and pinyon-juniper). Roost sites include trees, caves, mines, rock crevices, and buildings. Reproductive colonies are highly vulnerable during spring and summer. This species is widely distributed but rare and sensitive to roost disturbance. The fringed myotis is a Federal species of concern.

Long-eared Myotis (*Myotis evotis*)

The long-eared myotis is found throughout the State in higher elevations associated with conifer forests and lower elevations in mixed conifer/hardwood forests. It roosts singly or in small groups in crevices and cavities under exfoliating tree bark, in hollow trees, cliffs, caves, mines, bridges, and rocky outcrops on the ground. Foraging associations include rivers and streams. This species is highly vulnerable during spring and summer reproductive periods. Suitable habitat occurs in the project area, although it is somewhat more likely to occur at higher elevations. The long-eared myotis is a Federal species of concern.

Small-footed Myotis (*Myotis ciliolabrum*)

The small-footed myotis occurs in a variety of habitats including woodlands, riparian communities, chaparral, and conifer forests. It roosts singly or in small groups in rock crevices, buildings, bridges, caves, mines, and occasionally under bark. Researchers are still investigating tree roosting by this species, but maternity colonies have been found in tree cavities. Colonies are highly vulnerable during reproductive periods in spring and summer. This species may have been among the myotid bats (*Myotis* spp.) that were found roosting in the project area during a survey conducted in 2002. The small-footed myotis is a Federal species of concern.

San Joaquin Pocket Mouse (*Perognathus inornatus*)

The San Joaquin pocket mouse is endemic to California's Central Valley ranging from Colusa County south to Ventura County. It inhabits dry, open grasslands, oak savannas, and chaparral. Fine-textured soils with an abundance of grasses and forbs are necessary for this species (Zeiner et al., 1990). This species is nocturnal, spending the day in constructed burrows. Their diet consists largely of seeds, but foliage and small insects are occasionally eaten. Breeding occurs between March and July. Habitat loss due to agricultural conversion and urban development are the principle threats to this species. There is only one historical record for the San Joaquin pocket mouse in Tehama County, near Beegum. It has not been reported to occur in the vicinity of the project site. The San Joaquin pocket mouse is listed as a Federal species of concern.

Plants

For the purposes of this evaluation, special-status plant species are vascular plants that are (1) designated as rare, threatened, or endangered by the State or Federal governments; or (2) are proposed for rare, threatened, or endangered status; and/or (3) are State or Federal candidate species; and/or (4) are listed as species of concern by USFWS and/or (5) are included on the California Native Plant Society (CNPS) List 1A, 1B, or 2. Primary sources on plant descriptions, distribution, habitats, and status were obtained from the following sources: CNDDB, the California Flora Occurrence Data base, the California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California (Skinner and Pavlik, 1994) and the Jepson Manual (Hickman, 1993).

Dwarf downingia (*Downingia pusilla*)

Dwarf downingia is a small annual in the bellflower family (Campanulaceae). It occurs throughout the Central Valley in California and is also found in Chile at elevations less than 1,300 feet. Habitats include vernal pools, wet meadows, and margins of small lakes, stock ponds, and drainage ditches. It typically occurs in areas with sparse vegetation and little competition from neighboring plants. The minute white flowers are present from April through May. While this species is relatively common in Tehama County, it is considered to be rare in California and threatened in some areas by grazing, non-native species, urbanization, and agricultural conversion. This species is a CNPS category 2 species (rare outside of California) but has no State or Federal designations. There is one known occurrence in the vicinity of the project area, along Belle Mill Road, several miles to the northeast of the project site.

Red Bluff Dwarf Rush (*Juncus leiospermus* var. *leiospermus*)

Red Bluff dwarf rush is a small, inconspicuous plant in the rush family (Juncaceae). Less than 5 inches tall at maturity, this variety is endemic to the Sacramento Valley and adjacent foothills in Tehama, Butte, and southern Shasta counties at elevations less than 1,650 feet. Habitats include vernal pool margins and moist areas in chaparral and woodlands where this species is often found in small patches of open ground with sparse vegetation. Mature plants may appear reddish-brown in color, and flowering occurs from late April to early June. There are currently no State or Federal listings for this species; however, it is considered to be rare due to restricted populations and is endangered in parts of its range due to extensive habitat loss. This species has been historically reported to occur (1916) in the project area at the confluence of Red Bank Creek and the Sacramento River, but no species were observed during 2001 plant surveys.

Silky Cryptantha (*Cryptantha crinita*)

Silky cryptantha is a hairy annual forb in the borage family (Boraginaceae). It is endemic to the northern Sacramento Valley and only known from Shasta and Tehama counties. This species is found in riparian areas associated with seasonal and perennial streams where it occurs on sand and gravel deposits at elevations between 500 and 1,000 feet. The small white flowers appear from late April through May. This species is considered to be rare in California due to limited population occurrences, and it is threatened in some areas as a result of habitat loss from flood control measures and water diversions. The only occurrence reported in the project area is at the mouth of Dibble Creek, to the northwest of the project site. The silky cryptantha is a Federal species of concern.

Woolly Meadowfoam (*Limnanthes floccosa* sp. *floccossa*)

Woolly meadowfoam is a small annual in the meadowfoam family (Limnanthaceae). It is distributed from the Central Valley to Southern Oregon where it occurs on the margins of vernal pools and in wet meadows at elevations less than 1,300 feet. The white flowers bloom between April and May. This species is considered to be uncommon in California, but widespread in other parts of its range. Continued threats include habitat loss due to agricultural conversion and development. One occurrence of this species has been reported near Tuscan Springs, several miles north of the project area. This species is a CNPS category 2 and has no State or Federal designations.

Adobe Lily (Fritillaria pluriflora)

The adobe lily is a member of the lily family (Liliaceae). This species is only known to occur in the northern Central Valley and southwestern Oregon. It can be found in a variety of habitats including grasslands, chaparral, and foothill woodlands, generally on clay soils below 1,650 feet. The pink-lavender flowers are present from February through April. The adobe lily is currently threatened by grazing, off-road vehicles, and horticultural collecting. Most of the occurrences of this species are in and around the Nature Conservancy's Vina Plains Preserve in southeastern Tehama County. This species is also found north of Lowrey, along Dry and Red Bank creeks. While it is considered to be rare in California due to limited distribution, the population does not appear to be immediately at risk; however, it is a Federal species of special concern.

Hairy Orcutt Grass (*Orcuttia pilosa*)

Hairy orcutt grass is a densely tufted annual grass (Poaceae) endemic to California. This species occurs in vernal pools along the eastern side of Sacramento Valley from Tehama to Stanislaus counties at elevations less than 650 feet. This small-stature grass grows between 2 and 8 inches tall and flowers between May and August. Currently, there are only 24 native populations and one introduced population known for the entire State, and only 12 of these populations are considered stable (USFWS, 1997). Nine populations occur in Tehama County, four of which are found on the Nature Conservancy's Vina Plains Preserve south of Red Bluff. The remaining populations are at risk from agricultural conversion, urbanization, and over-grazing. All reported occurrences are located in southern Tehama County. Hairy orcutt grass is a California State- and Federal-listed endangered species.

Slender Orcutt Grass (*Orcuttia tenuis*)

Slender orcutt grass is an annual grass (Poaceae) similar to hairy orcutt grass, but easily distinguished by its narrow leaves and loosely flowered inflorescence, which is present from May through July. Endemic to northern California, this species occurs in vernal pools at elevations less than 3,600 feet. There are currently 60 known populations of this species, with approximately half of the known occurrences from Tehama County. Primary threats include agricultural conversion, urbanization, and over-grazing; the overall trend for this species is one of decline (USFWS, 1997). Several large populations are known to occur north of the project site in the vicinity of Hog and Dales lakes and at the base of Table Mountain and the Tuscan Buttes. No populations have been reported in the immediate vicinity of the project site. Slender orcutt grass is listed as endangered by the State of California and is a Federal-listed threatened species.

Green's Tuctoria (*Tuctoria greenei*)

Green's tuctoria is a low-growing tufted annual grass (Poaceae) endemic to northern California vernal pools. It occurs at elevations less than 700 feet, and flowering culms are present from May through July. Nearly half of the original populations have been extirpated and currently only 20 known populations remain in five counties: Butte, Glenn, Merced, Shasta, and Tehama (USFWS, 1997). Threats includes agricultural and urban development, over-grazing, and off-road vehicles. All reported populations occur in the Vina Plains area, in southeastern Tehama County. The general trend for this species is one of decline, and it is a Federal-listed endangered species.

Hoover's Spurge (*Chamaesyce hooveri*)

Hoover's spurge is a prostrate, annual herb in the spurge family (Euphorbiaceae). This plant is associated with vernal pools along the eastern edge of California's Central Valley at elevations less than 850 feet. The small axially flowers bloom in July. Habitat loss from agricultural conversion and urbanization is the principal threat, and there are currently only 25 known populations, of which nearly half occur in Tehama County (USFWS, 1997). All reported populations in Tehama County occur in the southeastern portion of the county near Vina Plains. Hoover's spurge is a Federal-listed threatened species.

Indian Valley Brodiaea (*Brodiaea coronaria* sp. *rosea*)

A perennial forb in the lily family (Liliaceae), the Indian Valley Brodiaea, is endemic to California. This species occurs on serpentine soils in a variety of habitats including chaparral, grasslands, and conifer forests at elevations less than 500 feet. It may occur in wetland areas, gravelly creek bottoms, and swales as well. The lavender-pink flowers bloom between May and June. CNDDB lists only two historical occurrences at Hall and Riley Ridges in southwestern Tehama County. The CALFLORA database list an additional five occurrences in Tehama County. Threats includes off-road vehicles and illegal dumping. This species is considered to be extremely rare in California and is listed as a State endangered species as well as a Federal species of concern.

Oregon Fireweed (*Epilobium oreganum*)

Oregon fireweed is a large perennial in the evening primrose family (Onigraceae) associated with bogs, fens, and wet meadows in montane conifer forests in northern California and southern Oregon at elevations between 1,600 and 5,250 feet. The pink to rose purple flowers are present from June to August. There is limited information on the population status of this species in California, but in Oregon it is only known from 20 locations, with a total estimated population of around 1,000 plants. Logging appears to be the most significant threat to this species. There are only two reported occurrences of this species in Tehama County from Regan Meadow and Buck Rock in the Coast Range along the western edge of the county. It is not expected to occur in the project area due to lack of suitable habitat. Oregon fireweed is a Federal species of concern.

Butte Fritillary (*Fritillaria eastwoodiae*)

Endemic to northern California, the Butte fritillary is a conspicuous perennial in the lily family (Liliaceae). The species can be found in chaparral, woodlands, and lower montane conifer forests on a variety of soil types including serpentine, clay, and sandy loams at elevations between 100 and 5,000 feet. The pale greenish-yellow to red flowers are in bloom between March and May. Threats to this species include logging and land development. The populations in Tehama County are found in the Cascade Foothills in the northeastern part of the county. The closest population to the project area occurs at the western base of Inskip Hill; however, this population may have been improperly identified and may be the more common scarlet fritillary. The Butte fritillary is a Federal species of concern.

Legenere (*Lengenere limosa*)

Legenere is an annual in the bellflower family (Campanulaceae) endemic to California's Central Valley. It occurs in vernal pools with generally long periods of inundation at elevations up to 3,300 feet. The plant is heterophyllous, meaning it produces two types of leaves. Submerged leaves are about an inch long and linear, and the terrestrial leaves are shorter and more elliptical. This plant blooms between May and June and flowers are often without petals. Many of the historical occurrences have been extirpated due to agricultural conversion and urbanization, and there are currently only 36 reported occurrences remaining. Large populations have been observed at Dales and Hog lakes to the northeast of the project site and near Gerber and Rawston Station south of the project site. Legenere is currently listed as a Federal species of concern.

Red-Flowered Lotus (*Lotus rubriflorus*)

The red-flowered lotus is an annual forb in the pea family (Fabaceae). It is endemic to California and known to occur in only four counties, Colusa, Stanislaus, Tehama, and Santa Clara. This species occurs in grasslands and woodlands at elevations between 600 and 1,500 feet. The small pinkish-red flowers are present from April through June. In Tehama County, the only population reported occurs on red soils derived from volcanic mudflow deposits along the PG&E pipeline west of Dales Lake. While no specific threats have been identified, because of its limited distribution and extreme rarity, it has been listed as a Federal species of special concern.

Ahart's Paronychia (*Paronychia ahartii*)

Ahart's paronychia is an inconspicuous annual in the pink family (Caryphyollace) found in only Butte, Shasta, and Tehama counties in northern California. This species occurs in grasslands, chaparral, and woodlands on rocky soils, often associated with the upper margins of vernal pools at elevations less than 1,650 feet. The small, tightly clustered flowers bloom from April to June. This plant has a very limited distribution and is considered to be extremely rare throughout its range. Current threats include habitat loss, overgrazing, and trampling. The largest known populations have been found in Tehama County. While there are no reported occurrences in the immediate vicinity of the project site, several populations have been reported from the surrounding areas including Gerber, near Antelope and Salt creeks east of the HogBack, along the pipeline north of Paynes Creek, and around Hog Lake. Ahart's paronychia is a Federal species of concern.

Valley Sagittaria (*Sagittaria sanfordii*)

The valley sagittaria is an emergent, rhizomatous perennial in the water-plantain family (Alismataceae). Endemic to California, this species occurs in freshwater wetlands in areas of standing or slow-moving water including marshes, ponds, and ditches. Flowering period occurs from May through August. While it was once widely distributed throughout much of central California from Orange County to Del Norte County at elevations below 2,000 feet, habitat loss from development, water diversion, and over-grazing have resulted in the extirpation of many of the Central Valley populations. No populations have been reported in the immediate vicinity of the project site, but several large populations are known to occur around Hog and Dales lakes north of the project area. Valley sagittaria is a Federal species of concern.

Tracy's Sanicle (*Sanicula tracyi*)

Tracy's sanicle is a conspicious perennial in the carrot family (Apiaceae) that is endemic to northwestern California. It occurs in openings in woodlands and conifer forests at elevations between 300 and 3,500 feet. The flowering period is from April through July. This species is considered rare, but there are several large localized populations throughout its range.

Current threats include logging, grazing, and development. While it has been historically reported to occur in Tehama County, there are no recent reports of this species. Tracy's sanicle is a Federal species of concern.

Baker's Navarretia (*Nabarretia leucocephala* sp.*bakerii*)

Baker's navarretia is a small annual in the phlox family (Polemoniaceae) endemic to California. It occurs in a variety of habitats including woodlands, grasslands, meadows, vernal pools, and seeps on moist to wet clay soils at elevations ranging from sea level to 5,500 feet. The small white to blue flowers are present from April to June. This subspecies is uncommon and is considered to be endangered in portions of its range due to habitat loss resulting from urban expansion and industrial development. There is one known occurrence of this species in Tehama County 8.5 miles south of Corning. Baker's navarretia is a Federal species of concern.

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TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Birds						
American Bittern *Botaurus lentiginosus*		SC		Freshwater and brackish wetlands with dense vegetation	Resident	BBS: Rare
Black–crowned Night Heron *Nycticorax nycticorax*		SC		Freshwater and brackish wetlands, occasionally rice fields	Resident	BBS: Rare
White-faced Ibis *Plegadis chihi*	SC	SC		Freshwater wetlands and irrigated fields	April-September	No reported occurrences
Aleutian Canada Goose *Branta canadensis leucopareia*		T		Freshwater wetlands and agricultural fields	October-April	Non-specific Canada Goose BBS: Rare; CBC: 172
Cooper's Hawk *Accipiter cooperii*	SC			Woodlands, riparian forests, and agricultural fields	Resident	BBS: Rare; CBC: 5
Sharp-shinned Hawk *Accipiter striatus*	SC			Woodlands, riparian forests, and shrub thickets	September-April (Resident)	BBS: Rare; CBC: 3
Northern Goshawk *Accipiter gentilis*	SC	SC		Montane coniferous forests; woodlands; and, rarely, agricultural fields	Resident	BBS: Rare
Golden Eagle *Aquila chrysaetos*	SC			Grasslands, open woodland, chaparral, wetlands, and agricultural areas	Resident	BBS: Rare; CBC: 1
Ferruginous Hawk *Buteo regalis*	SC	SC		Grasslands and agricultural fields	September-April	CBC: 4
Swainson's Hawk *Buteo swainsoni*	T			Mature riparian forests, oak woodlands, and agricultural fields	March-August	BBS: Rare; CNDDB: 1 (Salt Creek)
Northern Harrier *Circus cyaneus*	SC			Wetlands, grasslands, and agricultural fields	Resident	BBS: Rare; CBC: 14
White-tailed Kite *Elanus leucurus*		SC		Grasslands, oak woodlands, riparian forest habitat, and agricultural fields	Resident	BBS: Rare; CBC: 3
Bald Eagle *Haliaeetus leucocephalus*	E	T		Lakes, rivers, and wetlands.	September-April	BBS: Rare; CBC: 3

TABLE D-1
Special-status Species

Species	Status CA	Status Fed.	Status CNPS	Habitat	Season	Reported Occurrences
Osprey *Pandion haliaetus*	SC			Lakes and rivers	March-September	BBS: Rare; CBC: 4; CNDDB: 1 (Red Bank Creek)
Prairie Falcon *Falco mexicanus*	SC			Grasslands and agricultural fields	Resident	BBS: Rare; CBC: 2
Peregrine Falcon *Falco peregrinus anatum*	SE	D		Wetlands, lakes, rivers, grasslands, and agricultural fields	Resident	BBS: Rare; CBC: 2
Black Tern *Chlidonias niger*	SC	SC		Lakes, wetlands, and agricultural fields	April-September	BBS: Rare
Western Yellow-billed Cuckoo *Coccyzus americanus occidentalis*	SE	MBM C		Riparian forest habitats	June-September	CNDDB: 1 (Mooney-Todd islands)
Short-eared Owl *Asio flammeus*	SC	SC		Wetlands, grasslands, and agricultural fields	Resident	BBS: Rare
Western Burrowing Owl *Athene cunicularia hypougea*	SC	SC		Grasslands, pastures, agricultural fields, road embankments, and near open urban areas	Resident	BBS: Rare; CNDDB: 1 (Little Salt Creek)
Vaux's Swift *Chaetura vauxi*	SC	SC		Mixed oak and conifer woodlands, forages over grasslands, lakes, and streams	April-September	BBS: Rare
Black Swift *Cypseloides niger*	SC	SC		Open habitats such as grasslands, agricultural fields, and along rivers	May-September	BBS: Rare
Rufous Hummingbird *Selasphorus rufus*	WL	SC		Riparian habitat, open woodlands, chaparral, orchards, and gardens	February-May	BBS: Rare
Lewis' Woodpecker *Melanerpes lewis*		SC		Open woodlands and riparian habitats	Resident	BBS: Rare; CBC: 34
Olive-sided Flycatcher *Contopus borealis*	WL	SC		Montane coniferous forests and woodlands	April-October	BBS: Rare

TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Little Willow Flycatcher *Empidonax traillii brewsteri*		SC		Riparian habitat dominated by dense willows	May-September	BBS: Rare
California Horned Lark *Eremophila alpestris*	SC			Grasslands and open woodlands	Resident	BBS: Rare; CBC: 205
Purple Martin *Progne subis*	SC			Grasslands, wet meadows, wetlands, woodlands, and riparian habitat	March-September	BBS: Rare
Bank Swallow *Riparia riparia*	T			Riparian areas; nest in friable soils of vertical streambanks	April-September	BBS: Rare; CNDDB: 2 (Blackberry Island, Red Bluff Diversion Dam)
Bewick's Wren *Thryomanes bewickii*		SC		Chaparral, woodlands, conifer forests, and riparian habitat	Resident	BBS: Uncommon; CBC: 7
Loggerhead Shrike *Lanius ludovicianus*	SC	SC		Grasslands, savannas, and chaparral	Resident	CBC: 5
Tricolored Blackbird *Agelaius tricolor*	SC	SC		Wetlands in dense emergent vegetation	Resident	BBS: Uncommon; CBC: 6
Grasshopper Sparrow *Ammodramus savannarum*		SC		Grasslands and agricultural fields	March-September	BBS: Rare
Lark Sparrow *Chondestes grammacus*		SC		Chaparral, oak woodlands, and conifer forests	Resident	BBS: Rare; CBC: 184
Hermit Warbler *Dendroica occidentalis*		SC		Montane conifer forests and woodlands	April-September	BBS: Rare
Yellow Warbler *Dendroica petechia*	SC			Riparian habitat	April-September	BBS: Rare; CNDDB: 1 (Todd Island)
Yellow-breasted Chat *Icteria virens*	SC			Riparian habitat	April-September	BBS: Rare; CNDDB: 1 (Todd Island)
Yellow-headed Blackbird *Xanthocephalus xanthocepha*	?	?		Wetlands	Residents	BBS: Rare

TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Lawrence's Goldfinch Carduelis lawrencei	WL			Oak woodlands	March-September	BBS: Rare
Reptiles						
Western Pond Turtle *Clemmys marmorata*		SC		Wetlands, ponds, irrigation ditches, rivers, and streams	Resident	No reported occurrences
Giant Garter Snake *Thamnophis gigas*	T	T		Wetlands, sloughs, irrigation ditches, and rice fields	Resident	No reported occurrences
California Horned Lizard *Phrynosoma coronatum frontale*		SC		Grasslands, chaparral, and riparian habitat	Resident	No reported occurrences
Amphibians						
Western Spadefoot Toad *Scaphiopus hammodii*		SC		Streams and pools in grasslands and woodlands, particularly vernal pools	Resident	No reported occurrences
California Red-legged Frog *Rana aurora draytonii*		T		Streams, ponds, wetlands, and stock ponds	Resident	No reported occurrences
Foothill Yellow-legged Frog *Rana boylii*		SC		Large streams with open gravel bars and rocks	Resident	No reported occurrences
Invertebrates						
Valley Elderberry Longhorn Beetle *Desmocercus californicus dimorphus*		T		Elderberry shrubs in riparian areas, savannas, and woodlands	Resident	CNDDB: Several occurrences along Sacramento River near project area
Sacramento Anthicid Beetle *Anthicus sacramento*		SC		Sandbars		No reported occurrences
Antioch Dunes Anthicid Beetle *Anthicus antiochensis*		SC		Sandbars		No reported occurrences
Leech's Skyline Diving Beetle *Hydroporus leechii*		SC		Streams		No reported occurrences

TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Vernal Pool Fairy Shrimp *Branchinecta lynchi*		SC		Vernal pools	March-May	No reported occurrences in the project area.
Mammals						
Townsend's Big-eared Bat *Plecotus townsendii palescens*		SC		Grasslands, chaparral, woodlands, and conifer forests	Resident	No reported occurrences in the project area
Western Big-eared Bat *Corynorhinus townsendii townsendii*		SC		Grasslands, chaparral, woodlands, and conifer forests	Resident	No reported occurrences the project area
Spotted Bat *Euderma maculatum*		SC		Grasslands and mixed conifer forest	Resident	No reported occurrences the project area
Long-eared Myotis *Myotis evotis*		SC		Chaparral, woodlands, coniferous forests, riparian habitats	Resident	No reported occurrences the project area
Fringed Myotis *Myotis thysanodes*		SC		Oak woodlands, mixed conifer-hardwood forests, riparian habitats	February-September	No reported occurrences the project area
Long-legged Myotis *Myotis volans*		SC		Chaparral, woodlands, coniferous forests, riparian habitats	Resident	No reported occurrences the project area
Small–footed Myotis *Myotis leibii*		SC		Open forests, woodlands, chaparral, riparian habitats	April-October	No reported occurrences the project area
Yuma Myotis *Myotis yumanensis*		SC		Open forests, woodlands, riparian habitats	Resident	No reported occurrences the project area
San Joaquin Pocket Mouse *Perognathus inornatus*		SC		Grasslands and oak woodlands	Resident	No reported occurrences the project area
Plants						
Dwarf Downingia *Downingia pusilla*			2	Vernal pools, wet meadows	March-May	CNDDB
Red Bluff Dwarf Rush *Juncus leiospermus* var. *leiospermus*			1B	Vernal pools, wet meadows, riparian areas, chaparral, and woodlands	March-May	CNDDB

TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Silky Cryptantha *Cryptantha crinita*		SC	1B	Riparian areas, gravelly streambeds	April-May	CNDDB
Wooly Meadowfoam *Limnanthes floccosa* sp. *Floccosa*			2	Vernal pools, wet meadows	March-June	CNDDB
Adobe Lily *Fritillaria pluriflora*		SC	1B	Grasslands, chaparral, and woodlands	February-April	No reported occurrences in the project area
Hairy Orcutt Grass *Orcuttia pilosa*	E	E	1B	Vernal pools	May-August	No reported occurrences in the project area
Slender Orcutt Grass *Orcuttia tenuis*	E	T	1B	Vernal pools	May-July	No reported occurrences in the project area
Green's Tuctoria T*uctoria greenei*	R	E	1B	Vernal pools	May-July	No reported occurrences in the project area
Hoover's Spurge *Chamaesyce hooveri*		T	1B	Vernal pools	July	No reported occurrences in the project area
Indian Valley Brodiaea *Brodiaea coronaria* sp. *rosea*	E	SC	1B	Chaparral, woodlands, and coniferous forests / Serpentine soils	May-June	No reported occurrences in the project area
Oregon Fireweed *Epilobium oreganum*		SC	1B	Wetlands, lower montane conifer forests / mesic	June-August	No reported occurrences in the project area
Butte Fritillary *Fritillaria eastwoodiae*		SC	1B	Chaparral, woodlands, open conifer forests	March-May	No reported occurrences in the project area
Legenere *Legenere limosa*		SC	1B	Vernal pools	May-June	No reported occurrences in the project area
Red-flowered Lotus *Lotus rubriflorus*		SC	1B	Woodlands and grasslands	April-June	No reported occurrences in the project area
Ahart's Paronychia *Paronychia ahartii*		SC	1B	Woodlands, grasslands, and vernal pools	April-June	No reported occurrences in the project area

TABLE D-1
Special-status Species

Species	Status			Habitat	Season	Reported Occurrences
	CA	Fed.	CNPS			
Valley Sagittaria *Sagittaria sanfordii*		SC	1B	Wetlands	May-August	No reported occurrences in the project area
Tracy's Sanicle *Sanicula tracyi*		SC	1B	Woodlands and open conifer forests	April-July	No reported occurrences in the project area
Baker's Navarretia *Navarretia leucocephala* sp. *bakeri*		SC	1B	Lower montane conifer forests, meadows and seeps, valley and foothill grassland, vernal pools	May-July	No reported occurrences in the project area

E: Endangered
T: Threatened
SC: Species of Concern
D: Delisted
CNDDB: California Natural Diversity Database
BBS: Breeding bird surveys, abundance rank based on mean counts from the Red Bluff area between 1982 and 1996.
CBC: Audubon Christmas bird counts from the Red Bluff area in December 1999.
CNPS: California Native Plant Society Rare and Endangered Plants
1B: Plants rare, threatened or endangered in California and elsewhere.
2: Plants rare or endangered in California, but more common elsewhere
3: Plants about which more information is needed
4: Plants of limited distribution

Appendix E
Conservation Guidelines for Valley Elderberry Longhorn Beetle

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

Conservation Guidelines for the Valley Elderberry Longhorn Beetle

9 July 1999

The following guidelines have been issued by the U.S. Fish and Wildlife Service (Service) to assist Federal agencies and non-federal project applicants needing incidental take authorization through a section 7 consultation or a section 10(a)(1)(B) permit in developing measures to avoid and minimize adverse effects on the valley elderberry longhorn beetle. The Service will revise these guidelines as needed in the future. The most recently issued version of these guidelines should be used in developing all projects and habitat restoration plans. The survey and monitoring procedures described below are designed to avoid any adverse effects to the valley elderberry longhorn beetle. Thus a recovery permit is not needed to survey for the beetle or its habitat or to monitor conservation areas. If you are interested in a recovery permit for research purposes please call the Service's Regional Office at (503) 231-2063.

Background Information

The valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*), was listed as a threatened species on August 8, 1980 (*Federal Register* 45: 52803-52807). This animal is fully protected under the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.). The valley elderberry longhorn beetle (beetle) is completely dependent on its host plant, elderberry (*Sambucus* species), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. Use of the elderberry by the beetle, a wood borer, is rarely apparent. Frequently, the only exterior evidence of the elderberry's use by the beetle is an exit hole created by the larva just prior to the pupal stage. The life cycle takes one or two years to complete. The animal spends most of its life in the larval stage, living within the stems of an elderberry plant. Adult emergence is from late March through June, about the same time the elderberry produces flowers. The adult stage is short-lived. Further information on the life history, ecology, behavior, and distribution of the beetle can be found in a report by Barr (1991) and the recovery plan for the beetle (USFWS 1984).

Surveys

Proposed project sites within the range of the valley elderberry longhorn beetle should be surveyed for the presence of the beetle and its elderberry host plant by a qualified biologist. The beetle's range extends throughout California's Central Valley and associated foothills from about the 3,000-foot elevation contour on the east and the watershed of the Central Valley on the west (Figure 1). All or portions of 31 counties are included: Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Kern, Kings, Lake, Madera, Mariposa, Merced, Napa, Nevada, Placer, Sacramento, San Benito, San Joaquin, San Luis Obispo, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Tuolumne, Yolo, Yuba.

If elderberry plants with one or more stems measuring 1.0 inch or greater in diameter at ground level occur on or adjacent to the proposed project site, or are otherwise located where they may be directly or indirectly affected by the proposed action, minimization measures which include planting replacement habitat (conservation planting) are required (Table 1).

All elderberry shrubs with one or more stems measuring 1.0 inch or greater in diameter at ground level that occur on or adjacent to a proposed project site must be thoroughly searched for beetle exit holes (external evidence of beetle presence). In addition, all elderberry stems one inch or greater in diameter at ground level must be tallied by diameter size class (Table 1). As outlined in Table 1, the numbers of elderberry seedlings/cuttings and associated riparian native trees/shrubs to be planted as replacement habitat are determined by stem size class of affected elderberry shrubs, presence or absence of exit holes, and whether a proposed project lies in a riparian or non-riparian area.

Elderberry plants with no stems measuring 1.0 inch or greater in diameter at ground level are unlikely to be habitat for the beetle because of their small size and/or immaturity. Therefore, no minimization measures are required for removal of elderberry plants with no stems measuring 1.0 inch or greater in diameter at ground level with no exit holes. Surveys are valid for a period of two years.

AVOID AND PROTECT HABITAT WHENEVER POSSIBLE

Project sites that do not contain beetle habitat are preferred. If suitable habitat for the beetle occurs on the project site, or within close proximity where beetles will be affected by the project, these areas must be designated as avoidance areas and must be protected from disturbance during the construction and operation of the project. When possible, projects should be designed such that avoidance areas are connected with adjacent habitat to prevent fragmentation and isolation of beetle populations. Any beetle habitat that cannot be avoided as described below should be considered impacted and appropriate minimization measures should be proposed as described below.

Avoidance: Establishment and Maintenance of a Buffer Zone

Complete avoidance (i.e., no adverse effects) may be assumed when a 100-foot (or wider) buffer is established and maintained around elderberry plants containing stems measuring 1.0 inch or greater in diameter at ground level. Firebreaks may not be included in the buffer zone. In buffer areas construction-related disturbance should be minimized, and any damaged area should be promptly restored following construction. The Service must be consulted before any disturbances within the buffer area are considered. In addition, the Service must be provided with a map identifying the avoidance area and written details describing avoidance measures.

Protective Measures

1. Fence and flag all areas to be avoided during construction activities. In areas where encroachment on the 100-foot buffer has been approved by the Service, provide a minimum setback of at least 20 feet from the dripline of each elderberry plant.

2. Brief contractors on the need to avoid damaging the elderberry plants and the possible penalties for not complying with these requirements.

3. Erect signs every 50 feet along the edge of the avoidance area with the following information: "This area is habitat of the valley elderberry longhorn beetle, a threatened species, and must

not be disturbed. This species is protected by the Endangered Species Act of 1973, as amended. Violators are subject to prosecution, fines, and imprisonment." The signs should be clearly readable from a distance of 20 feet, and must be maintained for the duration of construction.

4. Instruct work crews about the status of the beetle and the need to protect its elderberry host plant.

Restoration and Maintenance

1. Restore any damage done to the buffer area (area within 100 feet of elderberry plants) during construction. Provide erosion control and re-vegetate with appropriate native plants.

2. Buffer areas must continue to be protected after construction from adverse effects of the project. Measures such as fencing, signs, weeding, and trash removal are usually appropriate.

3. No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant should be used in the buffer areas, or within 100 feet of any elderberry plant with one or more stems measuring 1.0 inch or greater in diameter at ground level.

4. The applicant must provide a written description of how the buffer areas are to be restored, protected, and maintained after construction is completed.

5. Mowing of grasses/ground cover may occur from July through April to reduce fire hazard. No mowing should occur within five (5) feet of elderberry plant stems. Mowing must be done in a manner that avoids damaging plants (e.g., stripping away bark through careless use of mowing/trimming equipment).

TRANSPLANT ELDERBERRY PLANTS THAT CANNOT BE AVOIDED

Elderberry plants must be transplanted if they can not be avoided by the proposed project. All elderberry plants with one or more stems measuring 1.0 inch or greater in diameter at ground level must be transplanted to a conservation area (see below). At the Service's discretion, a plant that is unlikely to survive transplantation because of poor condition or location, or a plant that would be extremely difficult to move because of access problems, may be exempted from transplantation. In cases where transplantation is not possible the minimization ratios in Table 1 may be increased to offset the additional habitat loss.

Trimming of elderberry plants (e.g., pruning along roadways, bike paths, or trails) with one or more stems 1.0 inch or greater in diameter at ground level, may result in take of beetles. Therefore, trimming is subject to appropriate minimization measures as outlined in Table 1.

1. Monitor. A qualified biologist (monitor) must be on-site for the duration of the transplanting of the elderberry plants to insure that no unauthorized take of the valley elderberry longhorn beetle occurs. If unauthorized take occurs, the monitor must have the authority to stop work until corrective measures have been completed. The monitor must immediately report any unauthorized take of the beetle or its habitat to the Service and to the California Department of Fish and Game.

2. Timing. Transplant elderberry plants when the plants are dormant, approximately November through the first two weeks in February, after they have lost their leaves. Transplanting during the non-growing season will reduce shock to the plant and increase transplantation success.

3. Transplanting Procedure.

   a. Cut the plant back 3 to 6 feet from the ground or to 50 percent of its height (whichever is taller) by removing branches and stems above this height. The trunk and all stems measuring 1.0 inch or greater in diameter at ground level should be replanted. Any leaves remaining on the plant should be removed.

   b. Excavate a hole of adequate size to receive the transplant.

   c. Excavate the plant using a Vermeer spade, backhoe, front end loader, or other suitable equipment, taking as much of the root ball as possible, and replant immediately at the conservation area. Move the plant only by the root ball. If the plant is to be moved and transplanted off site, secure the root ball with wire and wrap it with burlap. Dampen the burlap with water, as necessary, to keep the root ball wet. Do not let the roots dry out. Care should be taken to ensure that the soil is not dislodged from around the roots of the transplant. If the site receiving the transplant does not have adequate soil moisture, pre-wet the soil a day or two before transplantation.

   d. The planting area must be at least 1,800 square feet for each elderberry transplant. The root ball should be planted so that its top is level with the existing ground. Compact the soil sufficiently so that settlement does not occur. As many as five (5) additional elderberry plantings (cuttings or seedlings) and up to five (5) associated native species plantings (see below) may also be planted within the 1,800 square foot area with the transplant. The transplant and each new planting should have its own watering basin measuring at least three (3) feet in diameter. Watering basins should have a continuous berm measuring approximately eight (8) inches wide at the base and six (6) inches high.

   e. Saturate the soil with water. Do not use fertilizers or other supplements or paint the tips of stems with pruning substances, as the effects of these compounds on the beetle are unknown.

   f. Monitor to ascertain if additional watering is necessary. If the soil is sandy and well-drained, plants may need to be watered weekly or twice monthly. If the soil is clayey and poorly-drained, it may not be necessary to water after the initial saturation. However, most transplants require watering through the first summer. A drip watering system and timer is ideal. However, in situations where this is not possible, a water truck or other apparatus may be used.

PLANT ADDITIONAL SEEDLINGS OR CUTTINGS

Each elderberry stem measuring 1.0 inch or greater in diameter at ground level that is adversely affected (i.e., transplanted or destroyed) must be replaced, in the conservation area, with elderberry seedlings or cuttings at a ratio ranging from 1:1 to 8:1 (new plantings to affected stems). Minimization ratios are listed and explained in Table 1. Stock of either seedlings or cuttings should be obtained from local sources. Cuttings may be obtained from the plants to be transplanted if the project site is in the vicinity of the conservation area. If the Service determines that the elderberry plants on the proposed project site are unsuitable candidates for transplanting, the Service may allow the applicant to plant seedlings or cuttings at higher than the stated ratios in Table 1 for each elderberry plant that cannot be transplanted.

PLANT ASSOCIATED NATIVE SPECIES

Studies have found that the beetle is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native plants associated with the elderberry plants at the project site or similar sites will be planted at ratios ranging from 1:1 to 2:1 [native tree/plant species to each elderberry seedling or cutting (see Table 1)]. These native plantings must be monitored with the same survival criteria used for the elderberry seedlings (see below). Stock of saplings, cuttings, and seedlings should be obtained from local sources. If the parent stock is obtained from a distance greater than one mile from the conservation area, approval by the Service of the native plant donor sites must be obtained prior to initiation of the revegetation work. Planting or seeding the conservation area with native herbaceous species is encouraged. Establishing native grasses and forbs may discourage unwanted non-native species from becoming established or persisting at the conservation area. Only stock from local sources should be used.

Examples

Example 1

The project will adversely affect beetle habitat on a vacant lot on the land side of a river levee. This levee now separates beetle habitat on the vacant lot from extant Great Valley Mixed Riparian Forest (Holland 1986) adjacent to the river. However, it is clear that the beetle habitat located on the vacant lot was part of a more extensive mixed riparian forest ecosystem extending farther from the river's edge prior to agricultural development and levee construction. Therefore, the beetle habitat on site is considered riparian. A total of two elderberry plants with at least one stem measuring 1.0 inch or greater in diameter at ground level will be affected by the proposed action. The two plants have a total of 15 stems measuring over 1.0 inch. No exit holes were found on either plant. Ten of the stems are between 1.0 and 3.0 inches in diameter and five of the stems are greater than 5.0 inches in diameter. The conservation area is suited for riparian forest habitat. Associated natives adjacent to the conservation area are box elder (*Acer negundo californica*), walnut (*Juglans californica* var. *hindsii*), sycamore (*Platanus racemosa*), cottonwood (*Populus fremontii*), willow (*Salix goodding*ii and *S. laevigata*), white alder (*Alnus rhombifolia*), ash (*Fraxinus latifolia*), button willow (*Cephalanthus occidentalis*), and wild grape (*Vitis californica*).

Minimization (based on ratios in Table 1):

- Transplant the two elderberry plants that will be affected to the conservation area.
- Plant 40 elderberry rooted cuttings (10 affected stems compensated at 2:1 ratio and 5 affected stems compensated at 4:1 ratio, cuttings planted:stems affected)
- Plant 40 associated native species (ratio of associated natives to elderberry plantings is 1:1 in areas with no exit holes):
  5 saplings each of box elder, sycamore, and cottonwood

5 willow seedlings
5 white alder seedlings
5 saplings each of walnut and ash
3 California button willow
2 wild grape vines
Total: 40 associated native species

• Total area required is a minimum of 1,800 sq. ft. for one to five elderberry seedlings and up to 5 associated natives. Since, a total of 80 plants must be planted (40 elderberries and 40 associated natives), a total of 0.33 acre (14,400 square feet) will be required for conservation plantings. The conservation area will be seeded and planted with native grasses and forbs, and closely monitored and maintained throughout the monitoring period.

Example 2
The project will adversely affect beetle habitat in Blue Oak Woodland (Holland 1986). One elderberry plant with at least one stem measuring 1.0 inch or greater in diameter at ground level will be affected by the proposed action. The plant has a total of 10 stems measuring over 1.0 inch. Exit holes were found on the plant. Five of the stems are between 1.0 and 3.0 inches in diameter and five of the stems are between 3.0 and 5.0 inches in diameter. The conservation area is suited for elderberry savanna (non-riparian habitat). Associated natives adjacent to the conservation area are willow (*Salix* species), blue oak (*Quercus douglasii*), interior live oak (*Q. wislizenii*), sycamore, poison oak (*Toxicodendron diversilobum*), and wild grape.

Minimization (based on ratios in Table 1):
• Transplant the one elderberry plant that will be affected to the conservation area.

• Plant 30 elderberry seedlings (5 affected stems compensated at 2:1 ratio and 5 affected stems compensated at 4:1 ratio, cuttings planted:stems affected)

• Plant 60 associated native species (ratio of associated natives to elderberry plantings is 2:1 in areas with exit holes):
20 saplings of blue oak, 20 saplings of sycamore, and 20 saplings of willow, and seed and plant with a mixture of native grasses and forbs.

• Total area required is a minimum of 1,800 sq. ft. for one to five elderberry seedlings and up to 5 associated natives. Since, a total of 90 plants must be planted (30 elderberries and 60 associated natives), a total of 0.37 acre (16,200 square feet) will be required for conservation plantings. The conservation area will be seeded and planted with native grasses and forbs, and closely monitored and maintained throughout the monitoring period.

CONSERVATION AREA—PROVIDE HABITAT FOR THE BEETLE IN PERPETUITY

The conservation area is distinct from the avoidance area (though the two may adjoin), and serves to receive and protect the transplanted elderberry plants and the elderberry and other native plantings. The Service may accept proposals for off-site conservation areas where appropriate.

1. <u>Size</u>. The conservation area must provide at least 1,800 square feet for each transplanted elderberry plant. As many as 10 conservation plantings (i.e., elderberry cuttings or seedlings and/or associated native plants) may be planted within the 1800 square foot area with each transplanted elderberry. An additional 1,800 square feet shall be provided for every additional 10 conservation plants. Each planting should have its own watering basin measuring approximately three feet in diameter. Watering basins should be constructed with a continuous berm measuring approximately eight inches wide at the base and six inches high.

   The planting density specified above is primarily for riparian forest habitats or other habitats with naturally dense cover. If the conservation area is an open habitat (i.e., elderberry savanna, oak woodland) more area may be needed for the required plantings. Contact the Service for assistance if the above planting recommendations are not appropriate for the proposed conservation area.

   No area to be maintained as a firebreak may be counted as conservation area. Like the avoidance area, the conservation area should connect with adjacent habitat wherever possible, to prevent isolation of beetle populations.

   Depending on adjacent land use, a buffer area may also be needed between the conservation area and the adjacent lands. For example, herbicides and pesticides are often used on orchards or vineyards. These chemicals may drift or runoff onto the conservation area if an adequate buffer area is not provided.

2. <u>Long-Term Protection</u>. The conservation area must be protected in perpetuity as habitat for the valley elderberry longhorn beetle. A conservation easement or deed restrictions to protect the conservation area must be arranged. Conservation areas may be transferred to a resource agency or appropriate private organization for long-term management. The Service must be provided with a map and written details identifying the conservation area; and the applicant must receive approval from the Service that the conservation area is acceptable prior to initiating the conservation program. A true, recorded copy of the deed transfer, conservation easement, or deed restrictions protecting the conservation area in perpetuity must be provided to the Service before project implementation.

   Adequate funds must be provided to ensure that the conservation area is managed in perpetuity. The applicant must dedicate an endowment fund for this purpose, and designate the party or entity that will be responsible for long-term management of the conservation area. The Service must be provided with written documentation that funding and management of the conservation area (items 3-8 above) will be provided in perpetuity.

3. <u>Weed Control</u>. Weeds and other plants that are not native to the conservation area must be removed at least once a year, or at the discretion of the Service and the California Department of Fish and Game. Mechanical means should be used; herbicides are prohibited unless approved by the Service.

4. <u>Pesticide and Toxicant Control</u>. Measures must be taken to insure that no pesticides, herbicides, fertilizers, or other chemical agents enter the conservation area. No spraying of these agents must be done within one 100 feet of the area, or if they have the potential to drift, flow, or be washed into the area in the opinion of biologists or law enforcement personnel from the Service or the California Department of Fish and Game.

5. Litter Control. No dumping of trash or other material may occur within the conservation area. Any trash or other foreign material found deposited within the conservation area must be removed within 10 working days of discovery.

6. Fencing. Permanent fencing must be placed completely around the conservation area to prevent unauthorized entry by off-road vehicles, equestrians, and other parties that might damage or destroy the habitat of the beetle, unless approved by the Service. The applicant must receive written approval from the Service that the fencing is acceptable prior to initiation of the conservation program. The fence must be maintained in perpetuity, and must be repaired/replaced within 10 working days if it is found to be damaged. Some conservation areas may be made available to the public for appropriate recreational and educational opportunities with written approval from the Service. In these cases appropriate fencing and signs informing the public of the beetle's threatened status and its natural history and ecology should be used and maintained in perpetuity.

7. Signs. A minimum of two prominent signs must be placed and maintained in perpetuity at the conservation area, unless otherwise approved by the Service. The signs should note that the site is habitat of the federally threatened valley elderberry longhorn beetle and, if appropriate, include information on the beetle's natural history and ecology. The signs must be approved by the Service. The signs must be repaired or replaced within 10 working days if they are found to be damaged or destroyed.

MONITORING

The population of valley elderberry longhorn beetles, the general condition of the conservation area, and the condition of the elderberry and associated native plantings in the conservation area must be monitored over a period of either ten (10) consecutive years or for seven (7) years over a 15-year period. The applicant may elect either 10 years of monitoring, with surveys and reports every year; or 15 years of monitoring, with surveys and reports on years 1, 2, 3, 5, 7, 10, and 15. The conservation plan provided by the applicant must state which monitoring schedule will be followed. No change in monitoring schedule will be accepted after the project is initiated. If conservation planting is done in stages (i.e., not all planting is implemented in the same time period), each stage of conservation planting will have a different start date for the required monitoring time.

Surveys. In any survey year, a minimum of two site visits between February 14 and June 30 of each year must be made by a qualified biologist. Surveys must include:

1. A population census of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations. Visual counts must be used; mark-recapture or other methods involving handling or harassment must not be used.

2. A census of beetle exit holes in elderberry stems, noting their precise locations and estimated ages.

3. An evaluation of the elderberry plants and associated native plants on the site, and on the conservation area, if disjunct, including the number of plants, their size and condition.

4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.

5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

The materials and methods to be used in the monitoring studies must be reviewed and approved by the Service. All appropriate Federal permits must be obtained prior to initiating the field studies.

Reports. A written report, presenting and analyzing the data from the project monitoring, must be prepared by a qualified biologist in each of the years in which a monitoring survey is required. Copies of the report must be submitted by December 31 of the same year to the Service (Chief of Endangered Species, Sacramento Fish and Wildlife Office), and the Department of Fish and Game (Supervisor, Environmental Services, Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814; and Staff Zoologist, California Natural Diversity Data Base, Department of Fish and Game, 1220 S Street, Sacramento, California 95814). The report must explicitly address the status and progress of the transplanted and planted elderberry and associated native plants and trees, as well as any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area must be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed must be included. For the elderberry and associated native plants, the survival rate, condition, and size of the plants must be analyzed. Real and likely future threats must be addressed along with suggested remedies and preventative measures (e.g. limiting public access, more frequent removal of invasive non-native vegetation, etc.).

A copy of each monitoring report, along with the original field notes, photographs, correspondence, and all other pertinent material, should be deposited at the California Academy of Sciences (Librarian, California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118) by December 31 of the year that monitoring is done and the report is prepared. The Service's Sacramento Fish and Wildlife Office should be provided with a copy of the receipt from the Academy library acknowledging receipt of the material, or the library catalog number assigned to it.

Access. Biologists and law enforcement personnel from the California Department of Fish and Game and the Service must be given complete access to the project site to monitor transplanting activities. Personnel from both these agencies must be given complete access to the project and the conservation area to monitor the beetle and its habitat in perpetuity.

SUCCESS CRITERIA

A minimum survival rate of at least 60 percent of the elderberry plants and 60 percent of the associated native plants must be maintained throughout the monitoring period. Within one year of discovery that survival has dropped below 60 percent, the applicant must replace failed plantings to bring survival above this level. The Service will make any determination as to the applicant's replacement responsibilities arising from circumstances beyond its control, such as plants damaged or killed as a result of severe flooding or vandalism.

SERVICE CONTACT

These guidelines were prepared by the Endangered Species Division of the Service's Sacramento Fish and Wildlife Office. If you have questions regarding these guidelines or to request a copy of the most recent guidelines, telephone (916) 414-6600 after August 5, 1999, or write to:

U.S. Fish and Wildlife Service
Ecological Services
2800 Cottage Way, W-2605
Sacramento, CA 95825

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Barr, C. B. 1991. The distribution, habitat, and status of the valley elderberry longhorn beetle *Desmocerus californicus dimorphus*. U.S. Fish and Wildlife Service; Sacramento, California.

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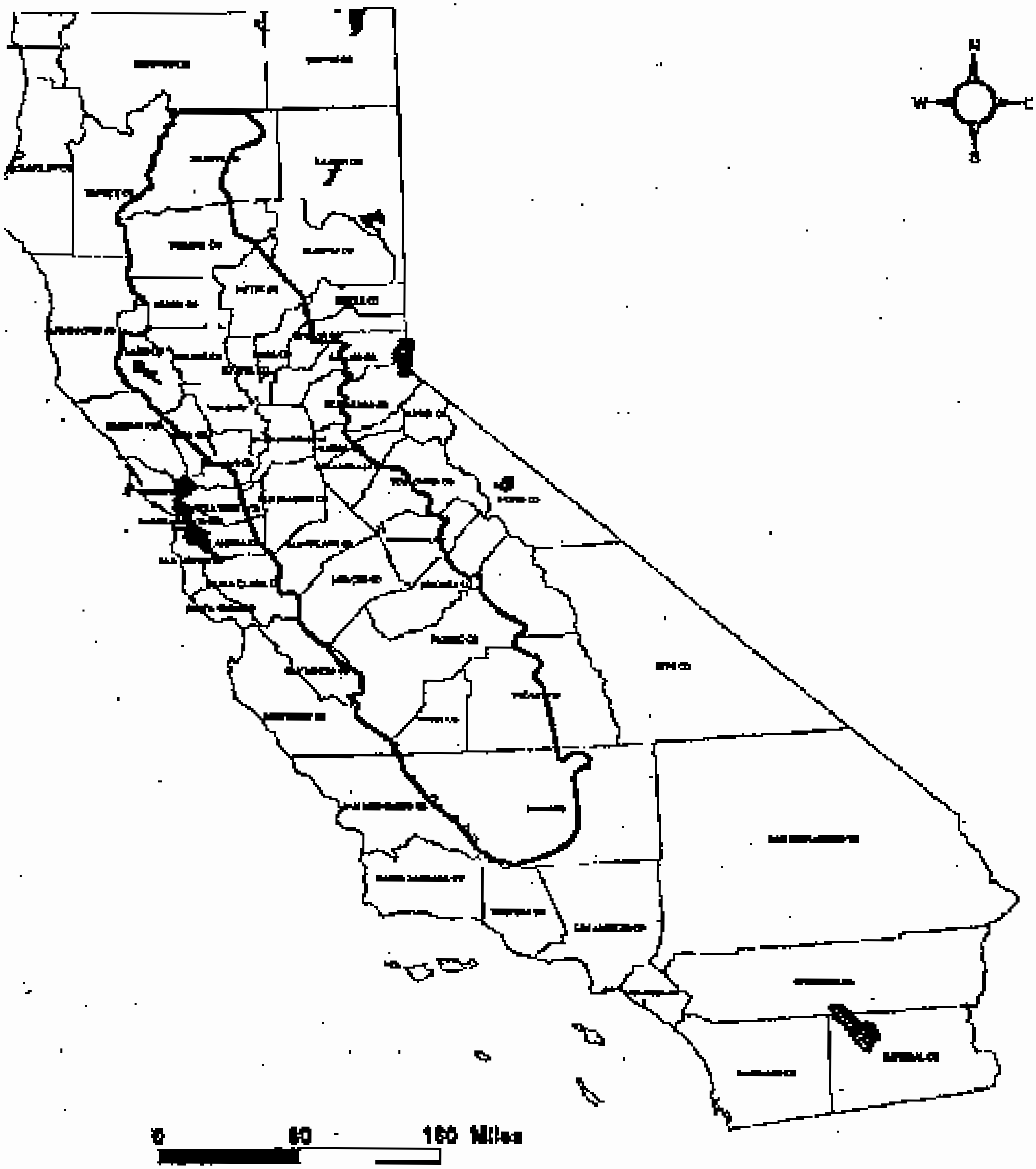

Figure 1: Range of the Valley Elderberry Longhorn Beetle

Table 1: **Minimization ratios based on location (riparian vs. non-riparian), stem diameter of affected elderberry plants at ground level, and presence or absence of exit holes.**

Location	Stems (maximum diameter at ground level)	Exit Holes Y/N (quantify)	Elderberry Seedling Ratio[1]	Associated Native Plant Ratio[2]
non-riparian	stems ≥ 1" & ≤ 3"	No:	1:1	1:1
		Yes:	2:1	2:1
non-riparian	stems > 3" & < 5"	No:	2:1	1:1
		Yes:	4:1	2:1
non-riparian	stems ≥ 5"	No:	3:1	1:1
		Yes:	6:1	2:1
riparian	stems ≥ 1" & ≤ 3"	No:	2:1	1:1
		Yes:	4:1	2:1
riparian	stems > 3" & < 5"	No:	3:1	1:1
		Yes:	6:1	2:1
riparian	stems ≥ 5"	No:	4:1	1:1
		Yes:	8:1	2:1

[1] Ratios in the *Elderberry Seedling Ratio* column correspond to the number of cuttings or seedlings to be planted per elderberry stem (one inch or greater in diameter at ground level) affected by a project.

[2] Ratios in the *Associated Native Plant Ratio* column correspond to the number of associated native species to be planted per elderberry (seedling or cutting) planted.

10 September 1999

Ms. Lori Rinek, Mr. Brian Twedt, and Mr. Chris Davis
U.S. Fish & Wildlife Service
3300 Cottage Way
Sacramento, CA 95825

RE: Potential Inconsistencies in Interpretation of VELB Mitigation Issues

Dear Lori, Brian, and Chris:

At my request, Chris recently mailed me a copy of the Tulare Irrigation District's Low-Effect HCP (TID HCP) for the Valley Elderberry Longhorn Beetle (VELB). He also sent me copies of the permit application and the Service's screening form for low-effect HCP determinations. Although the copy of the TID HCP that I received is missing pages i, 1, 4, 5, and 8, the information on these missing pages seems to be summarized elsewhere in the document.

Since I am preparing an HCP for remediation of contaminated soils at the Sacramento Rail Yard for Union Pacific Rail Road Company (UPRR), where the VELB is also an issue, I was interested in reviewing another current VELB HCP. In reviewing the TID HCP and comparing it to the UPRR HCP, I noticed several potential inconsistencies that I would like to bring to your attention. My comments are not meant to be included in the public comments on the TID HCP; rather I seek clarification on the proper interpretation of the Service's 1996 VELB mitigation guidelines, which were used to inventory the elderberries and to formulate mitigation recommendations for both project sites. In particular, I am concerned that UPRR may be proposing to mitigate the impacts of its rail yard remediation project at a higher level than is necessary, particularly when compared to the TID HCP.

Low vs. Medium-Effect HCP.

The attached table summarizes information on the number of elderberries, stems ≥ 1 inch, mitigation ratios, VELB mitigation units, and mitigation costs (based on $1,800/unit cost to the VELB Conservation Fund) for both HCPs and one alternative scenario for each project. The first scenario for each project presents the mitigation ratios and elderberry numbers described in the respective HCPs submitted to the Service. The alternative UPRR scenario interprets the 1996 VELB mitigation guidelines in the manner of the TID HCP, while the alternative TID analysis interprets the VELB guidelines as I did for the UPRR HCP. I would appreciate learning from you which scenarios correctly interpret the VELB guidelines.

For both projects, the number of stems ≥ 1 inch are similar, 253 for UPRR and 222 for TID. Only 2 bona fide VELB exit holes were noted for UPRR, while as many as 11 exit holes were noted for TID. As author of the Service's recovery plan on the VELB and with over 20 years experience in surveying for it, I can state that the density of exit holes for the TID project area is one of the highest densities I have ever encountered for the VELB, which normally occurs at very low density compared to most other insects. In addition, the density for the TID project area is 6.26 times greater than the VELB density at the UPRR site. Despite the potential for a greater impact on the VELB the Service's screening form states that the TID project qualifies as a low effect HCP, while the Service has previously advised me that the UPRR project does not qualify as a low effect HCP. Furthermore, all of the criteria stated on the screening form (p. 2) to substantiate the low-effect designation for the TID project seem to me to also apply to the UPRR project, hence my confusion.

Application of Mitigation Ratios.

The application of mitigation ratios from the 1996 VELB mitigation guidelines differs substantially in the two HCPs. Examples presented in these guidelines (pp. 5 & 6) imply that the migitation ratio is based on the percentage of all elderberries at a site that exhibit exit holes, which is the way I calculated the number of mitigation elderberries needed for UPRR HCP (i.e., < 50% of all 87 plants bearing 253 stems ≥ 1 inch at the project site had exit holes, so a 3:1 mitigation ratio resulted in a requirement of 759 mitigation elderberry plantings).

In contrast, the TID HCP applies different mitigation ratios to different elderberry groups within its project area. The 3:1 ratio was used only for those plant locations within the project area that had potential exit holes, while a 2:1 ratio was used for all other locations that lacked exit holes (Table 2, p. 13 of TID HCP). Thus, either the TID HCP underestimated it elderberry mitigation requirement or the UPRR HCP overestimated its requirement.

As is illustrated in the attached table, the application of different mitigation ratios for various groups of elderberries instead of one ratio for all elderberries yields substantially different numbers of required mitigation plants and corresponding VELB units. The table also illustrates how the cost of mitigation varies dramatically with each scenario.

Mitigation for Transplants.

The Service's 1996 VELB guidelines (p. 3) state that elderberries, which cannot be avoided, should be transplanted. Because UPRR did not feel it was appropriate to transplant impacted elderberry plants with contaminated soils from the rail yard, which is a state recognized superfund site, it proposed to double the normal 3:1 mitigation ratio to 6:1. This doubling of the mitigation ratio comes from p. 4 of the guidelines, which says, "the Service may allow the applicant to plant seedlings or cuttings at twice the stated ratios for each elderberry plant that cannot be transplanted. Thus, the total number of mitigation elderberries presented in the UPRR HCP is 1,518 plants or 304 units.

The TID HCP does not seem to discuss the issue of transplanting elderberries that cannot be avoided along the canal or any other form of compensation for impacted elderberries (at least in the pages of the HCP that I have). The only mitigation described in the TID HCP is elderberry cuttings. Similarly, the attached documents for the VELB Conservation Fund do not mention any need to compensate for impacted elderberries that would otherwise be transplanted, as do the VELB guidelines. This implies that if an applicant uses the VELB Conservation Fund, no compensation is necessary for impacted elderberries that would otherwise need to be transplanted to a mitigation site. If the TID HCP and VELB Conservation Fund do not include compensation for transplants, why does UPRR need to provide additional mitigation for not transplanting elderberries growing in contaminated soils that cannot be avoided during remediation of the rail yard? The inclusion of compensation for transplants substantially increases the mitigation costs for either project, as detailed in the attached table.

Clearly, each of these issues alone affects the required number of mitigation elderberries (VELB units). As the attached table illustrates, the combination of these three issues causes the mitigation costs for either the TID or UPRR project to vary by hundreds of thousands of dollars.

I am prepared to revise the draft UPRR HCP, and to prepare an EA for a medium-effect HCP if necessary, but in light of these apparent discrepancies I need clarification on the proper interpretation of these issues before I proceed. UPRR is anxious to obtain its take permit as quickly as possible, and is prepared to undertake whatever mitigation is necessary and consistent with the proper interpretation of the 1996 VELB guidelines. Indeed UPRR would like to contribute to the VELB Conservation Fund or purchase its mitigation credits before the end of 1999 and we anticipate that some lead time will be necessary to consumate such a transaction either through the VELB Conservation Fund or a Service approved mitigation bank. However, as noted in the attached table, UPRR's contribution amount to the VELB Conservation Fund could be as low as $108,000 or as high as $547,200 depending upon how the VELB guidelines are interpreted. Please advise me as to the correct interpretation of the guidelines, so UPRR can secure its necessary credits as quickly as possible and I can complete the necessary documents for the permit application.

Thank you for your assistance. I look forward to your prompt reply. Feel free to call me at (925) 825-3784 or email me at bugdetr@bgmc.com to discuss these matters further.

Comparison of Proposed and Alternative Mitigation Scenarios for TID and UPRR HCPs

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Number of elderberry plants with stems ≥ 1"	87	87	54	54
Number of stems ≥ 1"	253	255	227	227
Number of VELB exit holes	2	2	11	11
Mitigation ratio(s) used	3:1 for all plants within project site	2:1 for plants lacking exit holes; 3:1 for only plants (≤50%) that possess exit holes; and 5:1 for only plants (>50%) possess exit holes	2:1 for plants lacking exit holes; and 3:1 for only plants (≤ 50%) that possess exit holes	3:1 for all plants within project site
Preliminary required number of mitigation plants	759	297	465	681
Additional mitigation for not transplanting impacted elderberries	2:1 (2 x 759)	none	none	2:1 (2 x 681)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Footnotes:

[1] – interprets 1996 VELB guidelines in the same manner as the TID Low Effect HCP

* = interprets 1996 VELB guidelines in the same manner as the draft UPRR HCP

Appendix F
Preliminary Bat Survey

Preliminary Bat Survey for the Tehama-Colusa Canal Authority Fish Passage Improvement Project at the Red Bluff Diversion Dam, Red Bluff, California

PREPARED FOR: Laurel Karren/SAC

PREPARED BY: Heather L. Johnson/SAC

COPIES: Marjorie Tsang/SAC
Mike Urkov/RDD

DATE: June 14, 2002

Introduction

The Tehama-Colusa Canal Authority (TCCA) Fish Passage Improvement Project at the Red Bluff Diversion Dam (RBDD) is being proposed to improve the long-term ability to reliably pass anadromous fish and other species of concern past RBDD and improve the long-term ability to reliably and cost-effectively move sufficient water into the TCCA systems. New facilities will be constructed to facilitate the environmental and agricultural needs of the involved parties.

A preliminary bat survey was conducted in the proposed project area as part of biological surveys required by the National Environmental Protection Act (NEPA) and the California Environmental Quality Act (CEQA). The preliminary survey was conducted at RBDD, the abandoned storage buildings at the old mill site on the south side of the Sacramento River, and the U.S. Forest Service (USFS) campground on the north side of the Sacramento River. The preliminary bat survey was also conducted on other adjacent lands as a follow-up to observations of roosting bats made on a May 11, 2001, reconnaissance-level biological survey and to further assess habitat and document presence.

Project Location

The proposed RBDD alternative project is located near the City of Red Bluff, in Tehama County, California, along and through the Sacramento River. The project site is located on U.S. Geological Survey (USGS) quadrangle map Red Bluff East, CA, Township 27 N, Range 3 W, Section 33.

Methods

Two CH2M HILL biologists conducted the field survey on June 5, 2002. The survey consisted of daytime habitat assessment and focal roost searches, and nighttime monitoring of bat activity. The daytime survey was conducted by car and on foot; it consisted of driving the limits of the project area and walking and driving around the project site. U.S. Bureau of Reclamation (USBR) and USFS maintenance personnel were interviewed. Habitat conditions, surrounding land uses, and specific features that might provide roosting and foraging habitat for bats were noted and investigated. Specific roosting habitat features included abandoned buildings; dam facilities; and mature riparian vegetation with crevice, cavity, and foliage features suitable for bat occupancy.

Focal roost searches were conducted on portions of the dam and associated facilities, in abandoned storage buildings, and at most of the outbuildings in the Red Bluff Recreation Area. Outbuildings at the Recreation Area included bathroom exteriors, sheds, and picnic area roof structures. Structures were investigated visually with the aid of spotlights and a digital handycam with external light source attachment. Bat roost sites were located by the presence of sign, which includes guano deposits, urine stains, audible vocalizations, carcasses, and discarded prey remains. Roost locations were noted, and accessible roosts were investigated to identify species if possible.

The nighttime survey portion consisted of monitoring bat activity in two adjacent locations at the abandoned storage buildings. Emerging bats were concurrently monitored at two roost sites for approximately 45 minutes around the time of sunset. At one roost site, emergence was observed to note behavior and make a limited number count using the unaided eye and ambient light. At the second roost site, emerging and foraging bats were acoustically monitored using an ultrasonic detector (Anabat II, Titley Electronics, Ballina, Australia) in conjunction with a laptop computer to view real-time sonograms of bat echolocation calls.

Results

Bat species potentially occurring in the project area were identified by querying the California Natural Diversity Database (CNDDB), reviewing a U.S. Fish and Wildlife Service (USFWS) list for the project, reviewing information from the USFS and Bureau of Land Management (BLM), and performing field surveys (see Table 1). The presence of three species was visually confirmed, and a fourth species was acoustically detected. Numerous roost locations were documented in the two abandoned storage buildings. Evidence was found that bats roost in some of the hydroelectric structures of RBDD in concrete weep holes and under metal overhangs. Several areas appeared to provide potential roosting and foraging habitat: the camping and recreational park area on the north side of the Sacramento River, the upland vegetation and open grasslands on the southwest side of the river, and riparian and wetlands areas. Figure 1 illustrates potential bat roosting and foraging habitat that were identified during the survey conducted on June 5, 2002.

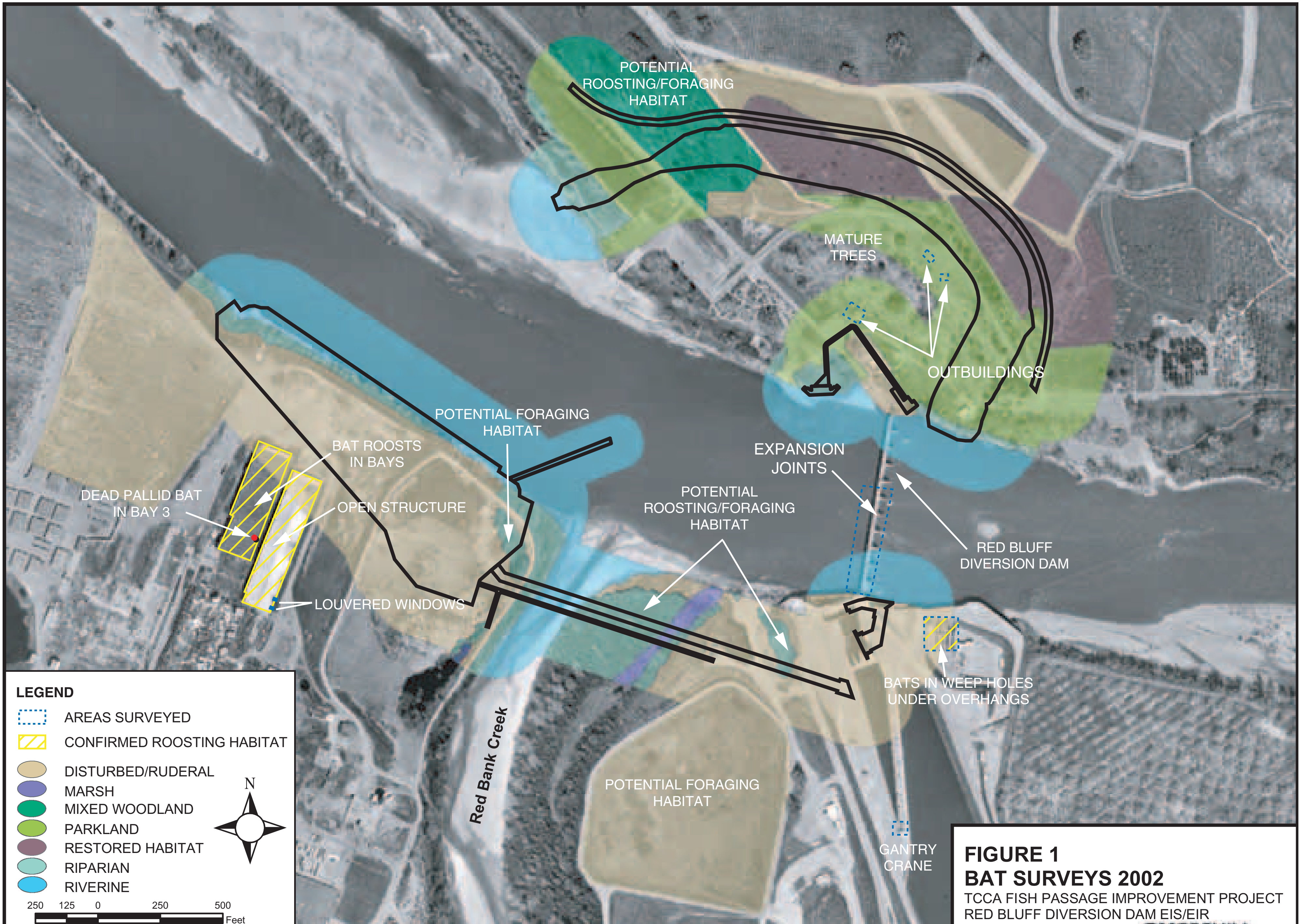

FIGURE 1
BAT SURVEYS 2002
TCCA FISH PASSAGE IMPROVEMENT PROJECT
RED BLUFF DIVERSION DAM EIS/EIR

CH2MHILL

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TABLE 1
Bat Species Potentially Occurring in the Red Bluff Diversion Dam Area

Species	Status	Habitat in Project Area	Comments
Mexican free-tailed bat *Tadarida brasiliensis*	NA	Oak woodland	Over 600 observed emerging after sunset, more are present
Townsend's big-eared bat *Corynorhinus townsendii*	CDFG-SC FWS-C USFS-S BLM-S	Oak woodland, riparian, active agricultural areas	Suitable habitat present, no evidence found
Spotted bat *Euderma maculatum*	CDFG-SC FWS-C	Mixed conifer forest	Not likely to be present, lack of suitable roosting habitat
Pallid bat *Antrozous pallidus*	CDFG-SC USFS-S BLM-S	Oak woodland, grasslands	Desiccated carcass found
Big brown bat *Eptesicus fuscus*	NA	Agricultural areas, oak woodland, pasture	Possible evidence of presence
Silver-haired bat *Lasionycteris noctivagans*	NA	Conifer/hardwood forests, in winter and during seasonal migrations in low elevation, more xeric habitats	Possibly migrating along river
Red bat *Lasiurus blossevillii*	CDFG-SC FWS-C USFS-S	Riparian, edge habitats adjacent to streams or open fields, orchards	Potential habitat present
Hoary bat *Lasiurus cinereus*	NA	Forested habitats, oak woodland	Potential habitat present
Yuma myotis *Myotis yumanensis*	FWS-C	Associated with rivers and streams, riparian, oak woodland, forests	*Myotis* sp. bats were observed, likely to be present
Little brown bat Yuma lucifugus	NA	Woodlands and coniferous forest	Not likely to be present, more common at higher elevations
Long-legged myotis *Myotis volans*	FWS-C	Woodlands and coniferous forest	Not likely to be present, more common at higher elevations
Fringed myotis *Myotis thysanodes*	CDFG-SC FWS-C	Oak woodland	*Myotis* sp. bats were observed, potential evidence of presence
Long-eared myotis *Myotis evotis*	CDFG-SC FWS-C	Agricultural areas, coniferous forests, oak woodland	*Myotis* sp. bats were observed, potentially present
California myotis *Myotis californicus*	NA	Coniferous forests, oak woodland	*Myotis* sp. bats were observed, likely to be present
Small-footed myotis *Myotis ciliolabrum*	FWS- C	Riparian, coniferous forests, oak woodland	*Myotis* sp. bats were observed, possible evidence of presence

NA Not Applicable
CDFG-SC California Department of Fish and Game Species of Special Concern
FWS-C U.S. Fish and Wildlife Service Species of Concern
USFS-S U.S. Forest Service Sensitive Species
BLM-S Bureau of Land Management Sensitive Species

Abandoned Storage Buildings

One abandoned, enclosed storage building consisted of a row of 25 (numbered) large bays made of concrete blocks (see Figure 2). Each bay provided a large, dark, cave-like environment, similar to a mine adit. Bats are roosting inside almost all of the bays during the day and at night, as revealed by guano deposits on the floor. Day roost sites consisted of crevices and cavities formed by crumbling cement plaster on the interior walls. Often the crevices opened up into cavities within the walls (see Figure 3). In two of the bays, bats roosted in large cracks in the cement frame of the bay openings. These day roosts were probably also occupied at night. In addition, guano deposits scattered along the floor and urine stains high on the walls indicated that bats night roost along the bay walls in the mid-section, and in or on the rear wall. Table 2 provides a summary of these observations.

FIGURE 2
Bat Habitat—Large Bays Made of Concrete Block in Abandoned Covered Storage Building

Three guano types were distinguishable; that of myotis (*Myotis* sp.), Mexican free-tail bats (*Tadarida brasiliensis*), and a larger type, probably pallid bats (*Antrozous pallidus*) or big brown bats (*Eptesicus fuscus*). Bats were also roosting in the corners at either side of the bay openings, and the guano type here was usually pallid bat, or possibly big brown bat since the guano did not have discarded prey remains, which is characteristic of pallid bat roosts.

FIGURE 3
Mexican Free-tail Bats Inside Cement Wall Cavity Roost

TABLE 2
Occupied Areas of the Two Abandoned Storage Buildings

Bay	Observation	Comments
1	No sign	
2	Guano on right (R) side	
3	Roosts on left (L) and R walls	L side occupied, R side not occupied
		Pallid bat carcass below roost, large bat partially seen inside roost
		Many Mexican free-tails seen and heard inside
4	Guano on R side	
5	Guano on L and R sides	
6	Guano on L and R sides	L side large pile
7	No sign	
8	Roost in back wall	*Myotis* sp. seen and heard inside
9	No sign	

TABLE 2
Occupied Areas of the Two Abandoned Storage Buildings

Bay	Observation	Comments
10	Guano in R corner	Pallid or big brown type
		Possible night roost only
11	Guano in R corner	Pallid or big brown type
		Possible night roost only
12	Guano in R corner	Pallid or big brown type in corner
	Guano mid-way below R wall	Mexican free-tail type below wall
13	Guano in R corner	Myotis-type guano
14	No sign	
15	Some guano in R corner	Pallid or big brown type-, and myotis-type guano in corner
16	Some guano in R corner, along back wall, along R wall	
17	Some guano in R corner, along back wall	Pallid or big brown type in corner
18	Guano in R corner	Pallid or big brown type
19	Guano on R wall mid-way, along back wall	
20	Guano in R corner, large amount scattered on R wall, possible roosting bats above ceiling beams	Pallid or big brown type- in corner, and large amounts of Myotis-type guano
	Possibly heard bats	
21	Some guano in R corner, some guano scattered on R wall	Pallid or big brown type in corner
22	Some guano in R corner, scattered below R wall, some in middle of floor toward the rear of the bay	
23	Roost in cracked frame of opening	Mexican free-tails in roost
	Guano scattered along R wall	Myotis-type guano below R wall
24	Guano in R corner, along R wall, along rear wall, large concentration below L wall mid-way	Mexican free-tail-type guano along rear wall, and myotis-type guano below L and R wall
25	Some guano in L corner, probable roost, heard bats but unable to locate them	Myotis-type guano
Storage Building	Guano deposits below louvers in several locations, bats roosting behind louvers and under loose board on upright pole	Mexican free-tails and myotis roosting on plywood boards under louvers, in window frame, and myotis roosting under loose board on pole
		Possible visual on two myotis species

The second abandoned storage building was a large, open, corrugated metal roof structure supported by a wooden frame (see Figure 4). This open-roofed structure had some interior walls of plywood and corrugated plastic sheets and one relatively short exterior wall that appeared to have been louvered windows that were backed by plywood squares. A few myotis and Mexican free-tail bats were roosting on the plywood behind the louvers and in the window frames. Greater numbers of bats were observed roosting here on May 11, 2001, and the guano deposits below suggested greater numbers. Also, myotis bats were roosting under a loose board on an upright pole. Video of the myotis bats under the board possibly revealed more than one species (based on morphology). Capture would be necessary for further identification.

FIGURE 4
Bat Habitat—Louvered Windows Backed by Plywood and Loose Boards at Open-walled Abandoned Storage Building

Behavior Observations

Over 600 Mexican free-tail bats were observed emerging from Bays 1 through 3. Up to 10 bats appeared to be a larger size than the rest; based on the carcass discovery they were pallid bats or possibly big brown bats. Bats flew in and out of adjacent bays. About 1.5 hours after sunset-myotis bats were seen flying in and out of Bay 8, which contained the rear wall roost site (evidence of night roosting).

Acoustic Monitoring

Four types of echolocation calls were recorded. Echolocation calls of the Mexican free-tail were distinctive in this case. A second call type could have been pallid bat or big brown bat;

either species (or both) are likely. The final two call types were myotis, which are often reported as phonic types based on the characteristic frequency of the sonagrams (40 kilohertz [kHz] and 50 kHz). The echolocation calls of many species of bats are indistinguishable by acoustic means alone (especially when recorded near roosts), and capture is required to confirm identification. However, the Yuma myotis is a 50-kHz phonic type and would be expected to occur in buildings along the Sacramento River. The 40-kHz calls may have been attributable to the small-footed myotis.

Conclusions

The following conclusions are made relevant to the June 5, 2001 survey:

- Additional species identification (especially myotis species) and habitat use characterization would require further surveys. A combination of capture and acoustic methods, as well as roost searches and emergence observations, would be necessary. Capture methods would also be required to obtain demographic information such as sex, reproductive condition, and the presence of juveniles, which would indicate site occupancy by maternity colonies. In addition, bat presence and activity is highly variable both seasonally and on a night-to-night basis; therefore, multiple surveys across habitats and seasons would be necessary.
- Foraging habitat would be lost as a result of the new facility construction. Replacement of the habitat by replanting vegetation is planned as part of project mitigation.
- The project area contains areas of riparian vegetation that include mature sycamores, cottonwoods, and willows; this is habitat that may potentially be used by the red bat and the hoary bat. Further surveys would be required to determine presence of these species.
- The two abandoned buildings used as bat roosts are within the 200-foot buffer area considered to be temporarily impacted by all project alternatives. Currently, there are no plans to remove these buildings. If at the time of project construction a decision is made to permanently impact the roosting habitat by removing the buildings, demolition would occur following confirmed exclusion of the bats. Observations of the type and location of bat roosts in these structures appear to support exclusion as a viable mitigation measure.

Mitigation

Temporary Impacts: Building Avoidance During Construction

To reduce temporary impacts, the following actions should be taken during construction:

- The buildings occupied by bats should be avoided during construction.
- Construction should not be conducted at night within 200 feet of the buildings occupied by bats.
- Construction materials should not be stored in the buildings occupied by bats.

Permanent Impacts: Exclusion and Building Removal

Removal of the abandoned buildings would displace hundreds and possibly thousands of bats and be a significant loss of roosting habitat. Current information on numbers and species of bats present is preliminary; additional special-status species may be present. The species currently identified are colonial, and displacement from the roosts may disrupt colony cohesion. Displaced bats may roost in exposed locations and be at increased risk of predation.

If the buildings are to be removed, prior mitigation in the form of exclusion would be performed. Exclusion is the process of preventing the bats from occupying the roosts. Bat emergence is controlled, and re-entry is prevented by covering the roost entrance with draped netting. The netting is secured on the top and sides, and the bottom is left open. Bats are able to walk down the wall and underneath the netting to escape from the bottom but are usually unable to re-enter in this manner. One-way valves made of plastic pipe may also be used. Exclusion consists of two phases: allowing emergence while temporarily blocking re-entry for 1 week, followed by permanently blocking the roost entrances. Surveys must be conducted to ensure that all bats have exited the roost before the entrances are permanently blocked to avoid direct mortality by entombment. Screening and insulation material such as expanding foam are often used to permanently block roost entrances.

It is vital that exclusion only be performed in the winter (November to February) after any young of the year are volant. A qualified nuisance control professional should perform the exclusion. A qualified biologist should monitor the bats during the procedures to prevent any mortalities from bats becoming entangled in the netting, and to conduct surveys to ensure that bats are successfully excluded.

Permanent Impacts: Provision of Alternate Roosting Habitat

To mitigate for the loss of roosting habitat, provision of alternate roosting habitat in the form of offsite installation of large bat houses is recommended. Large bat houses (“bat condos”) may be erected. The Red Bluff Recreation Area would be a good bat house construction site since the managers are already promoting the presence of bats in recognition of the bat’s beneficial role in insect pest management. Bat condos have been successful artificial roosts for large numbers of Mexican free-tail bats.

Bat condos are similar to raised wooden chicken coops with internal partitions to form roost crevices. The overall size should be 8 x 8 x 8 feet, and the width of the internal partitions should be approximately 0.75 to 1.0 inches for the free-tail bats and also 1.0 to 1.5 inches for the pallid bats. Bat condos should be oriented properly (usually southern or southeastern exposure), and the temperature regime and humidity inside the condo should replicate that found in the original roosts.

It is recommended that the existing exterior wall with the plywood-backed louvers be reconstructed in a suitable offsite location to provide for myotis bat roosting habitat. Alternately, bat houses mounted on poles may be erected that simulate the existing roost (the gap under the loose board attached to a pole). Managers at the Red Bluff Recreation Area are currently experimenting with bat house style and placement and may provide a cooperative bat management opportunity.