BUREAU OF RECLAMATION

Final Environmental Impact Statement

Long-Term Operation of the Central Valley Project and State Water Project

Central Valley Project, California

Interior Region 10 - California Great-Basin

U.S. Department of the Interior

November 2024

Mission Statements

Final Environmental Impact Statement

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Cover Photo: Shasta Dam in northern California. (Reclamation)

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Proposed Action Location

California Counties: Butte County, Colusa County, El Dorado County, Glenn County, Nevada County, Placer County, Plumas County, Shasta County, Sutter County, Tehama County, Yuba County, Stanislaus County, Madera County, Merced County, Fresno County, Tulare County, Kings County, Kern County, Contra Costa County, Sacramento County, San Joaquin County, Solano County, Yolo County, Alameda County, Santa Clara County, San Benito County, Napa County, San Luis Obispo County, Santa Barbara County, Ventura County, Los Angeles County, Orange County, San Diego County, Riverside County, San Bernardino County, Trinity County, Humboldt County, Del Norte County

Abstract

Reclamation prepared this environmental impact statement (EIS) to analyze potential modifications to the continued long-term operation of the Central Valley Project, for its authorized purposes, in a coordinated manner with the State Water Project, for its authorized purposes. This EIS evaluates alternatives to continue the operation of the CVP and the SWP, for authorized purposes, in a manner that: meets requirements under federal Reclamation law; other federal laws and regulations; and State of California water rights, permits, and licenses pursuant to Section 8 of the Reclamation Act; satisfies Reclamation contractual obligations and agreements; and implements authorized CVP fish and wildlife project purposes and meets federal trust responsibilities to Tribes, including those in the Central Valley Project Improvement Act (CVPIA).

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Chapter 0 Executive Summary

0.1 Introduction

The United States Department of the Interior, Bureau of Reclamation (Reclamation) prepared this environmental impact statement (EIS) for the 2021 Endangered Species Act Reinitiation of Section 7 Consultation on the Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP). This EIS is meant to inform the public and decision makers on potential federal actions by examining a range of reasonable alternatives and the potential effect on the environment. Reclamation manages the CVP. The California Department of Water Resources (DWR) manages the SWP. Collectively, the operation of the CVP and SWP provides flood control and navigation; delivers water to 30 million people; supports 4 million acres of agriculture; maintains 19 wildlife refuges on the Pacific Flyway; protects numerous iconic and endemic species such as Chinook salmon, coho salmon, steelhead, sturgeon, and smelt; generates 4.5 million megawatt hours of electricity; maintains water quality for beneficial uses in the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (Bay-Delta); and supports recreation throughout Northern California.

Figure 0-1. Shasta Dam (Bureau of Reclamation)

This summary provides a succinct overview of the development of alternatives in coordination with other agencies and the public, major conclusions for key environmental resource areas, the identification of avoidance and mitigation measures to address potential impacts, and issues that have been in dispute as raised by the public and other interested parties. This summary provides the material required by the Council on Environmental Quality's National Environmental Policy Act (NEPA) Implementing Regulations regarding the contents of an EIS summary.

0.2 Background

On January 20, 2021, President Biden issued *"Executive Order 13990 on Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,"* directing the Department of Interior to review all existing regulations, orders, guidance documents, policies, and any other similar agency actions (agency actions) promulgated, issued, or adopted between January 20, 2017, and January 20, 2021. This included the National Marine Fisheries Service (NMFS) Biological Opinion on Long-Term Operation of the Central Valley Project and the State Water Project (October 21, 2019) and U.S. Fish and Wildlife Service (USFWS) Biological Opinion for the Reinitiation of Consultation on the Coordinated Operations of the Central Valley Project and State Water Project (October 21, 2019).

To address the required review, and to voluntarily reconcile CVP operating criteria, as appropriate, with operational requirements of the SWP under the California Endangered Species Act (CESA), Reclamation reinitiated consultation with USFWS and NMFS on September 30, 2021. Reclamation must also comply with NEPA for agency decision making. On February 28, 2022, Reclamation posted a Notice of Intent (NOI) to Prepare an Environmental Impact Statement and Hold Public Scoping Meetings (87 *Federal Register* [FR] 11093).

0.3 Alternatives

This EIS considers a range of reasonable alternatives, consistent with 40 CFR Section 1502.14, including a No Action Alternative that would continue implementation of the 2020 Record of Decision on the Reinitiation of Consultation on the Coordinated Long-Term Operation of the CVP and SWP. The purpose of the action being considered is to continue the operation of the CVP and the SWP, for authorized purposes, in a manner that:

- Meets requirements under federal Reclamation law; other federal laws and regulations; and State of California water rights, permits, and licenses pursuant to Section 8 of the Reclamation Act;
- Satisfies Reclamation contractual obligations and agreements; and
- Implements authorized CVP fish and wildlife project purposes and meets federal trust responsibilities to Tribes, including those in the Central Valley Project Improvement Act (CVPIA).

The action alternatives must accomplish the purpose of this Proposed Action. As part of the EIS process, Reclamation formulated and considered a range of alternatives through a process involving agencies, interested parties, and the public. Reclamation released an Initial Alternatives Report (Bureau of Reclamation 2022) documenting an analysis of options to inform alternative formulation. Reclamation developed potential options through the NEPA scoping process, coordination under the Water Infrastructure Improvement for the Nation (WIIN) Act, interagency coordination teams, outreach to interested parties, and Reclamation's decades of experience in operating the CVP. Development of initial alternatives relied upon exploratory modeling to simulate potential water operations under a range of criteria. Reclamation then used the Initial Alternatives Report to develop public draft alternatives to be analyzed in the Public Draft EIS for potential impacts on the environment.

The alternatives consider the operation of dams, power plants, diversions, gates, and related facilities of the CVP and the Sacramento–San Joaquin Delta (Delta) facilities of the SWP. Operation of the CVP and SWP impacts the environment by altering hydrology through storing water in reservoirs, releasing water from storage, blending releases of water from different temperature strata within a reservoir, routing water into different channels, and diverting water for beneficial uses. This EIS analyzes the following alternatives.

- **No Action Alternative:** Continued operation of the CVP and SWP as described in the 2020 Record of Decision and subject to the 2019 Biological Opinions. DWR would also operate the SWP consistent with the California Department of Fish and Wildlife's (CDFW) 2020 Incidental Take Permit for the SWP. NEPA requires evaluation of the No Action Alternative.
- **Alternative 1 (Water Quality Control Plan [D-1641, 90-5, etc.]):** Operation to water right terms and conditions, including obligations for water quality control plan objectives for the Bay-Delta, water quality and minimum flows on CVP tributaries, and water right settlements. The needs of listed fish would rely upon habitat restoration and facility improvements completed since the 2008 and 2009 Biological Opinions rather than on additional flows.
- **Alternative 2 (Multi-Agency Consensus):** Actions developed with CDFW, DWR, NMFS, and USFWS to harmonize operational requirements of CVP with CESA requirements for the SWP. It includes actions and approaches for the CVP and SWP identified by the state and federal fish agencies, in addition to the water supply and power generation objectives of Reclamation and DWR.

  Alternative 2 is analyzed in phases to accommodate voluntary flow contributions and State Board decisions which are outside Reclamation's direct control. Those phases include operations with a Temporary Urgency Change Petition; the full Voluntary Agreement alternative to the Bay-Delta Plan update; early implementation of Delta export reductions; and no additional winter and spring Delta outflow.
- **Alternative 3 (Modified Natural Hydrograph):** Operation to increased Delta outflow up to 65% of unimpaired inflow and to carryover storage requirements in addition to other measures. This alternative was developed in coordination with the NGO community.

- **Alternative 4 (Risk Informed Operation):** Modified Shasta and Folsom Dam operations for a different balance between water made available for diversion and storage to protect against subsequent dry years. It scales Delta operations based on effects on listed fish populations.

Reclamation has identified Alternative 2 as the preferred alternative. Alternative 2 best meets the Purpose and Need, including the goals of E.O.13990 because NMFS and USFWS reached consensus on an alternative for Reclamation to submit for consultation. Alternative 2 incorporates the Delta criteria proposed in DWR's Incidental Take Permit for the Delta facilities of the SWP to harmonize operations of the CVP and SWP.

0.4 Major Conclusions

The alternatives described above establish different objectives for storage, release, blending, routing, and diversion of water that result in different downstream flow, water supply, and power generation impacts that change between wetter and drier periods, as well as seasonally and long-term. This EIS evaluates the potential positive and negative environmental impacts of each alternative on a broad suite of resources that could potentially be affected by the actions. The resources most anticipated to have impacts are summarized below.

0.4.1 Water Quality

The analysis of water quality impacts focuses on constituents of concern that could be affected by changes in CVP and SWP water operations. The Final California 2020-2022 Integrated Report (Clean Water Act Section 303(d) List/305(b) Report) and other water quality reports identify constituents of concern. Flow is used as a surrogate for water quality in the EIS water quality analysis. Changes in CVP and SWP operation will change the flow in rivers within the study area. Flow reductions in rivers could result in increased concentrations of constituents of concern because there would be less water in the waterway to dilute runoff containing those constituents. Constituents of concern are present in the study area due to urban and agricultural runoff along with legacy drainage from areas that historically had supported mining activities.

In the Trinity and San Joaquin rivers and their tributaries, the changes in river flows under Alternatives 1 through 4 would have minor effects on water quality compared with the No Action Alternative. In the Sacramento River (under Alternatives 1, 3, and 4), Stanislaus River (under Alternatives 2 and 4), and American River (under Alternative 3), changes in flow would have minor effects on water quality. These changes are not of sufficient magnitude to affect the concentration of constituents of concern and would not affect overall water quality.

In Clear Creek, the action alternatives would cause flow reductions in some water year types that could result in water quality degradation. In the Stanislaus River (under Alternatives 1, 2, and 4), American River (under Alternatives 1 and 2), and Sacramento River (under Alternative 3), flow reductions under certain water year types could result in water quality degradation from mercury contamination derived from historical gold mining.

Water quality in the Bay-Delta is influenced by Delta inflow, Delta outflow, and the position of X2 (see Figures 0-2, 0-3, and 0-4).

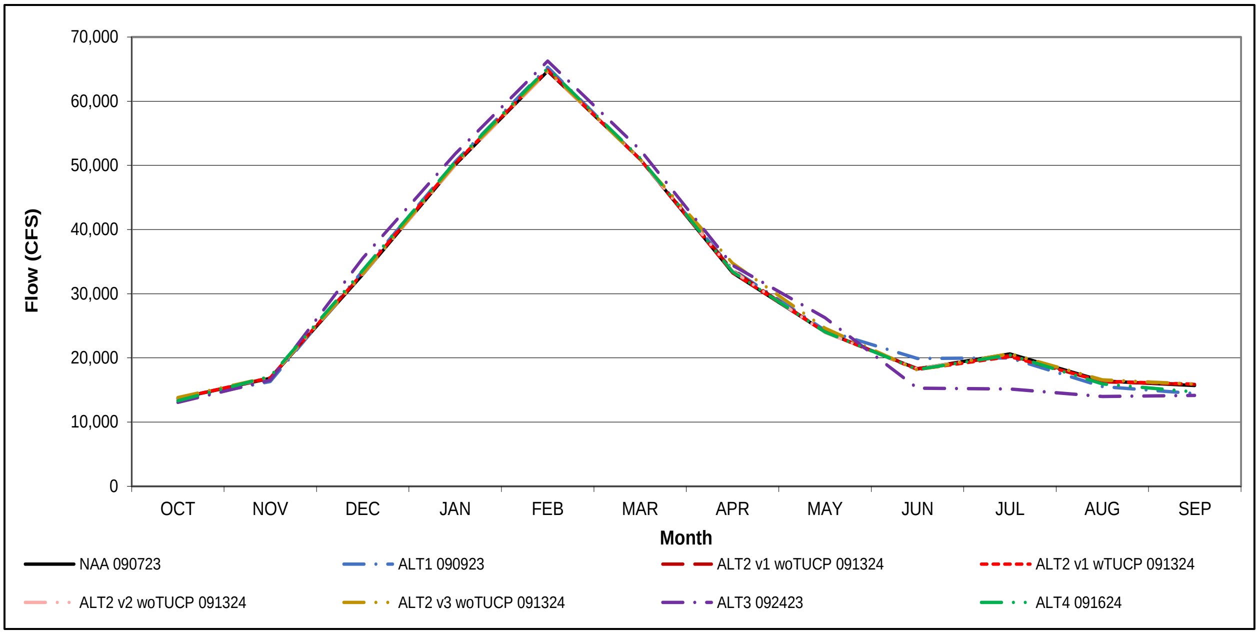

Figure 0-2. Delta Inflow Averages

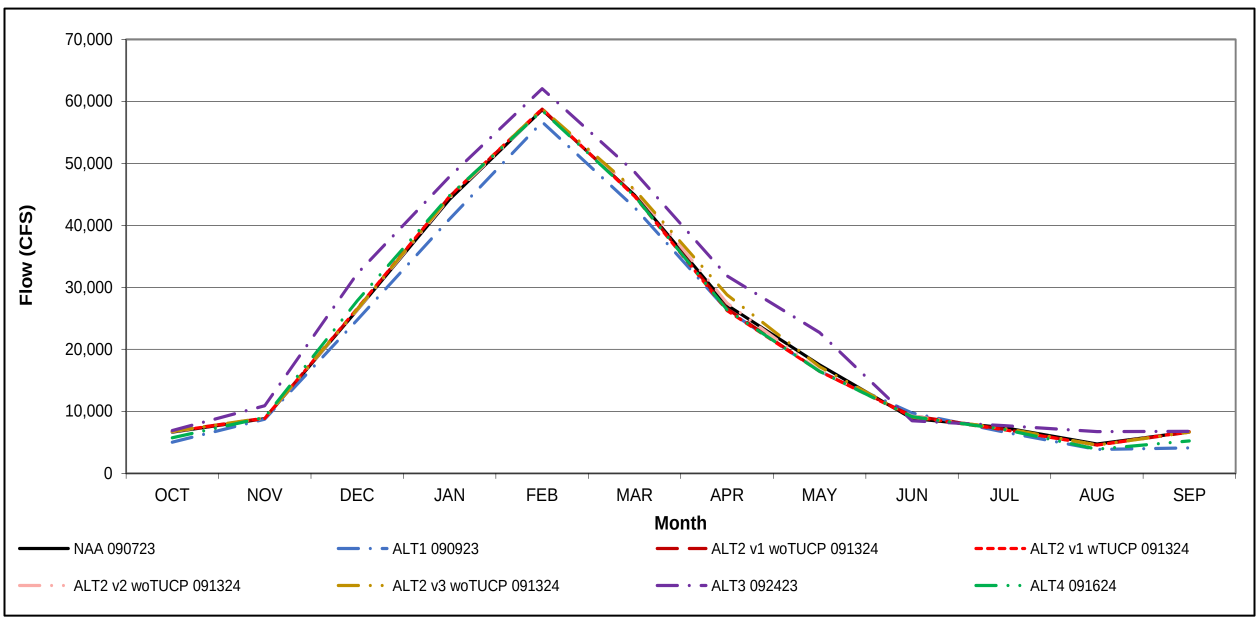

Figure 0-3. Delta Outflow Averages

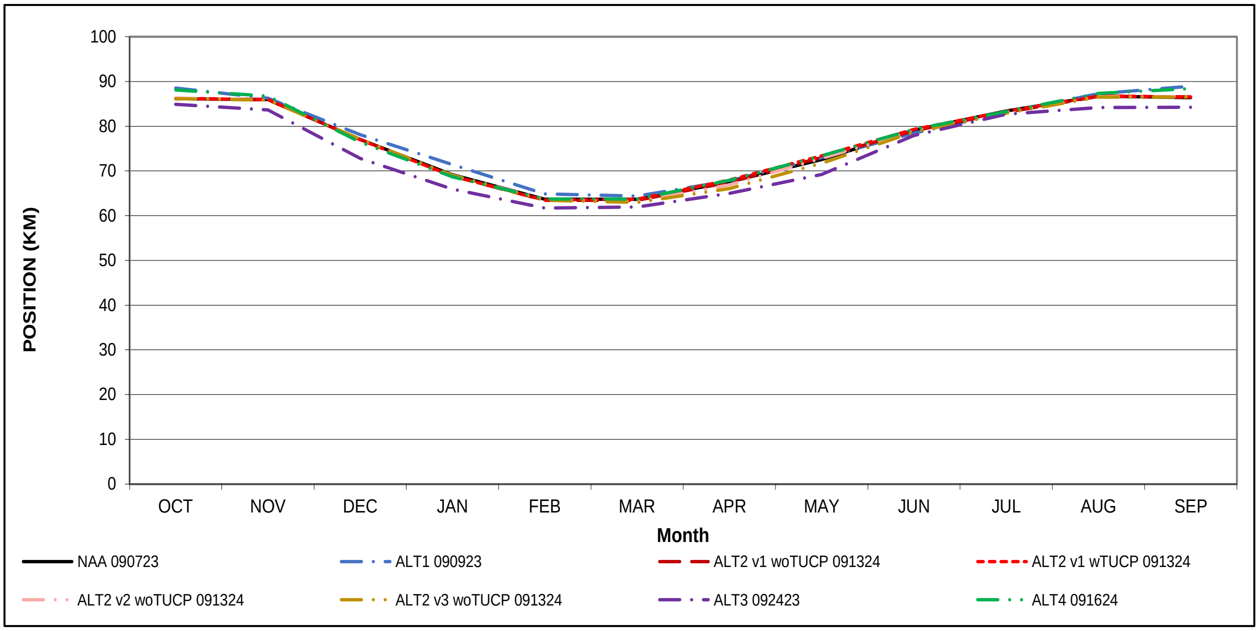

Figure 0-4. Long-Term Average X2 Position

In the Bay-Delta, the constituents for which there would be an appreciable difference in water quality under at least one of the action alternatives are the salinity-related parameters electrical conductivity (EC), chloride, bromide, methylmercury, and cyanobacteria harmful algal blooms (CHABs).

0.4.1.1 Electrical Conductivity, Chloride, and Bromide

Under Alternative 1, EC levels and chloride and bromide concentrations at western Delta locations would be substantially higher than under the No Action Alternative. EC levels and chloride and bromide concentrations also would be higher under Alternative 4 compared to the No Action Alternative at western Delta locations, but to a lesser degree than under Alternative 1. In contrast, under Alternative 3, EC levels and chloride and bromide concentrations at western Delta locations would be substantially lower compared with the No Action Alternative. EC levels and chloride and bromide concentrations under Alternative 2 would be similar to the No Action Alternative across the Delta. EC levels in Suisun Marsh would be higher than under the No Action Alternative in October and November under Alternatives 1 and 4, lower under Alternative 3, and similar under Alternative 2. Figure 0-5 presents the modeled average EC levels for the Sacramento River at Emmaton to illustrate the degree to which the alternatives could affect salinity parameters in the western Delta in the various months. Monthly average chloride concentrations in CVP and SWP reservoirs storing water diverted from the Delta are expected to increase under all action alternatives; however, the CVP and SWP would continue to operate to meet the Bay-Delta Plan water quality objectives.

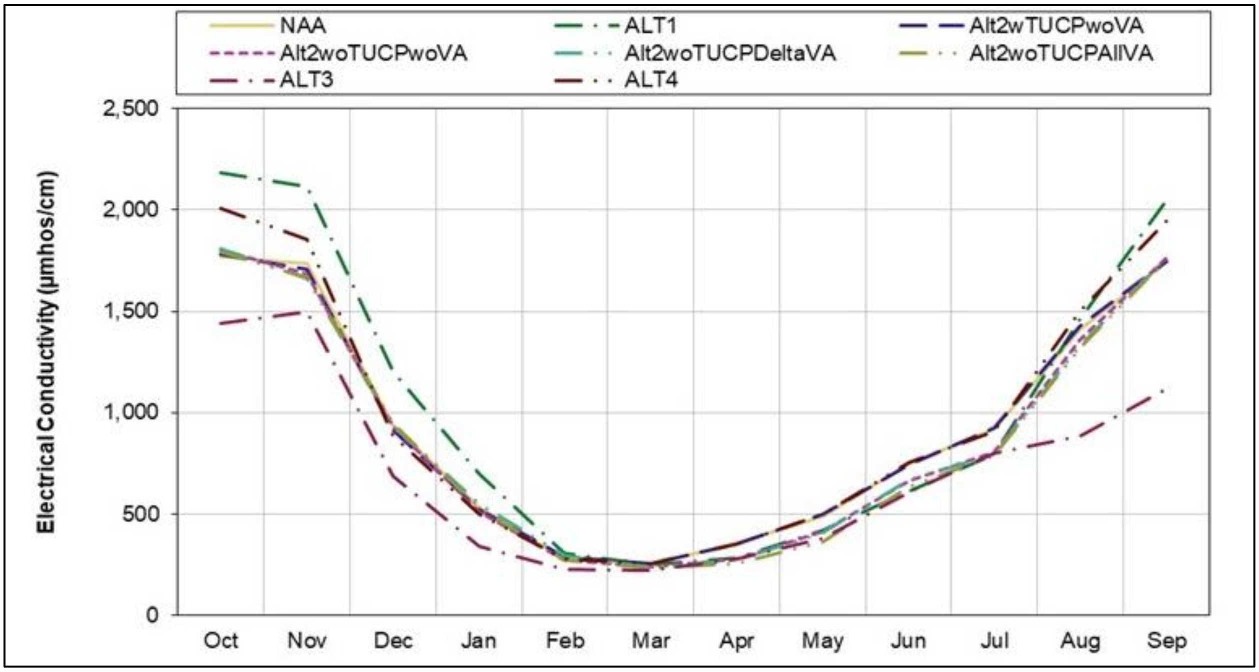

Figure 0-5. Long-Term Monthly Average Electrical Conductivity for the Sacramento River at Emmaton for Water Years 1922–2021

0.4.1.2 Methylmercury

Water column methylmercury concentrations and methylmercury bioaccumulation in biota of the Delta, Suisun Marsh, Suisun Bay, and San Francisco Bay are similar to the No Action Alternative under Alternatives 1, 2, and 4. Alternative 3 may result in higher water column methylmercury concentrations in the Delta, Suisun Bay, and San Francisco Bay. Figure 0-6 presents the average of the modeled average methylmercury concentrations in largemouth bass fish fillets 12 Delta assessment locations. The figure illustrates the differences in methylmercury concentrations between alternatives. Bars in the chart define the minimum and maximum average concentrations at the assessment locations.

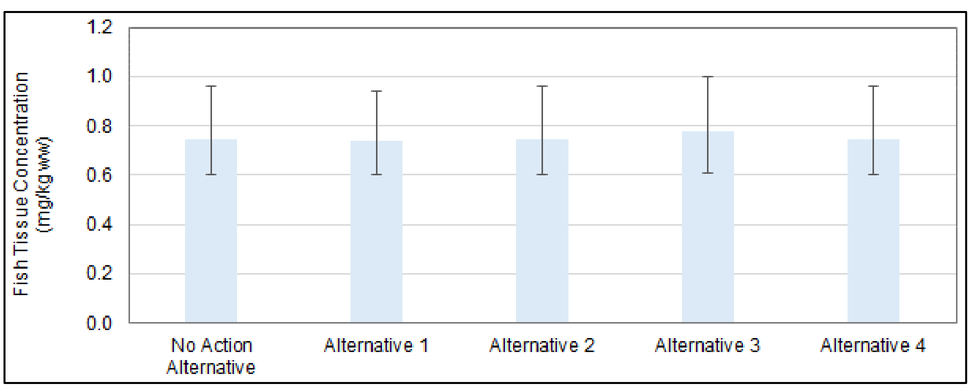

Figure 0-6. Average Modeled Total Methylmercury Concentrations in Largemouth Bass Fillets (in milligrams per kilogram wet weight) for all Delta Assessment Locations for the Full Simulation Period

0.4.1.3 Cyanobacteria Harmful Algal Blooms

Alternatives 1, 2, and 4 would not have substantial increased risk of increased CHABs in the Delta and Suisun Marsh. Alternative 3 could increase the risk of CHABs in the Delta and Suisun Marsh. There is no increased risk of CHABs in Suisun Bay and San Francisco Bay for the action alternatives.

0.4.2 Surface Water Supply

Surface water supply analysis was conducted using the CalSim 3 model, as described in Appendix F, *Modeling*, to simulate operational assumptions of each alternative. Inputs to CalSim 3 include water demands (including water rights), stream accretions and depletions, reservoir inflows, irrigation efficiencies, and parameters to calculate return flows, nonrecoverable losses, and groundwater operations. CalSim 3 outputs for the alternatives are compared with CalSim 3 outputs for the No Action Alternative to evaluate changes in water supply deliveries to CVP and SWP water users.

0.4.2.1 Central Valley Project Improvement Act Wildlife Refuges

Average annual deliveries to CVPIA wildlife refuges north of the Delta would remain similar under all alternatives. In certain multiple-year droughts, deliveries to CVPIA refuges north of the Delta would be reduced compared with the No Action Alternative, except under Alternatives 3 and 4.

Average annual deliveries to CVPIA wildlife refuges south of the Delta would remain similar under all alternatives, excluding dry and critical water year conditions under Alternative 3. Under Alternative 3, during dry and critical water year conditions within the Tulare Lake region, CVP Refuge Level 2 water deliveries would be reduced by approximately 8%.

0.4.2.2 Central Valley Project North of the Delta

Average annual deliveries to CVP Settlement Contractors north of the Delta would remain roughly the same under Alternative 1 and decrease for Alternatives 2, 3, and 4, particularly in dry and critical water year conditions.

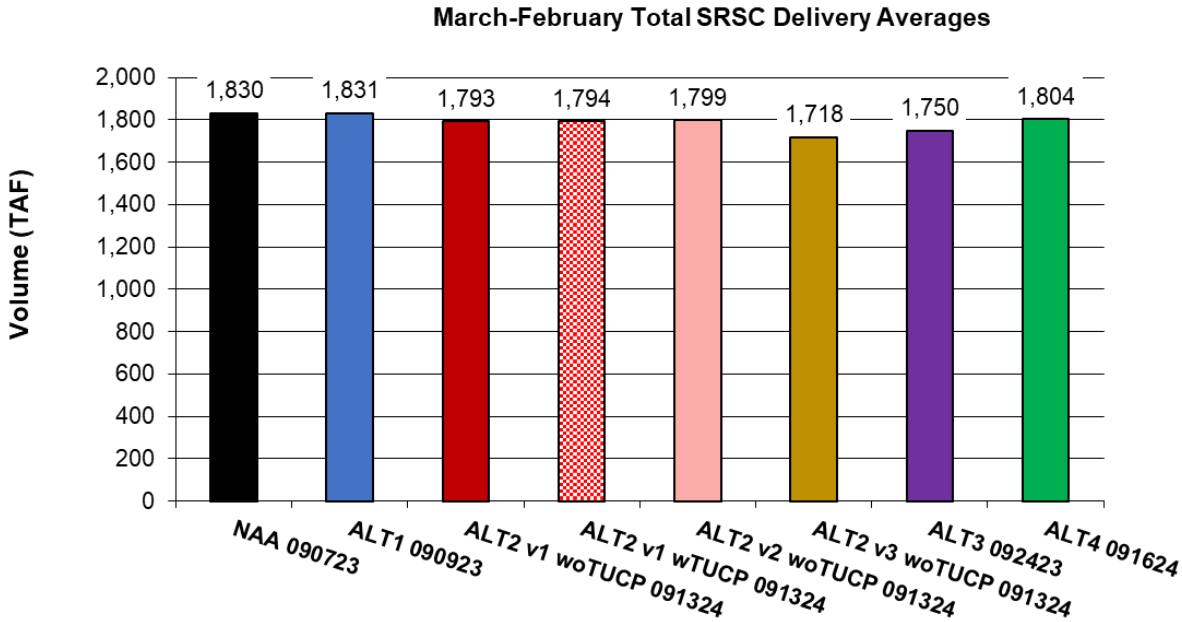

Figure 0-7. Sacramento River Settlement Contractor Average Annual Deliveries Under Alternative Long-Term Operation Criteria

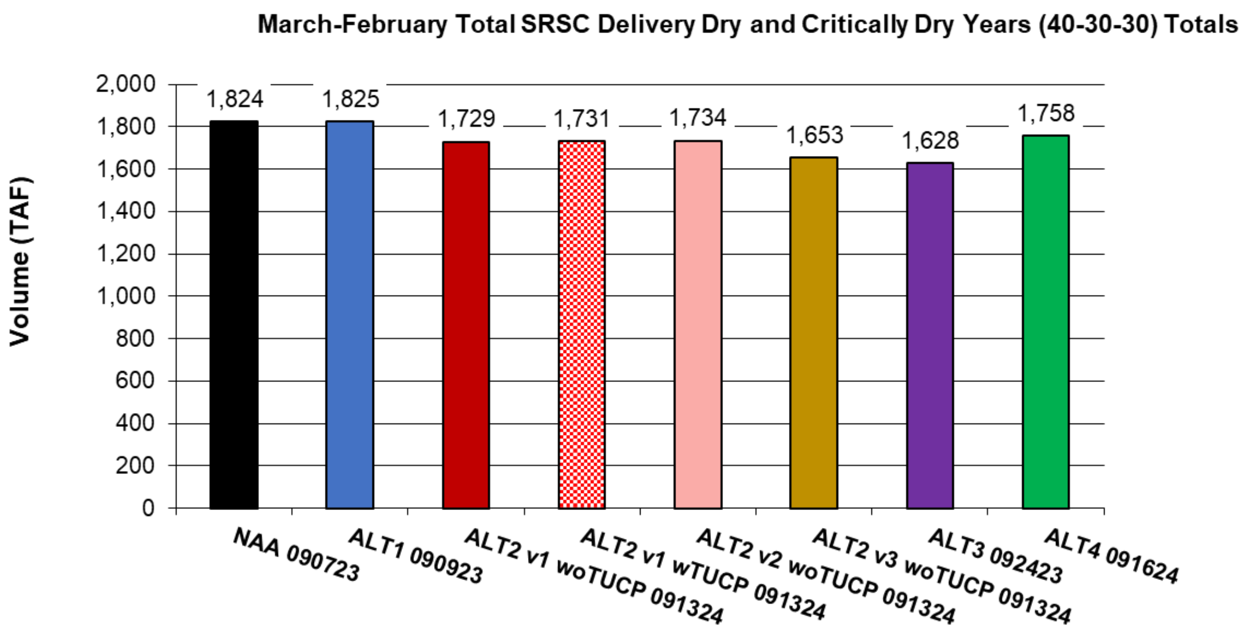

Figure 0-8. Sacramento River Settlement Contractor Deliveries in Dry and Critical Water Year Type Conditions Under Alternative Long-Term Operation Criteria

Average annual deliveries to CVP American River municipal and industrial water uses (M&I) Contractors north of the Delta would remain similar to the No Action Alternative under Alternatives 1, 3, and 4 and would increase under Alternative 2. Average annual deliveries to Contra Costa Water District would remain the same under all of the alternatives. Average annual deliveries to other CVP M&I contractors north of the Delta would remain similar under Alternatives 1, 2, and 4 and would decrease under Alternative 3.

Deliveries to CVP agricultural contractors north of Delta would remain similar to the No Action Alternative under Alternative 1 and 4 and would decrease under Alternatives 2 and 3 would decrease, particularly in dry and critical water year conditions.

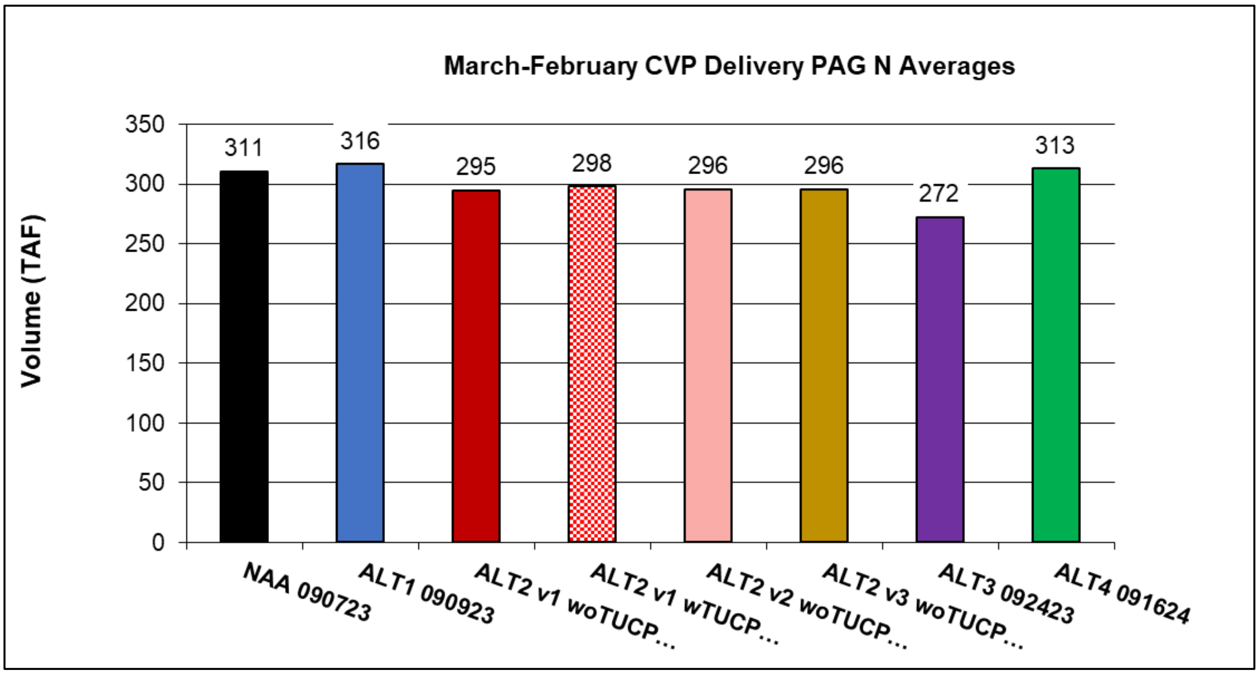

Figure 0-9. Central Valley Project North-of-Delta Agricultural Annual Average Deliveries Under Alternative Long-Term Operation Criteria

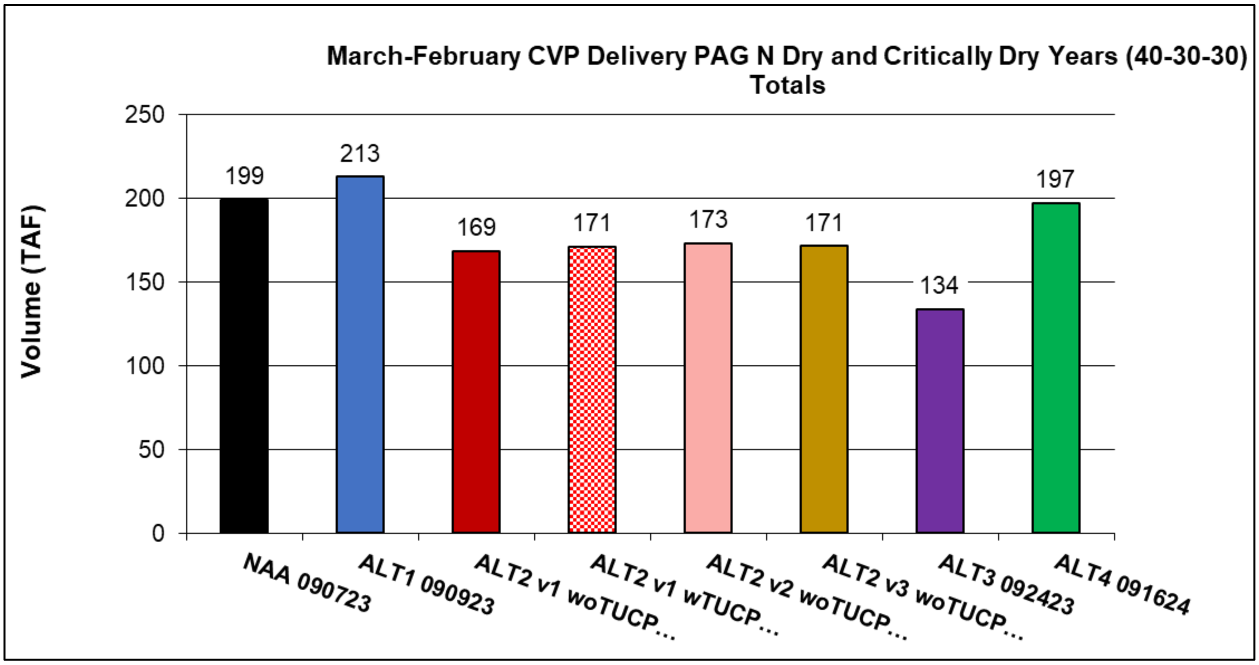

Figure 0-10. Central Valley Project North-of-Delta Agricultural Deliveries in Dry and Critical Water Year Type Conditions Under Long-Term Operation Alternatives

0.4.2.3 Central Valley Project South of the Delta

Average annual deliveries to CVP M&I water users south of the Delta would remain similar under Alternatives 1, 2, and 4 and would decrease under Alternative 3 when compared with the No Action Alternative. Average annual deliveries to CVP Exchange Contractors and to the Friant Division would remain similar under the alternatives.

Under Alternative 1, there would be an increase in water supply deliveries for CVP agricultural contractors south of the Delta. Under Alternatives 2, 3, and 4, deliveries to CVP agricultural water users would decrease. Changes are concentrated in dry and critical water year conditions.

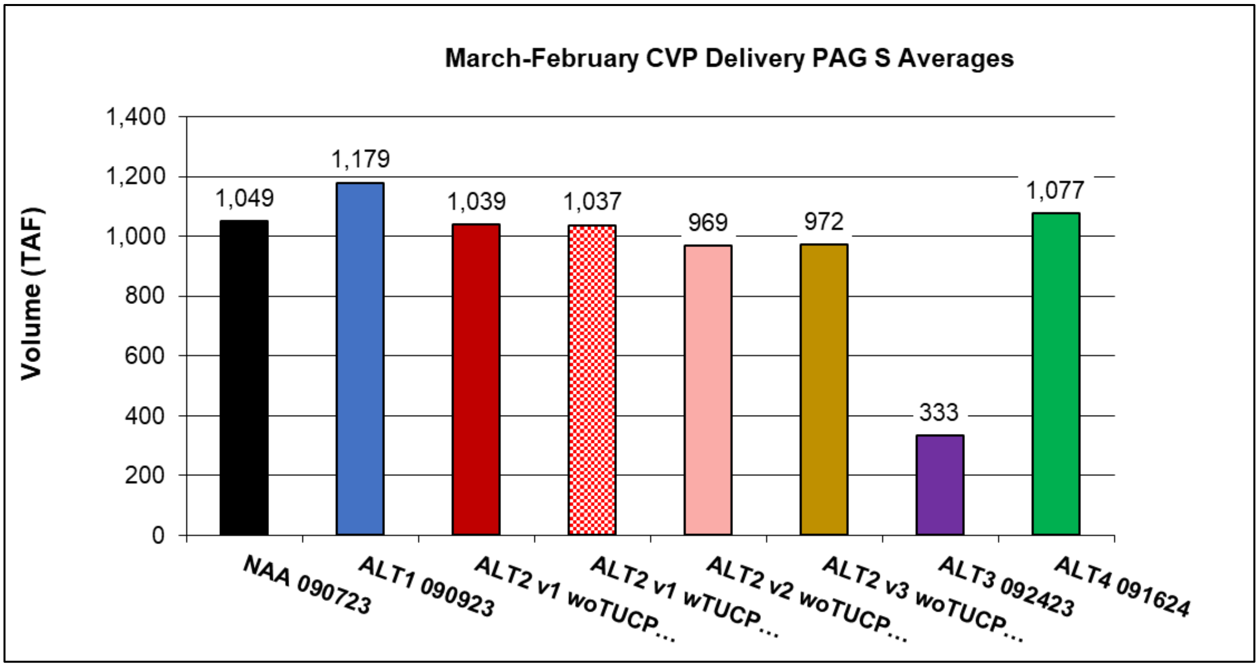

Figure 0-11. Central Valley Project South-of-Delta Agricultural Annual Average Deliveries Under Alternative Long-Term Operation Criteria

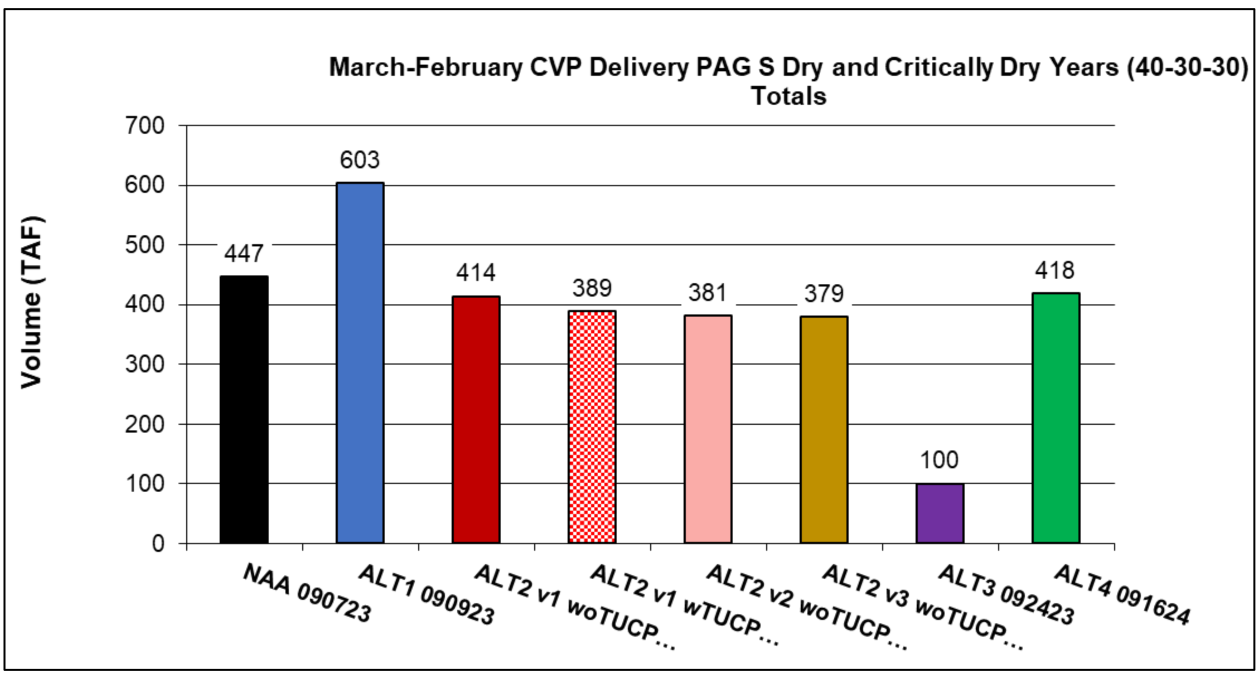

Figure 0-12. Central Valley Project South-of-Delta Agricultural Deliveries in Dry and Critical Water Year Type Conditions Under Long-Term Operation Alternatives

0.4.2.4 State Water Project North of Delta

Average annual deliveries to SWP M&I water users north of the Delta would remain the same under Alternatives 1, 2, and 4 and decrease under Alternative 3 when compared with the No Action Alternative.

0.4.2.5 State Water Project South of the Delta

Average annual deliveries to SWP agricultural and M&I water users south of the Delta would increase under Alternatives 1, 2, and 4 and decrease under Alternative 3. During dry and critical water year conditions, average annual deliveries to SWP agricultural and M&I water users south of the Delta would increase or remain the same under Alternatives 1, 2, and 4 and decrease under Alternative 3.

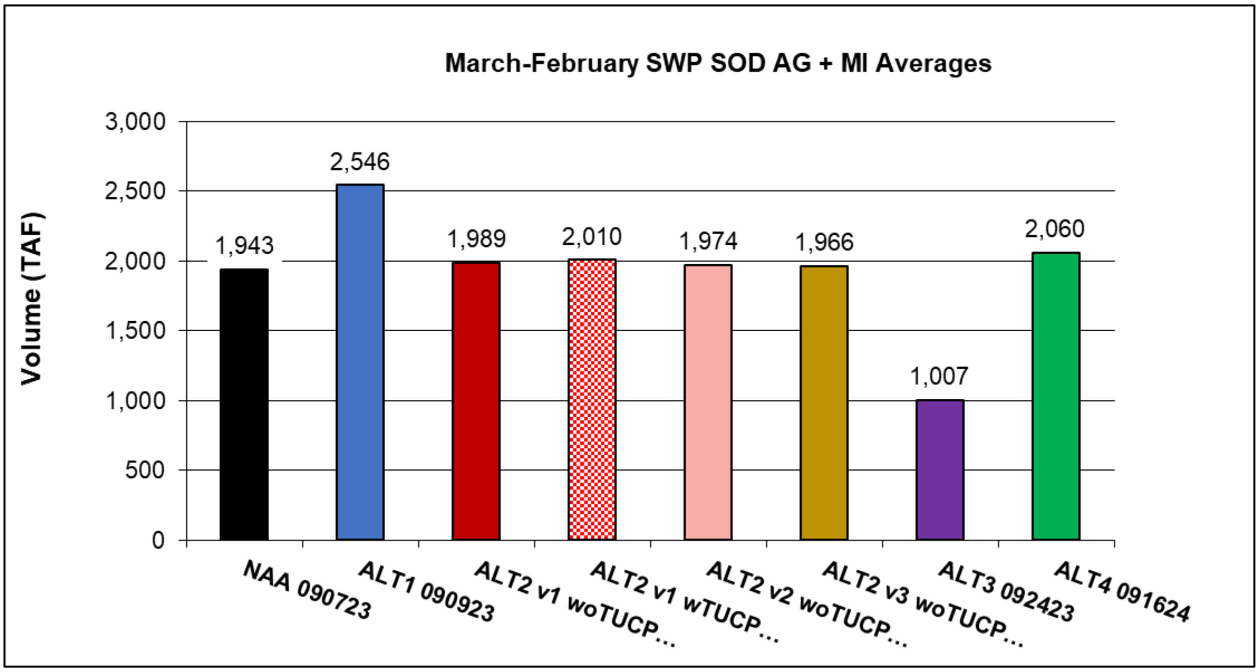

Figure 0-13. State Water Project South-of-Delta Annual Average Deliveries Under Alternative Long-Term Operation Criteria

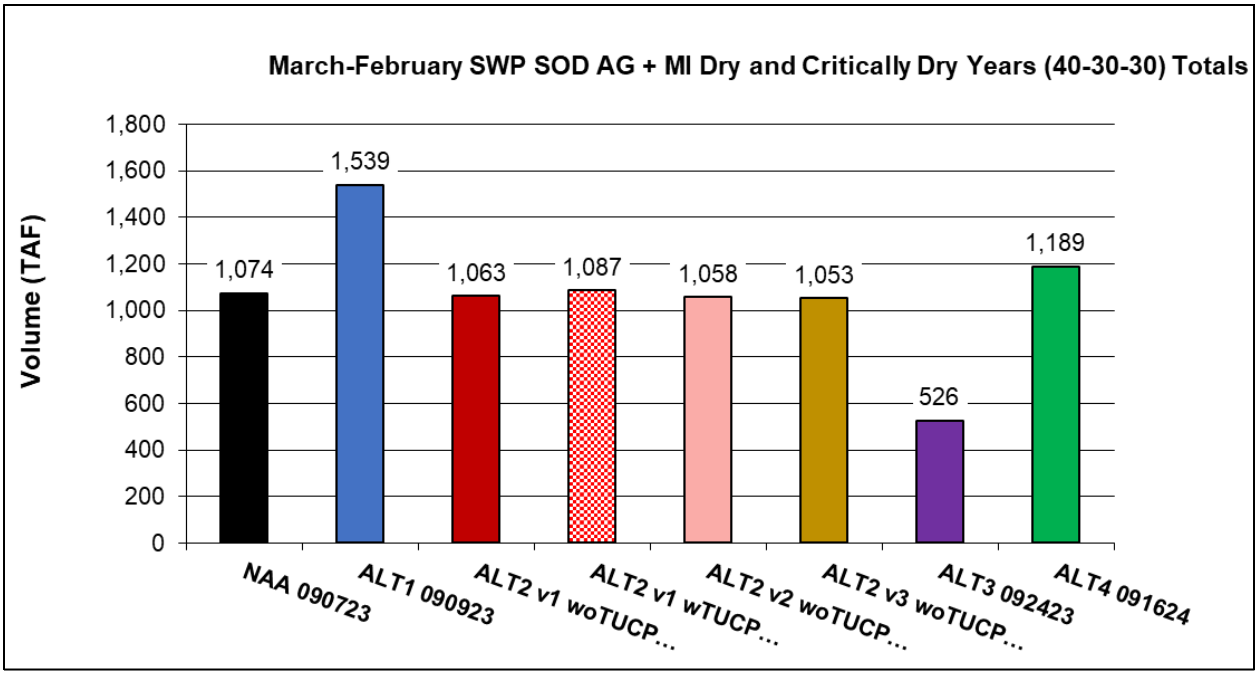

Figure 0-14. State Water Project South-of-Delta Deliveries in Dry and Critical Water Year Type Conditions Under Alternative Long-Term Operation Alternatives

0.4.3 Groundwater

Changes to CVP and SWP operations may result in water users changing their amount of groundwater pumping to offset changes to surface water supply. CalSim 3 results for surface water were applied to the California Central Valley Groundwater-Surface Water Simulation Model – Fine Grid (C2VSimFG) groundwater flow model to simulate changes in groundwater conditions, including the changes to pumping, groundwater-surface water interaction, and groundwater elevation.

Under Alternatives 1, 2, and 4, groundwater pumping would be similar to the No Action Alternative. Under Alternative 1, changes in SWP and CVP deliveries would result in a negligible reduction in the annual average groundwater pumping in Central Valley compared with the No Action Alternative. Alternatives 2 and 4 would result in a negligible average increase in groundwater pumping. Alternative 3 would increase groundwater pumping in the Central Valley. Figure 0-15 shows the simulated change in groundwater elevation in the western Sacramento Valley for each alternative compared with the No Action Alternative. Figure 0-16 presents similar information for the northern San Joaquin Valley. Figure 0-17 presents the simulated values for the southwestern San Joaquin Valley. Simulated changes in groundwater elevations for locations throughout the Central Valley are provided in Appendix I, *Groundwater Technical Appendix*.

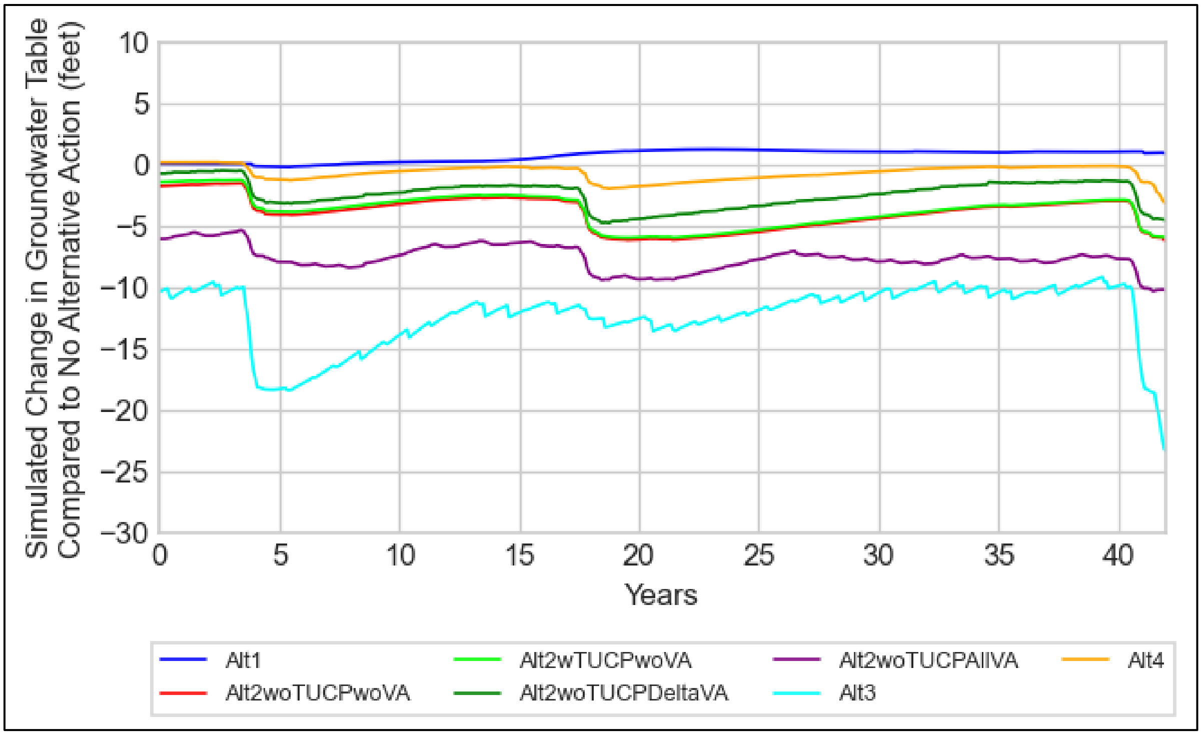

Figure 0-15. Simulated Change in Groundwater Table Elevation in the Western Sacramento Valley

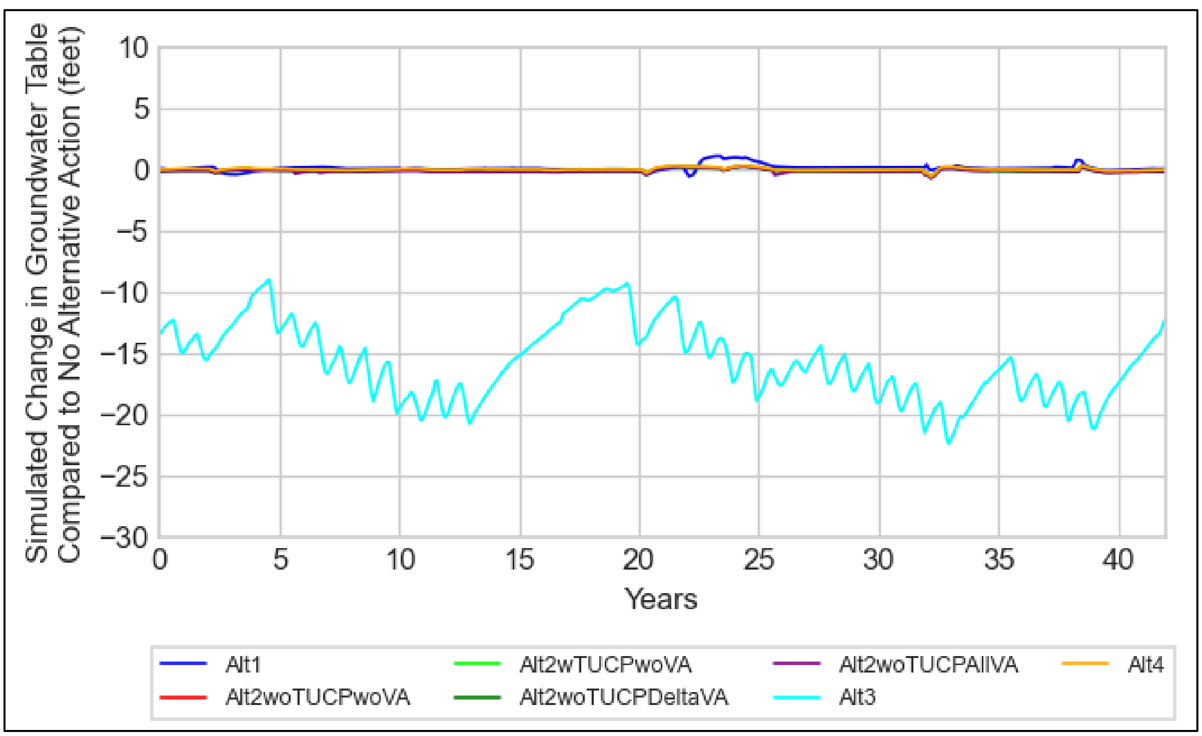

Figure 0-16. Simulated Change in Groundwater Table Elevation in the Northern San Joaquin Valley

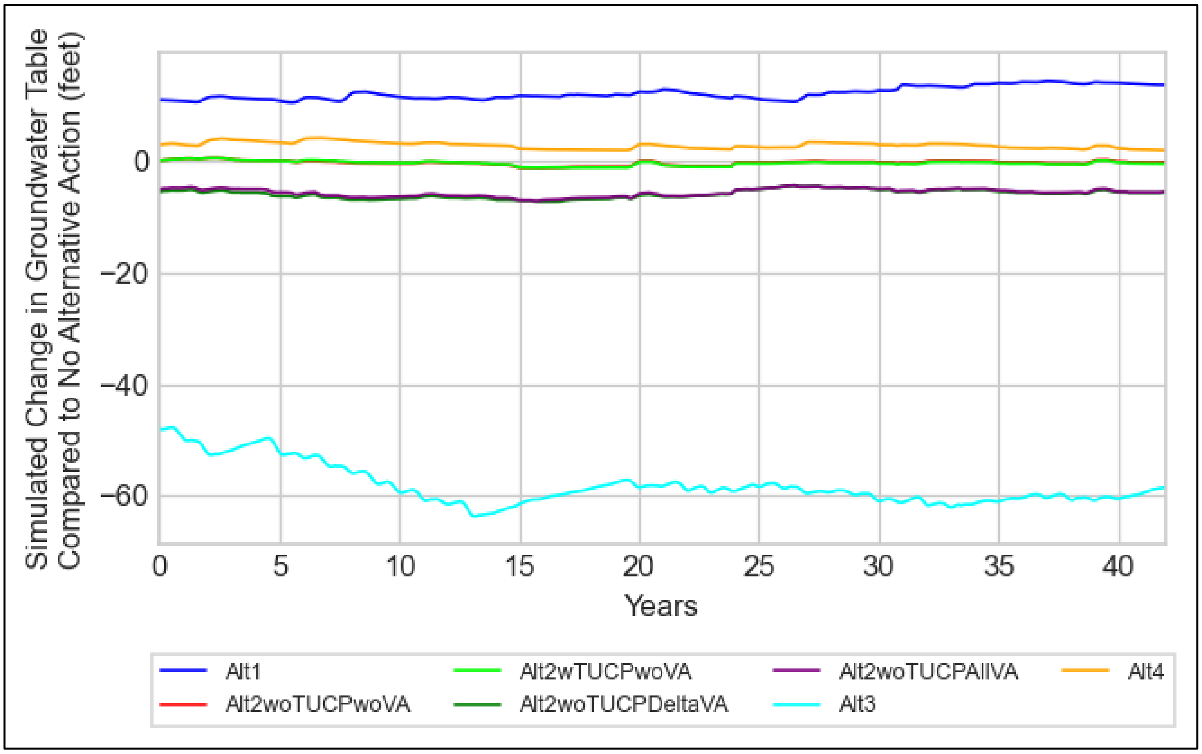

Figure 0-17. Simulated Change in Groundwater Table Elevation in the Southwestern San Joaquin Valley

Average groundwater elevations in Alternative 1 are expected to increase compared with the No Action Alternative due to the reduction in pumping. Depending on the year type and subregion, average groundwater water elevation changes could range between a decrease of 20 feet to an increase of 4 feet for Alternative 2 compared with the No Action Alternative. Alternative 4 would result in similar groundwater elevation changes as Alternative 2, with a range of a decrease of 4 feet to an increase of up to 7 feet. Larger increases in pumping associated with Alternative 3 could result in groundwater elevation decreases of up to 159 feet compared with the No Action Alternative, depending on the water year type and location.

Alternatives 1 and 4 would result in average decreases in annual discharge of groundwater to surface water compared with the No Action Alternative. Alternatives 2 and 3 would result in average annual increases in groundwater discharge from the subsurface to the surface water system similar to the No Action Alternative with variation from both increase and decreases depending on the location and water year type.

Additional land subsidence would generally not be expected due to the annual average decrease in pumping (Alternative 1). The relatively small increase in pumping (Alternatives 2 and 4) would also not result in additional land subsidence. The relatively large increase in pumping under Alternative 3 could result in increased land subsidence when compared with the No Action Alternative.

0.4.4 Aquatic Biological Resources

CVP and SWP operations under all alternatives impact aquatic species from changes in flow and water temperature. The aquatic biological resources evaluation is based principally on modeled changes in flow and water temperature, which come from CalSim 3 and HEC-5Q, respectively. Secondary biological models use those flow and temperature results to support the analysis of impacts to variables such as survival, abundance, and entrainment (e.g., Temperature-Dependent Mortality, Central Valley Improvement Act Decision Support Model Winter-run Chinook Salmon Lifecycle Model, Negative Binomial Loss Model). Secondary biological models have mainly been developed for some listed species of salmonids and smelt. Where a secondary biological model has not been developed, changes in flow and water temperature were used to analyze impacts to species.

0.4.4.1 Winter-run Chinook Salmon

Under the No Action Alternative, Reclamation operates the Temperature Control Device on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir for egg incubation. Storage of water in Shasta Reservoir reduces instream flows during the juvenile migration period. Restrictions on Delta exports minimize the loss of juvenile salmon at the Delta fish collection facilities. Increased spring Delta outflow may improve survival for outmigrating salmonids.

Figure 0-18. Winter-run Chinook Salmon (U.S. Fish and Wildlife Service)

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared with the No Action Alternative, Alternative 1 would increase temperature-dependent mortality during egg incubation. While operations would improve juvenile survival during migration down the Sacramento River, increased loss of juveniles at the Delta fish collection facilities would occur from increased Delta exports. Operations generally decrease through-Delta survival, especially in drier years in the December to February timeframe, with some variability dependent on water year type and month.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought and results in reduced temperature-dependent mortality during egg incubation. Alternative 2 would reduce deliveries for CVP water service and repayment contracts and Sacramento River Settlement (SRS) Contractors under specific drought conditions to increase storage in Shasta Reservoir. This increased storage would result in higher fall and winter releases in non-drought conditions. Higher fall and winter releases would improve juvenile Chinook salmon survival during migration down the Sacramento River. In drier years, Alternative 2 reduces fall and winter releases and reduces survival during migration. Loss of juvenile winter-run Chinook salmon at the Delta fish collection facilities is generally similar to the No Action Alternative based on similar Old and Middle River (OMR) flows. Through-Delta survival is also generally similar to the No Action Alternative, based on Delta inflow, with increases in January, March, and April of critically dry water year types.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir, which would generally decrease temperature-dependent mortality and improve juvenile Chinook salmon survival during migration down the Sacramento River. Delta inflow would generally increase and operations at the Delta fish collection facilities would generally decrease loss.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir to decrease temperature-dependent mortality during egg incubation. Increased fall flows due to real-time storage management would result in higher releases that would improve juvenile Chinook salmon survival during migration down the Sacramento River. Through-Delta survival is generally similar to the No Action Alternative with similar Delta inflows, and operations at the Delta fish collection facilities increase loss.

Figure 0-19 demonstrates how each alternative would affect temperature-dependent mortality (TDM) of winter-run Chinook salmon according to Martin et al. (2017) model outputs. In most years, the 80th percentile in proportional TDM would be highest under Alternative 1 and lowest under Alternative 3. Proportional TDM would be higher under the No Action Alternative and Alternative 1 in approximately 80% of years. Proportional TDM would be lower than the No Action Alternative under all phases of Alternative 2 and Alternative 3 in nearly all years.

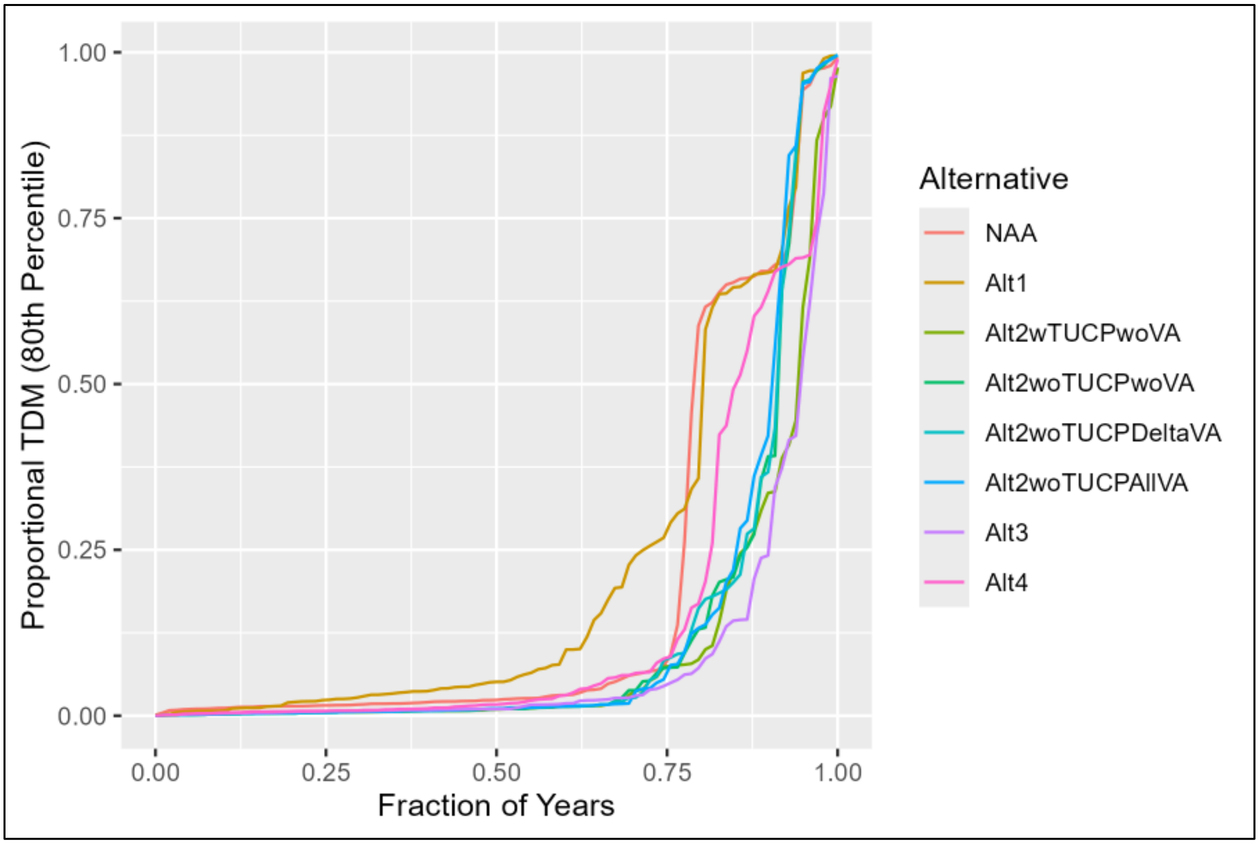

Figure 0-19. Exceedance Plots of Proportional Temperature-Dependent Mortality (TDM) Estimates Across All Water Year Types for the Martin TDM Model, Calculated Using the 80th Percentile of TDM for Each Water Year Type

Figure 0-20 demonstrates how each alternative would affect survival of migrating juvenile Chinook salmon migrating through the Delta according to STARS model. The greatest expected survival values occurred in January, February, and March, which corresponded to months with greater Delta inflows. The four phases of Alternative 2 and Alternative 3 had higher survival than the No Action Alternative, whereas Alternative 1 generally had decreased survival relative to the No Action Alternative. Alternative 4 had minimal differences in survival relative to the No Action Alternative.

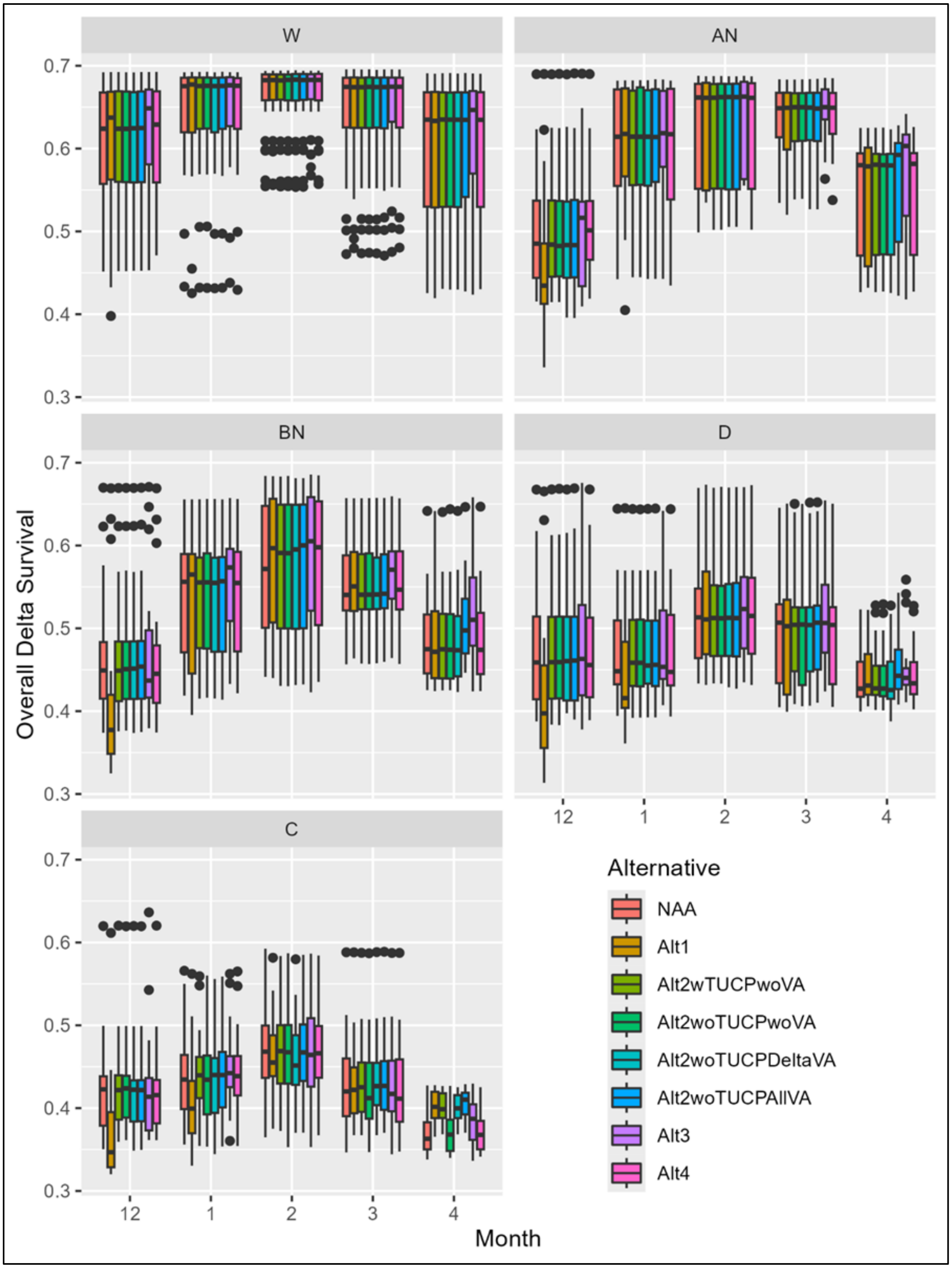

Figure 0-20. Boxplots of Predicted Mean Through-Delta Survival Across All Routes for Relevant Migratory Months, Box Edges Represent 25th and 75th Percentiles, Whiskers Are the Product of the Interquartile Range and 1.5, for Each Water Year Type

Spawner abundance predicted by the SIT CVPIA winter-run Chinook salmon life cycle model is generally similar with a slight annual decrease under Alternatives 1, 3, and 4, relative to the No Action Alternative. Spawner abundance under Alternative 2 is expected to generally decrease, with some annual increases in dry and wet water years. Figure 0-21 demonstrates how each alternative would affect winter-run Chinook salmon population change over time from 1980 to 1999 according to the SIT CVPIA winter-run Chinook salmon lifecycle model. The highest variation in lambda is predicted to occur under Alternative 2 without a Temporary Urgency Change Petition and Systemwide Voluntary Agreements, although mean lambda was very similar among all alternatives.

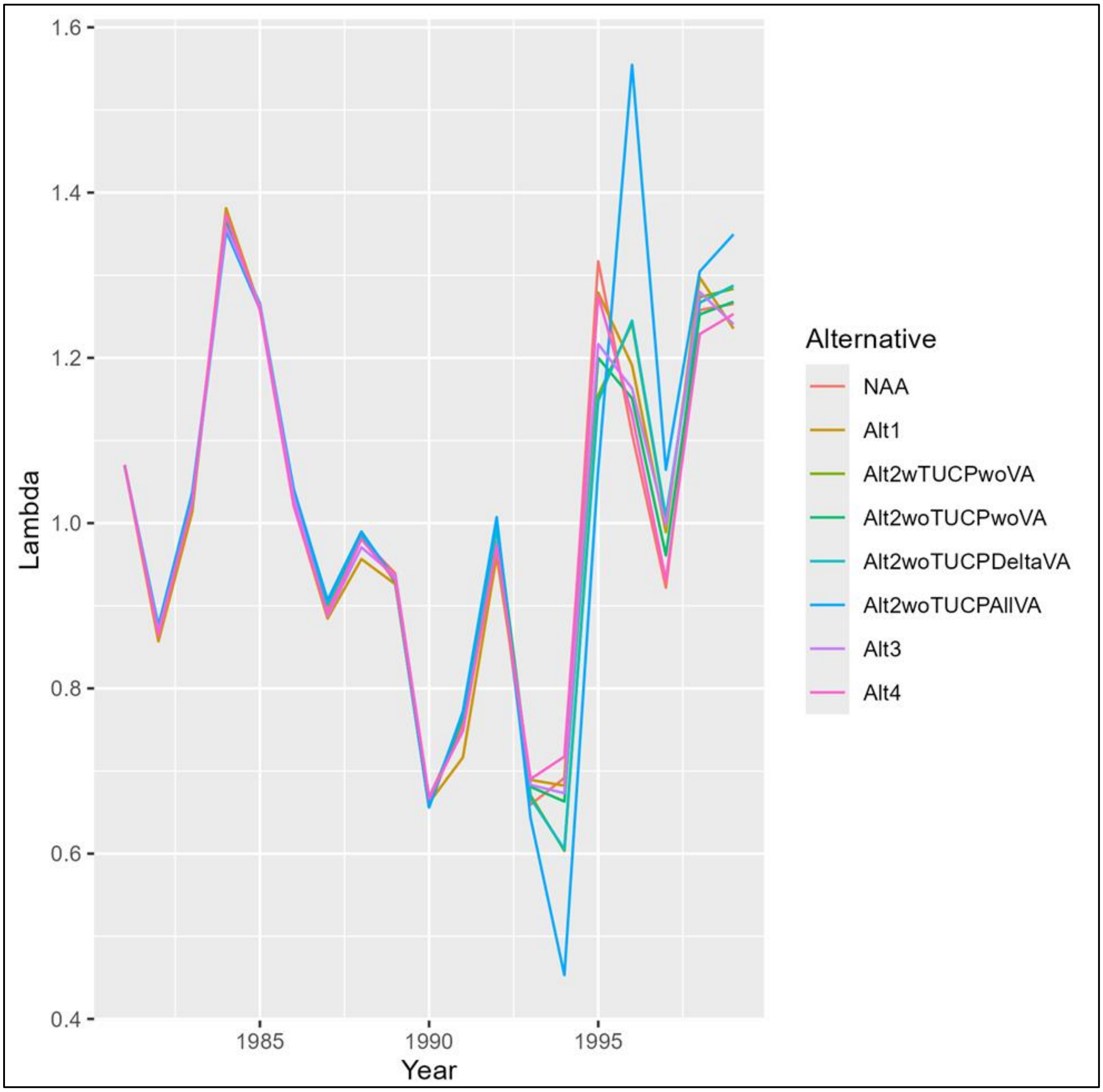

Figure 0-21. Predicted Annual Lambda Values (N_{t+1}/N_t) for Total Winter-run Spawner Abundance in the Upper Sacramento River, Including Both Natural- and Hatchery-Origin Fish, from Deterministic Model Runs

0.4.4.2 Spring-run Chinook Salmon

Under the No Action Alternative, Reclamation operates the Temperature Control Device (TCD) on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir to achieve fisheries objectives, including objectives for winter-run Chinook salmon, and suitable temperatures for spring-run Chinook salmon. Storage of water in Shasta Reservoir during the winter and spring reduces instream flows during the juvenile spring-run Chinook salmon migration period. Spring pulse flows help spring-run Chinook salmon juvenile outmigration, including spring-run Chinook salmon from non-project streams. Whiskeytown Reservoir summer and fall operations may adversely or beneficially impact spring-run Chinook salmon; potential adverse impacts include low flows and elevated water temperatures in Clear Creek, while potential beneficial impacts include coldwater releases to reduce thermal stress during holding, spawning, and egg incubation. Pulse flows in Clear Creek during the spring could attract spring-run Chinook salmon holding in the Sacramento mainstem, encouraging movement toward spawning habitat. In the Delta, export restrictions minimize the loss of juvenile salmon at the Delta fish collection facilities. Increased spring Delta inflow may improve survival for outmigrating salmonids.

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared with the No Action Alternative, Alternative 1 improves juvenile Chinook salmon survival during migration down the Sacramento River and negligibly impacts spawning, spawner abundance, and egg incubation. In Clear Creek, Alternative 1 provides minimum instream flows and water temperature management but does not include specific pulse flows and adversely impacts spawning habitat area. Higher OMR reverse flows increase loss of juveniles at the Delta fish collection facilities. Higher Delta inflows may increase through-Delta survival.

Alternative 2 prioritizes storage of water in Shasta Reservoir for temperature management during multiple years of drought and operates to higher fall and winter releases. Alternative 2 improves spawning and egg incubation as well as juvenile survival during migration down the Sacramento River. Adverse impacts on juvenile stranding in drier water year types may occur. In Clear Creek, operations would adversely impact spawning and rearing habitat. Water temperature management is not expected to impact spawning and egg incubation, but may impact juveniles and yearlings. Greater exports increase loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, especially in April, and operations to increase Delta inflow increase through-Delta survival.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Water temperatures for spawning and egg/incubation would improve, as would juvenile Chinook salmon survival during migration down the Sacramento River. In Clear Creek, operations would decrease flows, adversely impacting spawning habitat area and upstream migration in the summer. Differences in water temperatures would have a negligible impact on spawning, egg incubation, fry emergence, and juvenile and yearling rearing. Reduced exports would decrease loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, and operations to increase Delta inflow would increase through-Delta survival.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir to decrease TDM during egg incubation. Increased fall flows result in higher releases that improve juvenile Chinook salmon survival during migration down the Sacramento River. In Clear Creek, operations would adversely impact spawning and rearing habitat and is not expected to impact water temperatures for spawning and egg incubation. Greater exports would increase loss of juvenile spring-run Chinook salmon at the Delta fish collection facilities, and similar Delta inflows would have a negligible change on through-Delta survival.

0.4.4.3 California Central Valley Steelhead

Under the No Action Alternative, Reclamation operates the TCD on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir primarily for winter-run Chinook salmon egg incubation. There may be beneficial impacts of water temperature management for steelhead adult migration and juveniles rearing through reduction of thermal stress. Spring pulses may improve outmigration by decreasing travel time down the Sacramento River. In Clear Creek and the lower American River, pulse flows, minimum instream flows, and water temperature management would benefit steelhead. In the Stanislaus River, pulse flows, minimum instream, and winter instability flow would benefit steelhead. While these components of the No Action Alternative benefit steelhead, research over the last decade has identified that rivers with high, stable flows tend to favor residency (Courter et al. 2009; Kendall et al. 2015). Therefore, managed flows in these tributaries may have disparate impacts on rates of steelhead anadromy. Restrictions on Delta exports minimize loss of juvenile steelhead at the Delta fish collection facilities.

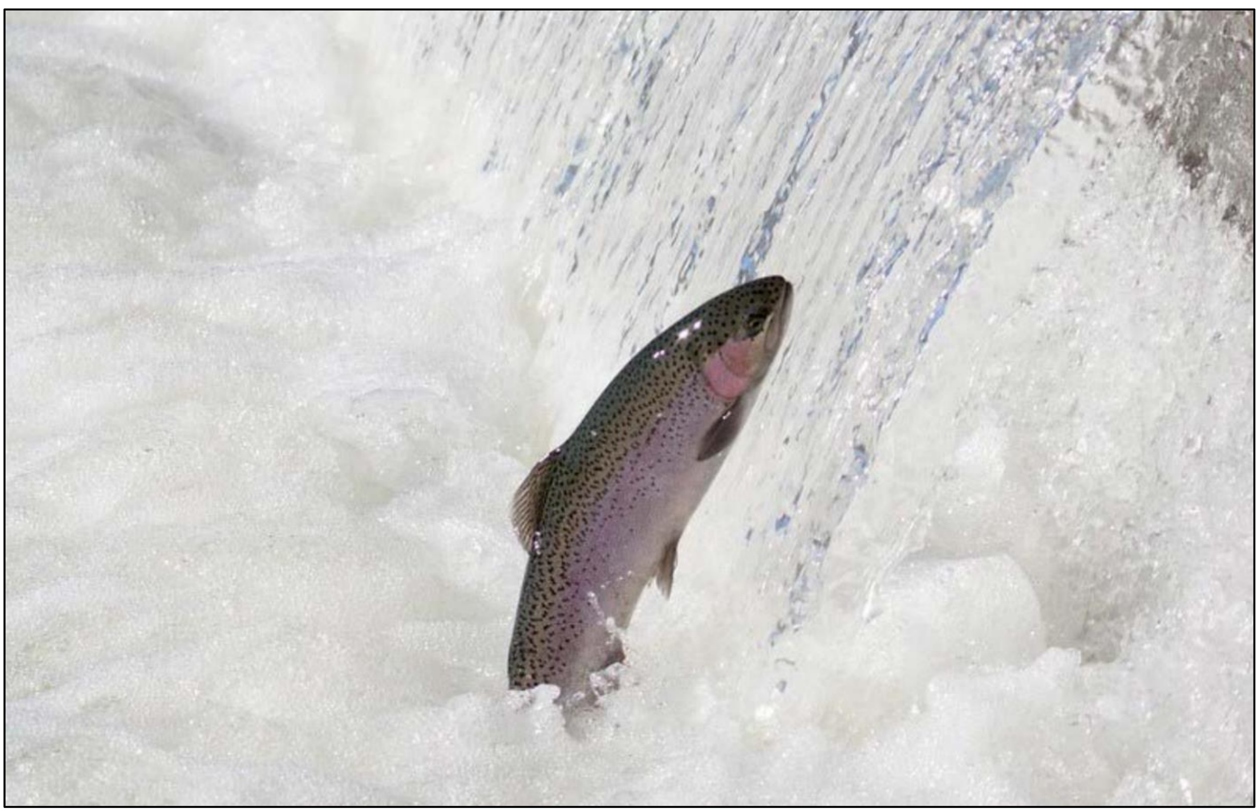

Figure 0-22. Steelhead at Coleman National Fish Hatchery (U.S. Fish and Wildlife Service)

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared with the No Action Alternative, Alternative 1 is expected to have a negligible impact on steelhead spawning and egg/alevin incubation below Keswick Dam. Increased flows in the Sacramento River would increase survival for outmigrating juveniles. Changes in flow would increase fry stranding during wetter water year types and would decrease fry stranding during drier water year types. In Clear Creek, flow reductions throughout the year would decrease spawning habitat and negatively impact juvenile rearing and emigration. In the lower American River, minimum instream flows would negatively impact spawning and rearing habitat, redd dewatering, and water temperatures for spawning and egg incubation. In the Stanislaus River, operations would generally decrease spawning and rearing habitat; however, there would be improved water temperatures for spawning, egg incubation, and juvenile emigration. Delta exports increase loss of juvenile steelhead at the Delta fish collection facilities, and operations increases survival due to a smaller proportion of flow routed to the interior Delta.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought, operates to higher fall and winter releases which impacts steelhead fry stranding (increased stranding in wetter water year types, decreased in drier water year types). Changes to water temperature would have a beneficial impact on juvenile rearing and emigration. In Clear Creek, changes in flows would improve spawning habitat area but would adversely impact juvenile rearing by reducing habitat and increasing water temperatures. In the lower American River, operations would negatively impact spawning habitat area and redd dewatering. In the Stanislaus River, operations would increase water temperatures during spawning, egg incubation, and juvenile emigration. Alternative 2 would affect loss at the Delta fish facilities; however, there is no clear trend by water year type on increased and decreased salvage. Survival of outmigrating juveniles would increase or decrease dependent on Delta inflow conditions.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Changes in flow in the Sacramento River would increase fry stranding during above normal/below normal water year types and decrease fry stranding during dry water year types. Changes to water temperature would benefit juvenile rearing and emigration. In Clear Creek, operations would have varying effects on habitat including improving spawning habitat, negligibly impacting fry rearing habitat, and adversely impacting juvenile rearing habitat. Water temperature impacts are negligible. In the lower American River, operations would worsen water temperature impacts for steelhead spawning and egg incubation and juvenile rearing and emigration. In the Stanislaus River, operations would have varying impacts on habitat area but would improve water temperature impacts for steelhead spawning and egg incubation and juvenile rearing and emigration. Delta exports decrease loss of juvenile steelhead at the Delta fish collection facilities, and survival of outmigrating juveniles would increase or decrease dependent on inflow conditions.

Alternative 4 aims to store more water in Shasta Reservoir to decrease TDM during egg incubation for winter-run Chinook salmon. Increases in fall flows due to storage result in higher releases that decrease steelhead fry stranding. Changes to water temperature would have a beneficial impact on steelhead juvenile rearing and emigration. In Clear Creek, operations would have varying impacts on habitat and negligible impacts from water temperature management. In the lower American River, operations would have adverse impacts on spawning and rearing habitat. Water temperature management impacts would vary, with negative impacts to spawning and egg incubation and similar negative and positive impacts to juvenile rearing and emigration. In the Stanislaus River, there are varying impacts on habitat and negligible impacts from water temperature management. Loss of juvenile steelhead at the Delta fish collection facilities and survival of outmigrating juveniles would increase or decrease dependent on inflow, exports, and increased use of real-time management would support water supply with smaller impacts to listed fish.

0.4.4.4 Delta Smelt

The No Action Alternative includes OMR flow management criteria and provides restrictions on Delta exports by incorporating real-time monitoring of fish distribution, turbidity, water temperature, hydrodynamic models, and entrainment models to focus protections for fish, attempting to minimize loss of Delta smelt at the Delta fish collection facilities.

Figure 0-23. Delta Smelt (Bureau of Reclamation)

Alternative 1 may result in minor increases to minor decreases in suitable habitat depending on water year type and the application of a water temperature threshold and would likely have adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 1, there would be lower population growth rates and lower sub-adult to adult survival during the winter. Results from the USFWS life cycle model found lower population growth rates, particularly during the below normal, dry, and critically dry water year types. Therefore, adverse impacts are anticipated specific to population abundance. Alternative 1 does not include OMR criteria resulting in lower Delta outflows, and exports are not adjusted beyond D-1641 to minimize south Delta entrainment of fish and protection of critical habitat.

Alternative 2 may result in minor increases or minor decreases in suitable habitat depending on water year type and the application of a temperature threshold. Alternative 2 would likely have negligible to minor adverse and minor beneficial impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 2, there would be minimal potential impacts on sub-adult to adult Delta smelt survival, with lower rates identified during wet and above normal water year types for the phases without VAs. Therefore, adverse and beneficial impacts are anticipated specific to population abundance. Alternative 2 includes OMR management, which adjusts exports to minimize south Delta entrainment of fish and protection of critical habitat.

Alternative 3 may result in minor increases and minor decreases in suitable habitat depending on water year type and the application of a temperature threshold and would likely have minor beneficial to minor adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 3, depending on the water year type, there would be a substantially higher population growth rate when compared with the No Action Alternative. Alternative 3 includes Old and Middle River Flow Management which adjusts exports to minimize south Delta entrainment of fish and protection of critical habitat.

Alternative 4 may result in minor increases and minor decreases in suitable habitat depending on water year type and the application of a temperature threshold and would likely have negligible to minor adverse impacts on juvenile Delta smelt summer and fall habitat. Under Alternative 4, there would be minimal potential impacts on sub-adult to adult Delta smelt survival. Alternative 4 ranged lower in terms of population growth rates depending on the water year type when compared with the No Action Alternative. Therefore, adverse impacts are anticipated specific to population abundance. Alternative 4 includes OMR management, which adjusts exports to minimize south Delta entrainment of fish and protection of critical habitat.

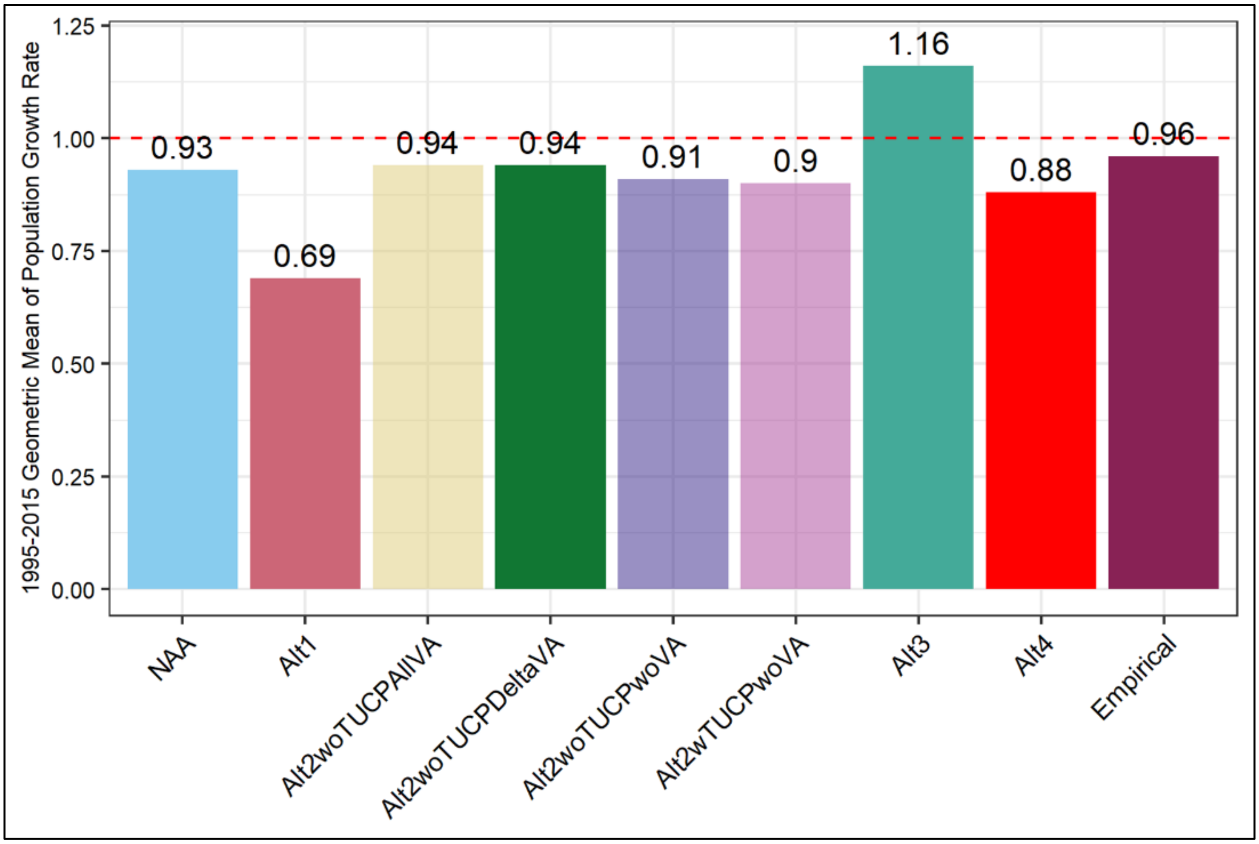

Figure 0-24. Mean Population Growth Rates Aggregated Across the Years. Bar Plot Demonstrating the Geometric Mean of Population Growth Rate (lambda) from 1995 to 2015 for the Various Alternatives

0.4.4.5 Longfin Smelt

The No Action Alternative includes OMR flow management criteria and provides restrictions on Delta exports by incorporating real-time monitoring of fish distribution, turbidity, water temperature, hydrodynamic models, and entrainment models to focus protections for fish, attempting to minimize loss of longfin smelt at the Delta fish collection facilities. Increased spring Delta outflow and managed Delta outflow in the summer and fall would support improvements in food resources for longfin smelt.

Figure 0-25. Longfin Smelt (California Department of Fish and Wildlife)

Alternative 1 does not include OMR flow management criteria. Under Alternative 1, there may be an increase in entrainment compared with the No Action Alternative, particularly during the above normal water year type. Compared with the No Action Alternative, catch per unit effort (CPUE) of longfin smelt prey species is expected to decrease under Alternative 1, particularly during the winter and spring. Under Alternative 1, abundance is predicted to be lower than the No Action Alternative. Therefore, adverse impacts are anticipated related to population abundance.

Alternative 2 includes OMR management criteria protections for listed species. Alternative 2 is expected to increase entrainment in all water years except in a dry year. Compared with the No Action Alternative, CPUE of longfin smelt prey species is expected to generally minorly change during the fall and winter and increase in the spring depending on Alternative 2 phase and water year type. Under Alternative 2, juvenile abundance will be lower during wet years and higher during critically dry years compared with the No Action Alternative. Therefore, adverse and beneficial impacts are anticipated related to population abundance.

Alternative 3 includes OMR management criteria allowing exports to meet public health and safety standards. Alternative 3 is expected to have a substantial beneficial impact on the entrainment due to differences in flow. Under Alternative 3, salvage would decrease substantially when compared with the No Action Alternative. Compared with the No Action Alternative, CPUE of longfin smelt prey species is expected to increase under Alternative 3 during the fall, winter, and spring. Juvenile longfin smelt abundance is predicted to be higher under Alternative 3 than it is for the No Action Alternative.

Under Alternative 4, OMR management criteria include protections for listed species. Compared with the No Action Alternative, Alternative 4 is expected to have an adverse impact on the entrainment. Compared with the No Action Alternative, CPUE of longfin smelt prey species is expected to minorly increase and decrease under Alternative 4 during the fall, winter, and spring, depending on water year type. Juvenile longfin smelt abundance is predicted to be no different to negligibly lower under Alternative 4 than it is for the No Action Alternative.

0.4.4.6 Green Sturgeon

Under the No Action Alternative, seasonal operations and other common components may negatively affect the population including potential adverse impacts of low flows and elevated water temperatures impacting the movement or survival of adults and larvae.

Figure 0-26. Green Sturgeon (National Marine Fisheries Service)

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Alternative 1 compared with the No Action Alternative is expected to have negligible impacts to potential adverse impacts on spawning and egg incubation habitat, larval and juvenile rearing, emigration, and entrainment due to differences in flow. Under Alternative 1, potential adverse impacts on upstream migration and holding habitats due to differences in flow are expected. Beneficial and adverse impacts are anticipated depending on location, month, and water year type due to differences in water temperature compared with the No Action Alternative.

Alternative 2 prioritizes storage of water in Shasta Reservoir for water temperature management during multiple years of drought and would reduce deliveries for CVP water service and repayment contracts and Sacramento River Settlement Contractors under specific drought conditions to increase storage in Shasta Reservoir. This increased storage would result in higher fall and winter releases in non-drought conditions. Alternative 2 relative to the No Action Alternative is expected to have negligible impacts and possible beneficial impacts on spawning habitat, minor adverse impacts on rearing and emigration, and beneficial impacts and adverse impacts on upstream migration and holding habitats dependent upon location, month, and/or water year type due to differences in flow. Alternative 2 relative to the No Action Alternative is expected to have beneficial impacts and minor adverse impacts on spawning and egg incubation, beneficial and adverse impacts on rearing and emigration, and negligible and adverse impacts on upstream migration and holding dependent upon location, month, and water year type due to differences in water temperature. Alternative 2 is expected to have negligible impacts on the loss of juveniles at facilities.

Alternative 3 prioritizes release of water for Delta outflow and reduces diversions to store water in Shasta Reservoir. Alternative 3 relative to the No Action Alternative is expected to have possible beneficial impacts and adverse impacts on spawning habitats, possible adverse impacts on rearing and emigration, and potential beneficial impacts and adverse impacts on migration and holding habitat due to differences in flow. Alternative 3 relative to the No Action Alternative is expected to have beneficial and adverse impacts on spawning, beneficial and adverse impacts on rearing and emigration, and adverse impacts and negligible beneficial impacts on migration and holding depending on location, month, and water year type due to differences in water temperature. Alternative 3 relative to the No Action Alternative is expected to have negligible impacts on the loss of juveniles.

Real-time management under Alternative 4 aims to store more water in Shasta Reservoir, and increased fall flows due to real-time storage management would result in higher releases. Alternative 4 relative to the No Action Alternative is expected to have negligible impacts on spawning habitats, negligible impacts or possible beneficial impacts on rearing and emigration habitats, and negligible impacts to possible beneficial impacts on upstream migration and holding habitats due to differences in flow. Alternative 4 relative to the No Action Alternative is expected to have beneficial and adverse water temperature-related impacts on spawning, beneficial and adverse impacts on rearing and emigration, and adverse impacts on upstream migration and holding depending on location, month, and water year type due to differences in water temperature. Alternative 4 relative to the No Action Alternative is expected to have negligible impacts on the loss of juveniles.

0.4.4.7 Fall-run Chinook Salmon

Adult fall-run Chinook salmon use the Sacramento River as a migration corridor and as spawning grounds between September and June. Release reductions from Shasta Reservoir early in the fall under the No Action Alternative may adversely impact the fall-run Chinook salmon population from low flows and elevated water temperatures leading to unsuccessful outmigration and redd dewatering. Similarly, in Clear Creek, low flows and elevated water temperatures may negatively impact fall-run Chinook salmon, and coldwater releases may be beneficial. In the lower American River, operations would ramp down to the revised minimum flows from Folsom Reservoir as soon as possible in the fall and maintain these flows through fall-run Chinook salmon spawning and egg emergence, where possible, to minimize redd dewatering and juvenile stranding. In the Stanislaus River, pulse flows may benefit migrating juveniles in the spring and adults in the fall. In the Delta, OMR management season may cause adverse or beneficial impacts for fall-run Chinook salmon in the Delta dependent on fish presence, distribution, and flows.

Alternative 1 includes minimum instream flows and does not operate to pulse flows. Compared with the No Action Alternative, flows in the Sacramento River under Alternative 1 would adversely and beneficially impact spawning and rearing habitat, reduce redd dewatering, and increase fry stranding in wetter years and decrease fry stranding in critically dry years. Water temperature under Alternative 1 would adversely impact spawning initiation and have varying effects on juvenile rearing and emigration. In Clear Creek, operations would adversely impact spawning and rearing habitat, and water temperature management would adversely impact spawning and egg incubation. In the lower American River, operations would have varying impacts on habitat and water temperatures for spawning, egg incubation, and juvenile rearing and emigration. In the Stanislaus River, operations would improve spawning habitat but adversely impact water temperatures for spawning and egg incubation. Alternative 1 would impact loss at the Delta fish facilities; however, there is no clear trend by water year type. Under Alternative 1, survival of outmigrating juveniles would generally decrease.

Flows in the Sacramento River under Alternative 2 would generally increase redd dewatering potential in drier years and reduce it in wetter years compared with the No Action Alternative. Generally, fry stranding would be reduced but water temperatures would have adverse impacts on spawning initiation. In Clear Creek, flows would improve spawning habitat, and water temperatures would have no anticipated impacts on spawning initiation. In the lower American River, flows would decrease spawning habitat, and water temperatures would have varying impacts on spawning, rearing, and emigration. In the Stanislaus River, water temperatures would have no anticipated impacts on spawning and egg incubation, and varying impacts on rearing and emigration. Flows would have varying impacts on spawning and rearing habitat. Alternative 2 would impact loss at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would be similar to the No Action Alternative.

Alternative 3 would change flows in the Sacramento River, resulting in adverse and beneficial impacts, with an increase in fry stranding and redd dewatering potential depending on water year type. Changes in water temperature would have similar impacts on spawning and egg incubation as the No Action Alternative and adverse and beneficial impacts on juvenile rearing and emigration. In Clear Creek, spawning habitat would improve while rearing habitat would decrease, and operations would have similar water temperatures to the No Action Alternative. In the lower American River, spawning habitat and redd dewatering would improve and water temperatures would adversely impact spawning and beneficially impact juveniles. In the Stanislaus River, spawning and rearing habitat would improve, and water temperatures would adversely impact spawning, egg incubation, and juvenile emigration. Alternative 3 would impact loss at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would improve.

Alternative 4 would change flows in the Sacramento River and increase redd dewatering potential in critically dry years compared with the No Action Alternative. Water temperatures would generally be similar to the No Action Alternative for spawning, egg incubation, and juvenile rearing and emigration. Alternative 4 seeks to preserve a portion of the coldwater pool for fall temperature management. In Clear Creek, spawning habitat would improve while rearing habitat would worsen. In the lower American River, redd dewatering potential would worsen in wet water year types and improve in critically dry years. Water temperatures would both improve and worsen conditions for fall-run Chinook salmon depending on life stage, water year type, month, and location. Flows in the Stanislaus River under Alternative 4 would impact spawning and rearing habitat in a similar or improved manner than the No Action Alternative. Water temperatures for juvenile rearing and emigration may have varying impacts. Alternative 4 would impact loss at the Delta fish facilities; however, there is no clear trend by water year type. Survival of outmigrating juveniles would be similar to the No Action Alternative.

0.4.4.8 Striped Bass

The No Action Alternative operates the TCD on Shasta Reservoir to manage water temperatures on the Sacramento River downstream of Keswick Reservoir for winter-run Chinook salmon egg incubation, which may prove detrimental to striped bass. In the lower American River, there may be beneficial impacts of continued water temperature management for juveniles rearing through reduction of thermal stress May through October. Minimum instream flows in the Stanislaus River would benefit spawning and rearing striped bass. With year-round presence in the Delta, impacts of spring outflow on striped bass are uncertain. Increased outflow may expedite the rate at which their prey base migrates through the system and could diminish their ability to access that prey.

Compared with the No Action Alternative, Alternative 1 Sacramento River flows and water temperatures would generally benefit striped bass spawning and juvenile rearing and emigration. In the lower American River, there would be beneficial and adverse impacts from flow for adult habitat and juvenile rearing and similar or improved water temperature conditions. In the Stanislaus River, flow changes would benefit all life stages of striped bass, and water temperatures would worsen conditions for spawning and egg incubation and may improve conditions for juveniles. Striped bass abundance in the Delta would be similar to the No Action Alternative except in critically dry years when the population may increase. Increased exports are likely to entrain higher numbers of striped bass juveniles.

Alternative 2 would have positive impacts on water temperature conditions for striped bass spawning and egg incubation in the Sacramento River. Flows and water temperature under Alternative 2 would negligibly impact juvenile rearing and emigration. In the lower American River, flow and water temperatures would generally be similar to the No Action Alternative for adults and juveniles. In the Stanislaus River, striped bass would be adversely impacted by flows during spawning and egg incubation and beneficially impacted during juvenile rearing and emigration. In the Delta, striped bass abundance would be similar to that under the No Action Alternative, except for an increase in critically dry water year types.

Alternative 3 flow and water temperatures would adversely impact striped bass in the Sacramento River during spawning and incubation. Impacts during larval–juvenile life stages would vary. In the American River, there would be generally beneficial and adverse flow impacts on adult habitat. There would be negligible water temperature-related impacts for adults and positive and negative water temperature-related impacts to juveniles. In the Stanislaus River, there would be beneficial flow impacts and negligible water temperature-related impacts on spawning and egg incubation. Water temperature-related impacts would negatively impact juveniles. In the Delta, abundance would increase under Alternative 3.

Under Alternative 4, flow and water temperature changes in the Sacramento River would be similar to the No Action Alternative for spawning, incubating eggs, and juvenile rearing and emigration. In the lower American River, impacts would be similar to the No Action Alternative except for varying water-temperature related impacts to juvenile rearing. In the Stanislaus River, operations would generally adversely impact flows in April and negligibly impact water temperature for spawning and egg incubation. Juvenile rearing would have negligible impacts from water temperatures, however, would benefit from flow changes. Abundance in the Delta would be similar to the No Action Alternative.

0.4.4.9 Coho Salmon

Under the No Action Alternative, Trinity River flow below Lewiston Dam would continue to be managed to improve habitat conditions for anadromous fish, including coho salmon. Seasonal flow releases in addition to water-year-specific peak flows would continue to include natural hydrograph elements that support habitat-forming processes, maintain suitable water temperatures, and support life-stage-specific habitat requirements.

Figure 0-27. Coho Salmon (National Marine Fisheries Service)

Compared with the No Action Alternative, Alternative 1 is expected to have spatially variable but negligible impacts of flow and water temperature on spawning and egg incubation and no adverse impacts on juvenile rearing habitat. Alternative 2 is expected to have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from negligible adverse to no adverse impacts. Alternative 3 would have spatially variable impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat, likely ranging from minorly adverse to no adverse impacts. Alternative 4 would have no adverse impacts of flow and water temperature on spawning and egg incubation and juvenile rearing habitat.

0.4.4.10 Eulachon

Under the No Action Alternative, Trinity River flow and water temperature below Lewiston Dam would continue to be managed to improve habitat conditions for anadromous fish. Monthly average flows from December through June would be equal to or greater than 300 cubic feet per second (cfs) in all water year types and would provide sufficient flows and suitable temperatures for eulachon spawning, larval emigration, and adult upstream migration in combination with Klamath River flows. Compared with the No Action Alternative, all action alternatives would have negligible or no adverse impacts from flow and water temperatures for all life stages.

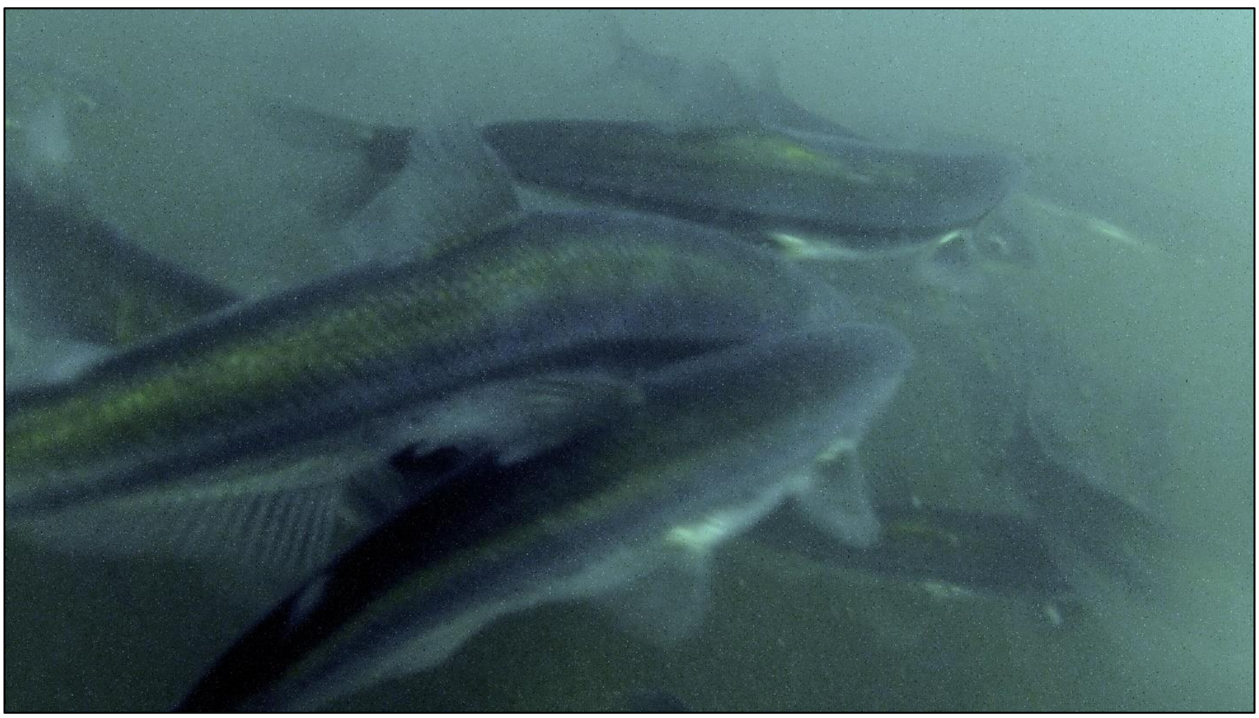

Figure 0-28. Eulachon (Skeenwild)

0.4.5 Terrestrial Biological Resources

Reclamation referenced existing data sources to evaluate the potential impacts on terrestrial biological resources. Reclamation used existing land cover data from sources such as the U.S. Geological Survey to identify which potential wetlands and waters land cover types may be affected. To identify federally listed as endangered and threatened species that may occur in the study area, Reclamation used the list generated by the USFWS's Information for Planning and Consultation (IPaC) online service. This species list fulfills the requirements of the USFWS under Section 7(c) of the Endangered Species Act of 1973, as amended (16 U.S.C. §§ 1531 et seq.). To determine which project components could affect the federally listed terrestrial species, Reclamation reviewed species range maps to assess which project components overlap the species' ranges and used existing species habitat models where available to assess which project components would affect the habitat of federally listed species. The California Natural Diversity Database (CNDDB) was used to identify non-federally listed special status species, and the CNDDB query is applicable to the SWP operations.

0.4.5.1 Giant Garter Snake

Giant garter snakes in the action area are within an active rice growing region that experiences variability in rice production and farming activities; therefore, they are already subject to the risks of fallowing under the No Action Alternative.

Source: U.S. Fish and Wildlife Service 2011.

Figure 0-29. Giant Garter Snake

Alternative 1 does not propose to decrease water diversions to SRS Contractors in agricultural areas. Therefore, temporary loss of habitat for giant garter snake as a result of cropland idling/shifting actions would be the same as the No Action Alternative.

Under Alternative 2, total SRS Contractor diversions would remain the same or decrease relative to the No Action Alternative. In dry and critical years, some of the largest reductions in average diversions would be up to 11% relative to the No Action Alternative during some months of the active season for giant garter snake. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical years under Alternative 2 could result in temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

Under Alternative 3, total SRS Contractor diversions would decrease in the spring through fall and would remain the same in the winter months relative to the No Action Alternative. In dry and critical years, SRS Contactor agricultural diversions would be reduced by 34% from 100 TAF to 66 TAF in April and approximately 11% during the remaining months of the active season for giant garter snake under Alternative 3. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical years under Alternative 3 could result in the temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

Under Alternative 4, total SRS Contractor diversions would remain the same or decrease. In dry and critical years, the largest reductions in SRS Contactor agricultural diversions would be up to 11% to 13% during some months of the active season for giant garter snake relative to the No Action Alternative under Alternative 4. Proposed decreases in water diversions to SRS Contractors in agricultural areas during dry and critical water years under Alternative 4 could result in the temporary loss of aquatic habitat for giant garter snake through the conversion of rice to dryland farming or fallowed lands.

0.4.5.2 Bank Swallow

Under the No Action Alternative, bank swallows experience variable flow conditions and water levels along the Sacramento River during the breeding season (April through June), where flows greater than 14,000 cfs regularly occur from Red Bluff, downstream to Verona and could result in localized bank collapses that result in partial or complete colony failure. Increased flows during the nonbreeding season (December through March) could provide bank erosion functions for new bank swallow breeding habitat. These risks to bank swallow occur under the No Action Alternative.

Source: U.S. Fish and Wildlife Service 2019.

Figure 0-30. Bank Swallow Colony

Flows on the Sacramento River would be higher under Alternative 1 for the majority of bank swallow breeding season while flows would be lower than the No Action Alternative toward the end of the breeding season (July to August). The increase of approximately 181 cfs more than the No Action Alternative could result in localized bank collapses that result in partial or complete colony failure. Projected flows would be higher under Alternative 1 during part of the nonbreeding season and could provide the necessary bank erosion functions needed for new bank swallow breeding habitat.

Average flows on the Sacramento River downstream of Keswick Reservoir would generally decrease under Alternative 2. Flows greater than 14,000 cfs during breeding season, such as at Verona under Alternative 2, where flows are predicted to be at 20,187 cfs (an approximate increase of 1,224 cfs compared with the No Action Alternative), could result in localized bank collapses that result in partial or complete colony failure.

Flows on the Sacramento River under Alternative 3 would be variable month to month during normal water years. The increased flows in the Sacramento River during a majority of the nonbreeding season could provide the necessary bank erosion functions needed for new bank swallow breeding habitat and therefore could result in a beneficial effect on bank swallow. Increased flows greater than 14,000 cfs, more than 1,600 cfs above the No Action Alternative), could result in localized bank collapses that result in partial or complete colony failure.

Flows on the Sacramento River would be higher under Alternative 4 at the beginning of bank swallow breeding season in April and lower for the duration of the breeding season compared with the No Action Alternative. Projected flows would be higher under Alternative 4 during the nonbreeding season, where higher flows would occur from September to March. However, flow increases are minor compared with the No Action Alternative (approximate increase of 50 cfs); therefore, habitat conditions are expected to be similar to habitat conditions experienced by bank swallow under the No Action Alternative.

Downstream of the Sacramento River at Verona, the river becomes channelized by levee banks that do not provide suitable bank habitat for nesting; therefore, there is no potential for the alternatives to impact bank swallow downstream of the confluence of the Sacramento and Feather Rivers.

0.4.5.3 Northwestern Pond Turtle

The No Action Alternative is expected to result in potential changes in northwestern pond turtle habitat at tributaries, the Delta, and reservoirs that store CVP water.

Source: U.S. Fish and Wildlife Service 2023.

Figure 0-31. Western Pond Turtle

Alternatives 1 through 4 would change river flows and reservoir levels that could adversely impact aquatic habitat for northwestern pond turtle. Depending on the tributary and water year, the alternatives would result in both increased flows and reduced flows, which may contribute to adverse impacts to northwestern pond turtle. Higher flows under Alternatives 1 through 4 would result in increased velocity and water levels, which may cause inundation of upland nesting, basking, overwintering, aestivation, and movement habitat. Increased flow velocity and water levels may directly kill eggs if nests are inundated and/or kill hatchlings and make hatchlings more vulnerable to predation by causing shallower areas to become more accessible to aquatic predators. Increased flows relative to the No Action Alternative may also result in lower water temperatures, which can slow growth rates of developing juveniles. Decreased flows relative to the No Action Alternative could limit availability of aquatic breeding and basking habitat and may increase the distances juveniles would need to traverse between areas of aquatic and upland habitat, making them more vulnerable to predation. Lower flows relative to the No Action Alternative may also cause aquatic habitat to become unsuitable for hatchlings and force them to move into deeper areas that are more accessible to aquatic predators. While lower flows can lead to adverse impacts to pond turtle, decreased flows can also increase water temperature, which could improve the growth of juveniles and lead to expanded basking areas.

The Suisun Marsh Salinity Control Gates (SMSCG) reoperations proposed under Alternative 1 would not include Delta smelt summer and fall habitat actions to improve Delta smelt food supply and habitat. This absence could incrementally increase marsh salinities in the summer and fall compared with the No Action Alternative. Higher basking activity of northwestern pond turtles has been observed in Suisun Marsh in areas with low salinity, indicating an increase in habitat suitability when salinity is decreased and vice versa. Thus, a seasonal increase in salinity in summer and fall may result in decreased habitat suitability and contribute to adverse impacts on northwestern pond turtle. The SMSCG are being proposed to direct more fresh water into the Suisun Marsh to improve habitat conditions for Delta smelt in the region under Alternatives 2 through 4, which will likely have a beneficial impact on northwestern pond turtle.

0.4.5.4 Foothill Yellow-legged Frog

The changes to terrestrial biological resources that are assumed to occur under the No Action Alternative conditions include climate change and sea-level rise and general plan development throughout California, including increased water demands in portions of the Sacramento Valley. The No Action Alternative could result in potential changes in foothill yellow-legged frog habitat at the Stanislaus River.

Source: Golden Gate National Parks Conservancy 2022.

Figure 0-32. Foothill Yellow-Legged Frog

Proposed flow changes in the lower Stanislaus River downstream from New Melones Reservoir under the alternatives could both positively and adversely impact aquatic habitat for the South Sierra distinct population segment of foothill yellow-legged frog.

Alternatives 1 through 4 would result in relatively minor increased flows in the Stanislaus River. Incrementally higher flows and water levels could impact adults' ability to feed or reside in the Stanislaus River and may lead to sedimentation of cobbled substrates. These impacts could adversely impact all the applicable life stages for the foothill yellow-legged frog associated with lower water temperatures in the summer, high pulse flow water releases during developmental periods, and a minor increase in sedimentation of cobbled substrates. Lower flows resulting from all alternatives may increase the dispersal distance required between aquatic and upland habitat, increasing the risk of predation. Potential benefits include the expansion of basking areas, improved juvenile growth from warmer water temperatures, and reducing natural variability in water releases, beyond major flood events, which will create more stable conditions (i.e., more stable flow levels that are less likely to flush and/or kill eggs, tadpoles, metamorphs, and adults, and increase sedimentation) for foothill yellow-legged frogs.

Compared with the No Action Alternative, the limited discretion on flow releases from New Melones Reservoir into the Stanislaus River will result in possible dislodging, isolation, or mortality of egg masses, and possibly strand and/or kill tadpoles and metamorphs. Incrementally higher flows and water levels under all alternatives could impact adults' ability to feed or reside in the Stanislaus River and may lead to sedimentation of cobbled substrates. Lower water temperatures in the summer, high pulse flow water releases during developmental periods, and a minor increase in sedimentation of cobbled substrates could adversely impact applicable life stages of the foothill yellow-legged frog.

0.4.6 Regional Economics

Regional economic effects from changes to M&I water supply were evaluated quantitatively using California Water Economics Spreadsheet Tool (CWEST) and IMPLAN models. CWEST is a spreadsheet representation of urban water supplies and costs for CVP and SWP project water agencies. IMPLAN estimates effects of various economic measures, including employment, labor income, and total value output.

The changes in water supply deliveries to M&I water contractors under the alternatives would affect regional economics (i.e., employment, labor income, and regional output). Alternatives 1 and 4 would result in an increase in regional economic activity while Alternative 3 and Alternative 2 without TUCP and Systemwide Voluntary Agreement are expected to have an overall decrease in regional economic activity compared with the No Action Alternative. Under the remaining Alternative 2 phases, all regions are expected to see an increase in regional economic activity with the exception of the San Francisco Bay Area under some Alternative 2 phases.

The changes in water supply deliveries to agricultural contractors would affect regional economics. Alternative 1 would result in an increase in regional economic activity in the Sacramento River region under dry conditions and San Joaquin River region under average and dry conditions. Under Alternative 2, regional economic activity in the Sacramento River and San Joaquin River regions would primarily decrease. Alternative 3 would result in a decrease in regional economic activity in the Sacramento River and San Joaquin River regions under the dry and average conditions. Alternative 4 would result in an increase in regional economic activity in the Sacramento River region under average and dry conditions and San Joaquin River region under average conditions compared with the No Action Alternative.

The commercial and recreational (ocean sports) ocean salmon fisheries along the Southern Oregon/Northern California coast are affected by the population of salmon that rely upon the Northern California rivers, including the Sacramento and San Joaquin Rivers. Annual average Central Valley Chinook salmon abundance (includes spring, winter, fall and late-fall runs) in the San Francisco Bay under all alternatives would be negligible in comparison to the No Action Alternative. Consequently, revenues received by fisherman from changes to ocean salmon harvest are expected to be the same. Ocean fisheries support industries such as fish processors, boat manufacturers, repair, and maintenance would see no changes in revenue.

Coho salmon and fall-run and spring-run Chinook salmon impacts under all the alternatives would be minor in comparison to the No Action Alternative. These salmon populations are extremely important to the Yurok Tribe and Hoopa Valley Tribe as part of their lives, cultural traditions, ceremonies, and community health (Bureau of Reclamation 2012). Salmon populations in the Trinity River would not be negatively affected under the alternatives; therefore, there would be no fisheries-related adverse effects on revenue and disposable incomes in the Trinity River region.

Changes in Trinity Reservoir levels (Figure 0-33) under the alternatives could affect recreational visitation and, consequently, recreation spending in Trinity County. No adverse effects on regional economy from recreational visitation are expected under Alternatives 1, 3, and 4 compared with the No Action Alternative. Under Alternative 2, some adverse and short-term impacts to regional economy would be expected to occur as a result of lower reservoir elevations.

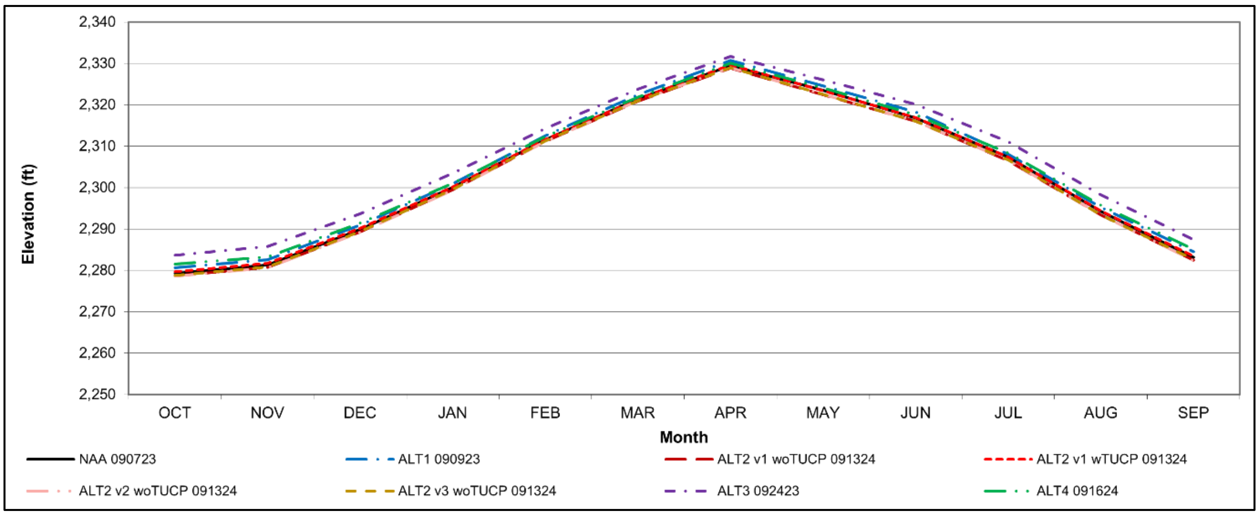

Figure 0-33. Trinity Reservoir Long-Term Average Water Level Elevation

The changes to hydropower generation from CVP and SWP operations under the alternatives could affect the regional economy through changes in electricity costs that are passed on to consumers. Alternative 1 is expected to result in more hydropower used for water supply and less available to offset electricity costs. Alternative 2 is expected to use less CVP hydropower for water supply and free more hydropower to reduce electricity costs and may result in increased regional economic activity but use more electricity for the SWP that would result in a decrease regional economic activity. Alternative 3 would result in more hydropower available in the regional economy from CVP and SWP operations. Alternative 4 is expected to result in less hydropower in the regional economy from CVP operations and use more electricity for SWP operations.

0.4.7 Power

The Power analysis considers CVP and SWP hydroelectric generation facilities, CVP and SWP energy use to move water, and transmission activities. Net generation is the difference between energy generation and use; a negative net generation means more energy is used than generated. When net generation values are negative, the CVP or SWP would purchase power from other generation facilities. Because California's energy system must always be balanced, purchasing power from other generation facilities would imply that additional generation is needed. Reservoir elevations and flow patterns through pumping facilities from the CalSim 3 model (Appendix F, *Modeling*) is used with Long-Term Generation (LTGen) and SWP power tools, as described in Attachment 1, Power Model Documentation. These tools estimate average annual peaking power capacity, energy use, and energy generation at CVP and SWP facilities.

The increase in CVP generation would be less than increases of annual energy use under Alternative 1, resulting in reductions in annual net generation. Under the Alternative 2 there would be or no change in CVP annual generation for both the long-term average and dry and critically dry years, resulting in a slight increase or no change in CVP annual net generation compared with the No Action Alternative. Under Alternative 3, there would be no change in CVP annual LTGen and an increase in CVP annual generation for dry and critically dry years, resulting in the largest increase in CVP annual net generation of all the alternatives because of the greater decreases in annual energy use. Under Alternative 4, there would be no change in the long-term average in annual generation and a slight increase (1%) in annual generation for dry and critically dry years, resulting in a slight decrease (1%) in annual net generation for the long-term average and a slight increase (1%) in net generation for dry and critically dry years. Figure 0-34 provides a comparison of the long-term average annual CVP energy use, generation, and net generation for the action alternatives compared with the No Action Alternative.

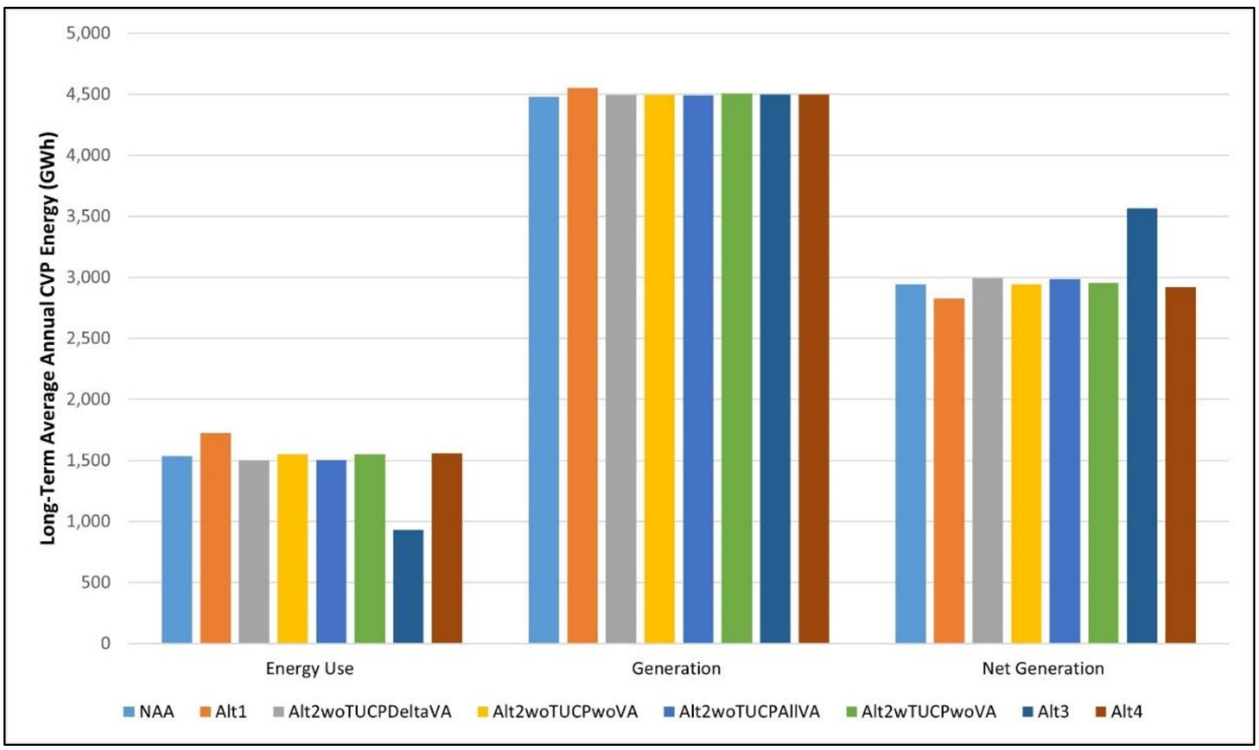

Figure 0-34. Comparison of Simulated Long-Term Average Annual Central Valley Project Energy Use, Generation, and Net Generation

Under Alternative 1 the increase in SWP annual generation would be less than increases of SWP annual energy use, resulting in the greatest reduction in SWP annual net generation of all the alternatives. Under Alternative 2 there would be slight increases and slight decreases in energy use, decreases or increases in SWP annual generation for both year types resulting in slight decreases in SWP annual net generation compared with the No Action Alternative. Under Alternative 3, there would be a decrease in SWP annual long-term average generation, and a decrease in SWP annual generation for dry and critically dry years, resulting in substantial increases in SWP annual net generation compared with the No Action Alternative because of the greater decreases in annual energy use than under the other alternatives. Under Alternative 4, there would be increases in energy use and generation for both year types, resulting in decreases in net generation for both year types because increases in energy use would be greater than increases in generation. Figure 0-35 provides a comparison of the long-term average annual SWP energy use, generation, and net generation for the action alternatives compared with the No Action Alternative.

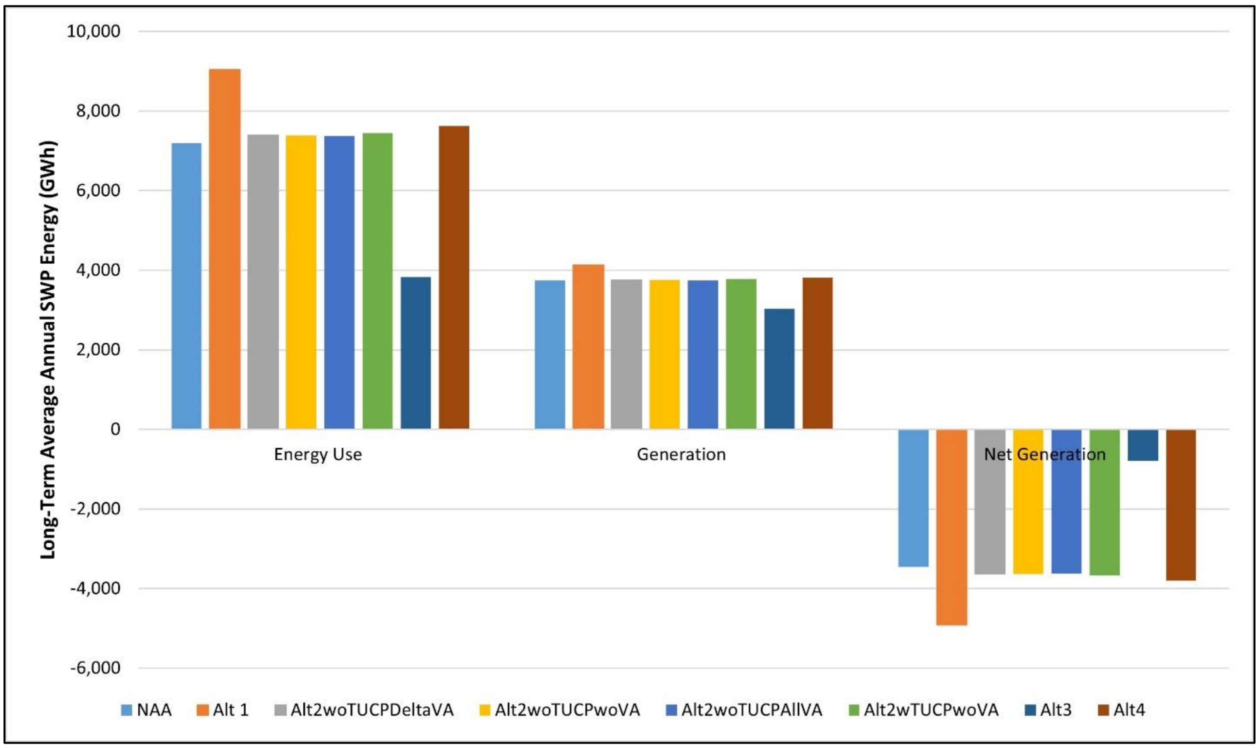

Figure 0-35. Comparison of Stimulated Long-Term Average Annual State Water Project Energy Use, Generation, and Net Generation

Reductions in monthly CVP net generation would not require the procurement of additional generation energy because generation would be positive in all months under all of the alternatives. Monthly reductions (greater than 5%) in CVP long-term average net generation for the action alternatives compared with the No Action Alternative would be greatest in January through March and September through October under Alternative 1 and in September under Alternative 4. In other months, Alternatives 1 through 4 would not have reductions in CVP long-term average net generation greater than 5%, with several months having an increase in CVP net generation, with the greatest monthly increases under Alternative 3. Figure 0-34 provides a comparison of the long-term monthly CVP net generation and percent change for the action alternatives compared with the No Action Alternative.

All alternatives would have negative SWP net generation in all months except for Alternative 3, where January through May would have positive net generation. Negative SWP net generation would require the procurement of additional generation elsewhere within the California energy system. Monthly reductions in SWP long-term average net generation would be greater under Alternative 1 than the other alternatives with the largest reduction occurring in January through March and July. Alternative 2 phases would vary in the months with the greatest reduction in SWP annual long-term net generation. However, some months would not have reductions greater than 5%. Under Alternative 3, monthly SWP long-term net generation would increase in all months compared with the No Action Alternative. Under Alternative 4, the greatest decreases in monthly SWP long-term net generation would occur in February, April, May, and July compared with the No Action Alternative.

0.5 Issues in Dispute

The EIS shall identify issues in dispute, "including issues raised by agencies and the public" (40 C.F.R. § 1502.12). *Public dispute* is not the same as *scientific dispute*, but many of the disagreements regarding choices to be made between alternatives stem from disputes about the science, including strongly held views raised by non-scientists. This section summarizes areas of uncertainty, and the existing information where the science is inconclusive or disputed may warrant further study.

Topics focus on substantial disputes over the size, location, nature, or consequences of the alternatives and their effects.

- **Old and Middle River Management:** Over the last twenty years, there has been substantial dispute over CVP and SWP export operations and the management of entrainment through restriction on the magnitude of reverse flows in Old and Middle Rivers during certain periods of the year, and the environmental effects of those flow changes.
- **Winter and Spring Delta Outflow:** Substantial dispute exists over the CVP and SWP management of the magnitude of winter and spring Delta outflow and effects of differing flows on the ecosystem and listed species during these seasons.
- **Summer and Fall Habitat Actions:** Substantial dispute exists over the operation of the CVP and SWP to create and/or maintain low salinity zone habitat for Delta smelt in late summer and fall, along with the operation of the SMSCG, and the effects of differing flows on habitat and food availability and quality.
- **Shasta Coldwater Pool Management:** Substantial dispute exists over storing and retaining stored water in Shasta Reservoir to meet temperature management, contractual demands, and the needs in consecutive drought and dry years under changing climates.

- **Folsom Flow and Temperature:** Dispute exists over the management of stored water within Folsom Reservoir during certain water year types. During dryer years it is challenging for Reclamation to address the tradeoffs for minimum releases and the use of available coldwater pool in Folsom Reservoir for water supply, power production and steelhead and fall-run Chinook salmon in the American River and a margin of safety on water levels for M&I intakes.
- **New Melones Stepped Release Plan:** Substantial dispute exists over the CVP management of stored water within New Melones Reservoir. It is challenging for Reclamation to address the tradeoffs for minimum releases for instream demands and water quality and the need to consider multi-year storage and refill needed to maintain sufficient reservoir levels for water temperature management.
- **Central Valley Tributary Habitat Restoration:** There has been substantial dispute over the effectiveness of tributary habitat restoration for meeting the needs of endangered fish species in addition to and/or in lieu of additional flows.
- **Delta Habitat Restoration:** There has been substantial dispute over the effectiveness of tidal habitat restoration for meeting the needs of endangered fish in addition to and/or in lieu of additional flows.

0.6 Issues to be Resolved

0.6.1 Preferred Alternative

While Reclamation has identified a preferred alternative in this EIS, selection of a final alternative will not be final until the Record of Decision. The decision on the alternative to implement will consider public comments and updates in the Final EIS.

0.6.2 Trinity River Division

The alternatives in this EIS, including the No Action Alternative, incorporate the continued implementation of the 2000 Trinity River Mainstem Fishery Record of Decision (2000 Trinity ROD) and the 2017 Long-Term Plan to Protect Adult Salmon in the Lower Klamath River Record of Decision. Changes or impacts described for resources associated with the Trinity Reservoir levels and Trinity River flows have been previously analyzed under the environmental compliance that led to those two Records of Decision.

Reclamation is separately and concurrently coordinating with the Hoopa Valley Tribe and the Yurok Tribe as joint leads (40 CFR part 1501) on Trinity River-specific considerations to develop potential Trinity River-specific alternatives for an updated operation for releases to the Trinity River and diversions from the Trinity River Basin to the Central Valley. Reclamation also is developing a Biological Assessment for listed species that are specific to the Trinity River Division and plans to request formal consultation with the appropriate federal resource agencies. Reclamation expects to update the analysis presented in this document to reflect changes in Trinity River Division operations if there are different impacts as a result of the decision on the Trinity River Division.

0.7 Mitigation Measures

NEPA requires federal agencies to consider appropriate mitigation measures to avoid or minimize specific impacts. Consideration and adoption of mitigation is a continuous process through completion of the EIS and Record of Decision. The Council on Environmental Quality defines mitigation to include avoidance, minimization, rectification, reduction over time, and compensation for impacts (Section 1508.20).

Because of the central focus of the alternatives on operations of the CVP and SWP in compliance with federal law, including the Endangered Species Act, the alternatives themselves include many species-related conservation measures that are considered avoidance and minimization measures integrated as part of the alternatives. These measures are considered avoidance and minimization measures because they are intended to avoid impacts or limit the degree and magnitude of the impacts. Hence, additional mitigation is often not identified for fish and aquatic species, except for very specific instances.

In addition to the avoidance and minimization measures and the additional mitigation associated with the alternatives discussed in this EIS, there are independent but related programs and activities that address some of the impacts inherent in the long-term operations of the CVP and SWP. The scope and complexity of agency actions in the Central Valley involve multiple activities that are implemented separately from the long-term operation. These "independent related actions" with their independent NEPA and Section 7 consultations, where warranted, are part of the affected environment but are not part of the operation of the CVP and SWP to store, release, divert, route, and blend water. Nevertheless, because of the ongoing and long-term operation of the CVP and SWP, some of these actions rectify and reduce and compensate impacts associated with operation of these facilities. Avoidance and minimization measures, additional mitigation and independent related actions are discussed in detail in Appendix D, *Mitigation Measures*.