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Fish and Wildlife Service

Fish and Wildlife Coordination Act Report

For the

SHASTA LAKE WATER RESOURCES INVESTIGATION

Prepared for:
U.S. BUREAU OF RECLAMATION
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EXECUTIVE SUMMARY

This document constitutes the U. S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (FWCA) report to the U. S. Bureau of Reclamation (Reclamation) for the Shasta Lake Water Resources Investigation (SLWRI) (Project). The FWCA requires Federal agencies proposing water resource development projects or involved in issuance of related permits or licenses to consult with the Service and provide equal consideration to the conservation, rehabilitation, and enhancement of fish and wildlife resources with other project purposes. The findings of this report are based on information provided in the December 2006 and May 2007 Plan Formulation Report (PFR) (USBR 2006a, 2007), September 2008 Administrative Draft Environmental Impact Statement (EIS) (USBR 2008), February 2011 Draft Feasibility Report and 2nd Administrative Draft EIS (Reclamation 2011a), November 2011 Draft Feasibility Report, Preliminary Draft EIS and Draft Appendices (USBR 2011b), June 2013 Draft EIS (USBR 2013), June 2014 Administrative Final EIS (USBR 2014), additional available data, field investigations, and results of biological surveys (*e.g.*, North State Resources [NSR] 2004, 2013 and Lindstrand 2007). Our report addresses the proposed Project-related beneficial and adverse effects on fish and wildlife resources and provides recommendations to mitigate Project implementation to the extent possible with the information provided to date.

Reclamation is the Federal lead agency for the SLWRI, pursuant to the National Environmental Policy Act (NEPA). In 2000, as a result of increases in demands for water supplies, and attention to ecosystem needs in the Central Valley of California, the Mid-Pacific Region of Reclamation reinitiated a feasibility-scope investigation to evaluate the potential of enlarging Shasta Dam. The SLWRI is being conducted under the general authority of Public Law 96-375 and the CALFED Bay-Delta Authorization Act, also known as Public Law 108-361. The SLWRI is designed to evaluate the feasibility of expanding the capacity of Shasta Lake for improved water supply reliability and improved anadromous fish survival, and to address other related resource needs in the primary and extended study areas.

In June 2008, the Service released the first draft FWCAR for the SLWRI. The report was based primarily on the Administrative Draft EIS/EIR, dated September 2008 (USBR 2008), and the Plan Formulation Report, dated March 2007 (USBR 2007), along with additional information available to the Service. The modeling information available was based on the Service's 2005 OCAP BO (USFWS 2005), and the NMFS 2004 Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (OCAP BO 2004). In 2013 Reclamation revised their modeling using the revised criteria of the Service's 2008 OCAP BO (USFWS 2008a) and the 2009 NMFS BO (NMFS 2009). In response to changes in the modeling results and additional environmental information, including Reclamation's selection of a new alternative, CP4A, in June 2014, the Sacramento Fish and Wildlife Office revised the FWCAR and released the Draft Final in September 2014. After receiving comments from Reclamation, the Service released a revised Draft Final FWCAR in November 2014. In December 2014 the Director of the Service's Pacific Southwest Regional Office withdrew the Draft Final FWCAR for further internal review. This revision addresses input from the additional internal review.

The primary study area as defined in the SLWRI Draft EIS (USBR 2013) includes the following areas (see Appendix A, Plate 1):

- Shasta Dam and reservoir (Shasta Lake) (see Appendix A, Plate 2);
- Lower portions of all contributing major and minor tributaries flowing into Shasta Lake, Trinity and Lewiston Reservoirs;
- Sacramento River between Shasta Dam and Red Bluff Pumping Plant (RBPP) including tributaries at their confluence;
- Areas surrounding Shasta Lake that would be inundated by raising Shasta Dam (Inundation Zone).

The Service believes that the primary study area should be expanded to include areas above the Inundation Zone that would be impacted by dam construction activities and the relocation of campgrounds, marinas, roads, bridges, and other facilities. Additionally, the primary study area should include the lower reaches of the tributaries to the Sacramento River between Keswick Dam and RBPP upstream from their confluence. These tributaries are important to the mainstem Sacramento River because of their significance in recruiting gravel and large woody debris, their importance for providing rearing habitat for salmonids (Maslin *et al.* 1996, 1997, 1998, 1999), and the potential for riparian restoration of the lower reaches of these tributaries within the SLWRI. Additionally, these tributaries may be affected by further downcutting and disconnection from the floodplain as a result of the reduction in flood flows in the mainstem Sacramento River with the proposed enlarging of Shasta Dam in the SLWRI (Mount 1995).

The extended study area as defined in the SLWRI EIS (USBR 2014) includes the following areas:

- Sacramento River downstream from RBPP, including portions of the American River and Feather River basins downstream from CVP/SWP facilities;
- San Francisco Bay/Sacramento – San Joaquin Delta (Bay-Delta),
- Lower portions of the San Joaquin River basin downstream from CVP facilities;
- Facilities and water service areas of the Central Valley Project (CVP) and State Water Project (SWP) that may be affected by operational changes at Shasta Dam and reservoir.

The Service believes that Reclamation should follow the example of the North-of-the-Delta Offstream Storage Investigation (NODOS) by establishing a secondary study area as defined to include the Sacramento River and its tributaries from RBPP to the Sacramento-San Joaquin River Delta and the area of potential operational effects, including SWP and CVP facilities that could experience reservoir water surface elevation fluctuations and stream flow changes downstream from their facilities due to an enlarged Shasta Dam (*e.g.,* Oroville Dam and the lower Feather River; Folsom Dam and the lower American River) (see Appendix A, Plate 3), along with the three areas defined above. The secondary study area should include the CALFED water storage projects currently being evaluated for construction in the future (i.*e.,* NODOS, In-Delta Storage and Upper San Joaquin River Basin Storage Investigation); likewise, the proposed raising of Shasta Dam should be included within planning for these future CALFED water storage projects.

Table 1. Retained Measures to Address Planning Objectives

Planning Objective	Resources Management Measure	
	Title	**Measure Description**
Primary Planning Objectives		
Anadromous Fish Survival	Restore Spawning Habitat	Augment spawning gravels for 10 years
	Modify TCD	Make additional modifications to Shasta Dam for temperature control
	Restore Riparian Habitat	Construct instream aquatic habitat downstream from Keswick Dam
	Modify Operations	Modify storage and releases operations at Shasta Dam
	Enlarge Shasta Lake Cold Water Pool	Raise Shasta Dam to increase the cold water pool in the lake for potential benefit to anadromous fish
Water Supply Reliability	Increase Conservation Storage	Increase conservation storage space in Shasta Lake by raising Shasta Dam
	Reoperate Shasta Dam	Increase the effective conservation storage space in Shasta Lake by increasing the efficiency of reservoir operation for water supply reliability
	Perform Conjunctive Water Management	Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam
	Demand Reduction	Identify and implement, to the extent possible, water use efficiency methods
Secondary Planning Objectives		
Ecosystem Restoration	Restore Shoreline Aquatic Habitat	Construct shoreline fish habitat around Shasta Lake
	Restore Tributary Aquatic Habitat	Construct instream fish habitat on tributaries to Shasta Lake
	Restore Riparian Habitat	Restore riparian and floodplain habitat along the upper Sacramento River
Flood Damage Reduction	Modify Flood Management Operations	Update Shasta Dam and reservoir flood management operations
Hydropower Generation	Modify Hydropower Facilities	Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased head
Maintain or Improve Water Quality	Operational flexibility	Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir
Recreation	Restore and Upgrade Facilities	Restore and upgrade recreation facilities and opportunities
	Reoperate Reservoir	Increase recreation use by stabilizing early season filling in Shasta Lake

Key: PMF = probable maximum flood; TCD = temperature control device From the Shasta Lake Water Resources Investigation [SLWRI] Plan Formulation Report (USBR 2007).

The extended study area includes the entire service areas of the SWP and the CVP. One of the primary purposes of the SLWRI project is to increase water supply reliability for the State of California which has potential long-term direct and indirect effects within the entire service areas of both the SWP and the CVP.

The primary planning objectives for the SLWRI are increasing water supply reliability for agricultural, municipal and industrial use, and environmental purposes, including increasing anadromous fish survival in the Sacramento River, primarily upstream of the RBPP. The secondary planning objectives for the SLWRI are ecosystem restoration and enhancement, flood damage reduction, increased hydropower generation, recreation on Shasta Lake, and water quality from Shasta Dam to the Delta. Table 1 summarizes the primary and secondary planning objectives of the SLWRI and the resource management measures that were retained to address the planning objectives as currently defined in the June 2014 EIS (USBR 2014). The planning objectives were developed for the SLWRI based on identified water resources problems, needs, and opportunities, and information contained in the August 2000 CALFED Record of Decision (ROD). Resource management measures are features or activities that address a specific planning objective.

The SLWRI developed a No Action Alternative and six comprehensive alternative plans (CPs) based on comments received on the Initial Alternatives Information Report, input from the public scoping process, and continued coordination. The various CPs call for raising Shasta Dam 6.5, 12.5, or 18.5 feet and modifying the temperature control device (TCD) to improve delivery of cold water to anadromous fish spawning and rearing habitat. The CPs are as follows (see SLWRI EIS for detailed descriptions of CPs):

- CP1 – 6.5-Foot Dam Raise
    1. Focuses on water supply reliability for agricultural and municipal and industrial (M&I) deliveries, and anadromous fish survival.
    2. Raises the reservoir's gross pool by 8.5 feet, and enlarges the total storage space by 256,000 acre-feet in Shasta Lake.
    3. Shasta Dam operational guidelines would continue unchanged.
    4. The additional storage would be retained for increased water supply reliability during drought and average years for M&I water deliveries.
    5. The increased pool depth and volume would be used to contribute to existing required management of water temperatures for anadromous fish on the upper Sacramento River.

- CP2 – 12.5-Foot Dam Raise
    1. Focuses on water supply reliability for agricultural and M&I deliveries, and anadromous fish survival.
    2. Increases the reservoir's gross pool by 14.5 feet, and enlarges the total storage space by 443,000 acre-feet in Shasta Lake.
    3. Shasta Dam operational guidelines would continue unchanged.
    4. The additional storage would be retained for increased water supply reliability during drought and average years for M&I water deliveries.
    5. The increased pool depth and volume would be used to contribute to existing required management of water temperatures for anadromous fish on the upper Sacramento River.

- CP3 – 18.5-Foot Dam Raise
    1. Focuses on water supply reliability for agricultural water deliveries and anadromous fish survival.
    2. Increases the reservoir's gross pool by 20.5 feet, and enlarges the total storage space by 634,000 acre-feet in Shasta Lake.
    3. Shasta Dam operational guidelines would emphasize irrigation water deliveries.
    4. The additional storage would be retained for increased water supply reliability during drought and average years for agricultural water deliveries.
    5. The increased pool depth and volume would be used to contribute to existing required management of water temperatures for anadromous fish on the upper Sacramento River.

- CP4 – 18.5-Foot Dam Raise
    1. Focuses on anadromous fish survival and water supply reliability for M&I water deliveries.
    2. Reserving 378,000 acre-feet of the increased storage in Shasta Lake to maintain cold-water volume or augment flows as part of an adaptive management plan for anadromous fish survival.
    3. Replenishing spawning gravel in the upper Sacramento River at an unspecified location between Keswick Dam and the RBPP (10 years).
    4. Restoring riparian, floodplain, and side channel habitat at potential locations along the upper Sacramento River between Keswick Dam and the RBPP.
    5. The additional storage would be retained for increased water supply reliability during drought and average years for M&I water deliveries.

- CP4A – 18.5-Foot Dam Raise; Preferred Alternative
    1. Focuses on water supply reliability for M&I water deliveries and anadromous fish survival.
    2. Reserving 191,000 acre-feet of the increased storage in Shasta Lake to maintain cold-water volume or augment flows as part of an adaptive management plan for anadromous fish survival.
    3. Replenishing spawning gravel in the upper Sacramento River at an unspecified location between Keswick Dam and the RBPP (10 years).
    4. Restoring riparian, floodplain, and side channel habitat at potential locations along the upper Sacramento River between Keswick Dam and the RBPP.
    5. The additional storage would be retained for increased water supply reliability during drought and average years for M&I water deliveries.

- CP5 – 18.5-Foot Dam Raise
    1. Focuses on water supply reliability, anadromous fish survival, ecosystem enhancements, and recreation.
    2. Constructing additional resident fish habitat in Shasta Lake and along the lower reaches of the Sacramento River, McCloud River, and Squaw Creek.
    3. Constructing shoreline fish habitat around Shasta Lake.

4. Replenishing spawning gravel in the upper Sacramento River at an unspecified location between Keswick Dam and the RBPP (10 years).
5. Restoring riparian, floodplain, and side channel habitat at potential locations along the upper Sacramento River between Keswick Dam and the RBPP.
6. Improving reservoir operation for recreation and enhancing recreation facilities at various locations around Shasta Lake.
7. The additional storage would be retained for increased water supply reliability during drought and average years for M&I water deliveries.

The reach of the Sacramento River between Keswick Dam and RBPP is important spawning habitat for anadromous fish (*e.g.*, Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*Oncorhynchus mykiss*), and green sturgeon (*Acipenser medirostris*)) and the only known spawning habitat for the federally endangered Central Valley winter-run Chinook salmon.

Three alternatives provide some tangible benefit for anadromous fish, CP4, CP4A, and CP5. CP4 provides for the dedication of 378,000 acre-feet of the cold-water pool for the purpose of maintaining the required downstream temperatures below Keswick Dam. CP4A would dedicate half that amount of the cold-water pool, 191,000 acre-feet, for water management to benefit anadromous fish. CP4, CP4A, and CP5 include a plan for proposed increase of riparian, floodplain, and/or side channel habitat between Keswick Dam and the RBPP. Only one alternative (CP4) provides *any* substantial benefit to anadromous fish survival; however, alternate CP4, in the majority of years, would result in either negligible or slightly negative impacts to Chinook salmon survival overall. In about 90 percent of the years, there would be no benefit to anadromous fish survival. Even in CP4, the benefits of an enlarged cold water pool for each of the four runs of Chinook salmon are limited to a few critical and dry water years representing 6 – 16 percent of the water years, based on the 1922 – 2002 period of simulation. Simulations based on current Chinook salmon population levels (*i.e.*, 1999 – 2006 population average) and predicted higher future Chinook salmon population levels (*i.e.*, Anadromous Fish Restoration Program [AFRP] population goals) show that increases in immature smolt production of winter-, fall-, and late fall-run Chinook salmon relative to No Action in excess of 10 percent occurred in only 5 – 11 percent of the years simulated. Increases in spring-run Chinook salmon immature smolt production of greater than 10 percent occurred in 15 – 16 percent of the years simulated. The modelling results do not take into account the conditions that would exist within the Sacramento River and the Delta and how that would affect the overall production and survivability of Chinook salmon.

An analysis of the SALMOD modeling results for the No Action alternative reveals that thermal mortality to winter-, fall-, and late fall-run Chinook salmon is very limited in the years simulated, and during the 11-year period 2002 to 2012, water temperatures upstream of the RBPP were at optimal levels for juvenile Chinook salmon (USFWS 2014). Predominant sources of mortality were due to superimposition, habitat constraints, the flushing or dewatering of redds, and entrainment in unscreened diversions. Restoration opportunities that could assist in reducing these causes of mortality have been removed from further consideration, or are included as potential actions, raising the prospect that those species could suffer further declines or, at a minimum, gain no long-term benefit.

For the period of 81 years (1922 -2002) used for Reclamation's modeling (SALMOD), no significant (an increase or decrease of greater than, or equal to 5 percent) change in overall production for any of the Chinook salmon runs (winter-run, spring-run, fall-run, and late fall-run) resulted from any of the proposed alternatives (CP1, CP2, CP3, CP4, CP4A, and CP5) compared to either the No-Action Alternative (Future Conditions 2030) or the Existing Condition (2005). The average fry-equivalent production estimates for Chinook salmon passing the RBPP for the period from 2002 – 2012 is 22,556,486 (USFWS 2014). The average SALMOD estimate of production for the preferred alternative (CP4A) is a 710,000 increase in annual production (USBR 2014). The modeled change in production resulting from CP4A is about 3.15 percent of the average production estimate, and less than a significant change (≥5 percent [USBR 2014]) in average Chinook salmon production.

Winter-run Chinook currently only exist in the Sacramento River downstream of Keswick Dam and spawn in late spring and summer when ambient air temperatures are at their peak. This means that cold water released from Shasta Dam during the period that winter-run are spawning and their eggs are incuabating is critical for their persistence as a population. This is most important during critical water years when the cold water storage storage is limited and winter-run are most at risk. Conversely, for late fall-run Chinook that spawn from December through March, additional cold water storage would have no effect on survival of eggs since cold water for spawning and egg incubation is not limited at that time of the year.

In addition, the life-cycle data and the spawning locations for winter-run Chinook salmon used by Reclamation in their SALMOD modeling are not current. Current data (2003 – 2014) shows that winter-run Chinook spawn in greater proportions in Spawning Segments numbers 1 and 2, and less in Segment 3 as Reclamation's modeling used. Also, winter-run Chinook salmon in the mainstem Sacramento River spawn approximately a month later on average than the dates used by Reclamation in their modeling (CDFW 2014).

The conclusions in this report concerning the effects of the proposed project on Chinook salmon in the upper Sacramento River are heavily contingent on the modeling results provided by Reclamation. Any changes to the assumptions and improvements to the modeling may yield different results and lead to different conclusions. Any refinements in the modeling could potentially be addressed in future environmental documents and also be addressed in the biological assessments that would be required for the proposed project should it move forward.

Restoring spawning and rearing habitat, improving fish passage, increasing minimum flows, and screening water diversions would likely result in greater increases in anadromous fish survival during the majority of the years when temperature is not a limiting factor, as well as address the secondary objective of Ecosystem Restoration. In the Action Alternatives as currently defined (USBR 2014), the only resource management measure remaining that addresses the secondary objective of Ecosystem Restoration, beyond the potential efforts specifically aimed at anadromous fish, is unspecified restoration around Shasta Lake and its tributaries in CP5.

The Service recommends that in order to address the primary objective of Anadromous Fish Survival and the secondary objective of Ecosystem Restoration, Reclamation should incorporate into the SLWRI alternatives the following resource management measures, most of which were initially considered but removed from further analysis:

- Restore the riparian corridor along the mainstem Sacramento River and the lower reaches of nonnatal tributaries (see Sacramento River Conservation Area Forum [SRCAF] 2003; Riparian Habitat Joint Venture [RHJV] 2004; USFWS 2001, 2007a).
- Implement appropriate actions from the Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (Chinook salmon and Steelhead Recovery Plan)(NMFS 2014).
- Promote cottonwood regeneration along the Sacramento River.
- Provide gravel augmentation in the mainstem Sacramento River and lower reaches of tributaries for as long as Shasta Dam affects spawning gravel recruitment.
- Increase minimum flows in the upper Sacramento River from the current 3,250 cubic feet per second (cfs) to 4,000 cfs Oct 1 - Apr. 30, if end-of-September storage is 2.4 million af (MAF) or greater (per the AFRP Final Restoration Plan, USFWS 2001).
- Collaborate with the Anadromous Fish Screen Program to screen diversions and improve fish passage in mainstem Sacramento River and lower reach of nonnatal tributaries.
- Restore habitat at inactive gravel mines along the Sacramento River and lower reaches of tributaries.
- Control invasive plant species along the Sacramento River and lower reaches of tributaries.

These measures are beyond any actions identified and/or required in the Central Valley Project Improvement Act (CVPIA), CALFED, and existing biological opinions.

Each of the resource management measures cited above are considered a high priority restoration goal by the AFRP (USFWS 2001), SRCAF (SRCAF 2003), California Partners in Flight (CalPIF) (CalPIF 2000, 2002a, 2002b, 2004), and/or RHJV (RHJV 2004). By including these instream, floodplain, and riparian restoration efforts in the SLWRI alternatives, the proposed project would be more likely to realize the primary and secondary planning objectives of Anadromous Fish Survival and Ecosystem Restoration. Additionally, by restoring a diversity of riparian successional stages along the Sacramento River, the SLWRI would have the added benefit of improving habitat for sensitive migratory bird species such as the bank swallow (*Riparia riparia*), black-headed grosbeak (*Pheucticus melanocephalus*), blue grosbeak (*Guiraca caerulea*), common yellowthroat (*Geothlypis trichas)*, song sparrow (*Melospiza melodia)*, Swainson's hawk (*Buteo swainsoni*), tree swallow (*Tachycineta bicolor*), tricolored blackbird (*Agelaius tricolor*), western yellow-billed cuckoo (*Coccycus americanus*), yellow-breasted chat (*Icteria virens)*, and yellow warbler (*Dendroica petechia*) (RHJV 2004).

In addition to the above resource management measures, the Service has the following recommendations for the SLWRI alternatives (beyond any actions identified and/or required in CVPIA, CALFED, and existing biological opinions):

- Clarify and quantify the extent that the cold water pool in CP4 and CP4A (378,000 af and 191,000 af, respectively) would be used to augment flows to provide additional benefits for fish and wildlife species. Specifically, the Service recommends that the authority for the use of the cold water pool be at the discretion of the Service, National Oceanic and Atmospheric

Association/National Marine Fisheries Service (NMFS), and California Department of Fish and Wildlife (CDFW; formerly California Department of Fish and Game);

- Include monitoring and specific adaptive management measures in all SLWRI alternatives;
- Develop a riprap removal strategy and program in coordination with flood risk management agencies, along reaches of nonnatal tributaries and the mainstem of the Sacramento River supporting salmonid spawning and/or rearing habitat (USFWS 2004);
- Increase water use efficiency to a specified level (*e.g.*, improve efficiency of the Anderson Cottonwood Irrigation District [ACID] canal);
- Ensure that Delta outflows for the Sacramento River and Yolo Bypass align with targets established in appropriate ongoing planning efforts and as provided in existing biological opinions.

Additionally, the Service believes that Reclamation should include a SLWRI alternative that evaluates the capability of increasing anadromous fish survival and water supply reliability without raising Shasta Dam. This could be accomplished by:

- Modifying the TCD at Shasta Dam to improve temperature control in the upper Sacramento River;
- Improving spawning habitat by gravel augmentation;
- Improving juvenile salmonid rearing habitat through placement of large woody debris and riparian restoration (*i.e.* shaded riverine aquatic [SRA] cover) in the Keswick – RBPP reach, in the lower reaches of the nonnatal tributaries, and in the Sacramento River downstream of the RBPP;
- Operational changes to Shasta Dam to increase cold water storage and/or increase minimum flows;
- Increasing water use efficiency to a specified level (*e.g.*, improve efficiency of the ACID canal);
- Considering conjunctive use of other existing and planned water storage facilities in the Central Valley.

Finally, the Service believes that the SLWRI could result in adverse effects to rare and special-status species in the vicinity of Shasta Lake, riparian habitat along the Sacramento River, and aquatic habitat in the Delta. Raising Shasta Lake would inundate a portion of the limited habitat of the following six rare, but not federally-listed, species each of which is endemic to the vicinity of Shasta Lake: Shasta snow-wreath (*Neviusia cliftonii*), Shasta salamander (*Hydromantes shastae*), Shasta sideband snail (*Monadenia troglodytes troglodytes*), Wintu sideband snail (*Monadenia troglodytes wintu*), Shasta chaparral snail (*Trilobopsis roperi*), and Shasta hesperian snail (*Vespericola shasta*) (USBR 2014). Additional habitat would be disturbed by construction-related activities and the relocation of campgrounds, roads, bridges, and other facilities above the Inundation Zone. The raising of Shasta Dam and implementation of the SLWRI would result in the loss, degradation, and fragmentation of habitat and may result in the need to further evaluate the factors threatening some of these six species pursuant to section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA). Comprehensive effects analysis is not available, but partial information indicates the following:

- The rare terrestrial mollusks Shasta sideband snail and Wintu sideband snail are restricted to limited limestone outcrops in the vicinity of Shasta Lake; therefore, a portion of their habitat would be lost due to inundation or disturbance by the SLWRI.
- Shasta snow-wreath, in particular, could be adversely affected with 46 percent of all known occurrences of the plant species (11 out of 24 occurrences) being partly or substantially inundated, with 11 of the remaining 13 occurrences threatened to some degree by other planned activities (Lindstrand and Nelson 2005a, b; Lindstrand 2007; CDFG 2007a; J. Nelson, Shasta-Trinity National Forest and L. Lindstrand, NSR, pers. comm. 2011; USBR *in litt.* 2014). The CALFED Final Programmatic Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) included Shasta snow-wreath among "evaluated species for which direct mortality as a result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy" (see Table 4-5 in Multi-Species Conservation Strategy section of CALFED 2000b). Further evaluation of the Shasta snow-wreath is needed to determine if the species can be conserved/protected from impacts associated with the SLWRI.
- The CALFED Final Programmatic EIS/EIR and ROD (CALFED 2000a, b) also stated that CALFED actions, such as the SLWRI, should maintain the status of and not threaten the population viability of the Shasta sideband snail and Shasta salamander.

The majority of nesting habitat of the Pacific purple martin (*Progne subis arboricola*) behind Shasta Dam would be inundated by the SLWRI. In addition, 3 – 6 bald eagle (*Haliaeetus leucocephalus*) nests would be inundated, with others likely disturbed by the SLWRI and would require coordination with the Service under the Bald and Golden Eagle Protection Act. The SLWRI could also inundate and disturb habitat of the Federal candidate species Pacific fisher (*Martes pennati pacifica*) and the federally-listed as threatened northern spotted owl (*Strix occidentalis caurina*).

Riparian and floodplain habitat along the Sacramento River and in the Yolo and Sutter Bypasses would be adversely affected by further changes in the timing, duration, and frequency of flood flows due to an enlarged Shasta Dam. Changes in flow regimes could affect nest sites of bank swallows and western yellow-billed cuckoo. The Service recommends that Reclamation should fully analyze the effects of the SLWRI on the Yolo and Sutter Bypasses utilizing a model based on daily river flow levels rather than one that relies on monthly flow averages, and ensure that any reduced flooding durations within the bypasses be identified and mitigated.

Raising the dam could also affect aquatic habitat in the Delta by potentially changing the location of the freshwater – saltwater mixing zone (X2), decreasing flushing flows, and increasing pumping at Jones and Banks facilities during critical water years when more water may be available to pump as a result of the project. These effects on the Delta ecosystem should be fully analyzed and mitigated.

The enlargement of Shasta Dam and the corresponding enlargement of Shasta Lake, and the operational scenario that would accompany the preferred alternative CP4A, will not significantly increase the overall productivity of Chinook salmon in the Sacramento River (USBR 2014). The limited benefit derived from the dam enlargement and the preferred alternative CP4A during dry and critically dry water years will likely be offset by river conditions downstream of RBPP in the mainstem Sacramento River and in the Delta. The enlargement of Shasta Dam and the water management scenario described for CP4A will reduce the rearing capacity of the Sacramento River for juvenile salmonids by further altering the natural successional process of riparian forest habitat, and by reducing juvenile salmonid access to the high quality rearing habitat found in floodplains and bypasses because of reduced high water flow events (USBR 2014).

The enlarged Shasta Lake will cause the direct loss of both individuals and habitat of rare plant and animal species including the Shasta snow-wreath, foothill yellow-legged frog, Shasta salamander, and a number of rare and uncommon terrestrial and aquatic mollusks. The enlarged Shasta Lake will likely inundate and eliminate most of the current nest sites of the remaining population of purple martins. It is not unreasonable to expect this population to be reduced to a point where it will no longer be self-sustaining and become extremely vulnerable to extirpation by stochastic events, eliminating one of the largest and most persistent breeding populations of a declining species left in California (BBS 2013).

As stated above, the water management scenario described for CP4A would further degrade the natural successional process of the riparian forest along the main stem of the Sacramento River (USBR 2014). This alteration of the process began with the initial construction of Shasta Dam and the resulting water management has adversely affected the process. The enlargement of the dam and the described altered and reduced flows on the Sacramento River will exacerbate the current conditions. The alteration of the natural successional process will degrade the quality of the riparian habitat for the limited number of breeding pairs of western yellow-billed cuckoo that are remaining along the Sacramento River. Unless a long-term commitment is made to actively manage the remaining riparian forests along the Sacramento River where the remaining breeding population of western yellow-billed cuckoos are found, it is not unreasonable to expect that the degradation of the quality of the riparian forest habitat will accelerate and the population will no longer persist, risking the loss of this important breeding population (Larsen, *et al* 2006; Greco 2008; Fremier, *et al* 2014).

Based on the Service's evaluation of the information available, as contained in this report, as well as evaluations contained in the EIS and associated documents provided by Reclamation, the Service has determined that the proposed project does not provide substantial benefits to fish and wildlife resources within the Shasta Lake pool or the adjacent upland habitats. The Service has also determined that the proposed project does not provide any substantial benefit to anadromous fish downstream of the RBPP and only provides minimal benefit to anadromous fish (winter- and spring-run Chinook salmon) upstream of the RBPP. It is the Service's opinion that based on the existing information; the proposed action, by further restricting high water flows, will result in additional losses of salmonid rearing and riparian habitat, and adversely affect the recruitment and natural succession of riparian forest along the Sacramento River and bypasses. Upon consideration of the information provided to date, the level of potential impacts to fish and wildlife resources, and the lack of specificity on potential mitigation and compensation measures the Service is unable to support the adoption of any of the proposed action alternatives.

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In 2000, as a result of increases in demands for water supplies, and attention to ecosystem needs in the Central Valley of California, the Mid-Pacific Region of the U.S. Bureau of Reclamation (Reclamation) reinitiated a feasibility-scope investigation to evaluate the potential of enlarging Shasta Dam. The Shasta Lake Water Resource Investigation (SLWRI) is being conducted under the general authority of Public Law 96-375 and the CALFED Bay-Delta Authorization Act, also known as Public Law 108-361.

The Environmental Impact Statement (EIS) (USBR 2014) identified two primary and five secondary planning objectives of the SLWRI (Table 1). The primary planning objectives are increasing water supply reliability and anadromous fish survival. The secondary planning objectives are ecosystem conservation, enhancement and restoration, flood damage reduction, hydropower generation, water quality, and recreation. The ecosystem restoration objective is to conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River (between Red Bluff Pumping Plant [RBPP] and Keswick Dam).

The EIS evaluates the future without Project condition (No Action Alternative) and 6 action alternatives (comprehensive plans [CP]). The CPs would raise the height of Shasta Dam 6.5 feet (CP1), 12.5 feet (CP2), or 18.5 feet (CP3, CP4, CP4A, and CP5). CP3 focuses on increasing water supply reliability for agriculture and anadromous fish survival. CP4 focuses on the primary objective of increasing anadromous fish survival by increasing the volume of cold water available through increased storage and reservoir operations, and increasing water supply reliability for Municipal and Industrial (M&I) users. CP4A focuses on anadromous fish survival and increasing water supply reliability for agricultural and M&I users. CP5 addresses both primary objectives as well as ecosystem restoration of shoreline and tributary fish habitat around Shasta Lake.

This document constitutes the U. S. Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (FWCA) report to Reclamation regarding the proposed SLWRI project. It has been prepared under the authority of, and in accordance with, section 2(b) of the FWCA (Public Law 85-624; 16 U.S.C. 661-667e) and is for inclusion in the EIS for the SLWRI project. The FWCA requires Federal agencies to: 1) consult with the Service before undertaking or approving projects (carried out under Federal permits and licenses) that control or modify any bodies of water for any purpose; 2) provide equal consideration of fish and wildlife resources; and 3) coordinate fish and wildlife conservation with other project features.

Details of project effects on federally-listed species and associated mitigation and compensation measures will be addressed in the associated SLWRI Biological Assessment (BA). The BA will identify, evaluate, and disclose environmental impacts of the proposed action on federally-listed species. The section 7 consultation and biological opinion provided by the Service for species under its jurisdiction for the construction and operation of the facilities, will describe Reclamation's responsibilities pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (ESA).

Table 1. Retained Measures to Address Planning Objectives

Planning Objective	Resources Management Measure	
	Title	**Measure Description**
Primary Planning Objectives		
Anadromous Fish Survival	Restore Spawning Habitat	Augment spawning gravels for 10 years
	Modify TCD	Make additional modifications to Shasta Dam for temperature control
	Restore Riparian Habitat	Construct instream aquatic habitat downstream from Keswick Dam
	Modify Operations	Modify storage and releases operations at Shasta Dam
	Enlarge Shasta Lake Cold Water Pool	Raise Shasta Dam to increase the cold water pool in the lake for potential benefit to anadromous fish
Water Supply Reliability	Increase Conservation Storage	Increase conservation storage space in Shasta Lake by raising Shasta Dam
	Reoperate Shasta Dam	Increase the effective conservation storage space in Shasta Lake by increasing the efficiency of reservoir operation for water supply reliability
	Perform Conjunctive Water Management	Develop conservation groundwater storage near the Sacramento River downstream from Shasta Dam
	Demand Reduction	Identify and implement, to the extent possible, water use efficiency methods
Secondary Planning Objectives		
Ecosystem Restoration	Restore Shoreline Aquatic Habitat	Construct shoreline fish habitat around Shasta Lake
	Restore Tributary Aquatic Habitat	Construct instream fish habitat on tributaries to Shasta Lake
	Restore Riparian Habitat	Restore riparian and floodplain habitat along the upper Sacramento River
Flood Damage Reduction	Modify Flood Management Operations	Update Shasta Dam and reservoir flood management operations
Hydropower Generation	Modify Hydropower Facilities	Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased head
Maintain or Improve Water Quality	Operational flexibility	Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir
Recreation	Restore and Upgrade Facilities	Restore and upgrade recreation facilities and opportunities
	Reoperate Reservoir	Increase recreation use by stabilizing early season filling in Shasta Lake

Key: PMF = probable maximum flood; TCD = temperature control device From the Shasta Lake Water Resources Investigation [SLWRI] Plan Formulation Report (USBR 2007).

BACKGROUND

Beginning in the 1980s, Reclamation began assessing options for increasing water storage at Shasta Lake by raising the height of Shasta Dam (USBR 1998, 1999). In 2000, the CALFED Final Programmatic Record of Decision (ROD) (CALFED 2000a) identified an enlarged Shasta Lake as a means to increase the cold water pool available to maintain certain fisheries in the upper Sacramento River and to provide a more reliable water supply. That same year, Reclamation reinitiated a feasibility-level investigation to evaluate the potential for enlarging Shasta Dam—the SLWRI (USBR 2004a; 2004b).

In 2004, the following overall mission statement was defined for the SLWRI:

> *Mission Statement*: To develop an implementable plan primarily involving the enlargement of Shasta Dam and Lake to promote increased survival of anadromous fish populations in the upper Sacramento River; increased water supply reliability; and to the extent possible through meeting these objectives, include features to benefit other identified ecosystem, flood control, and water resources needs (USBR 2004a).

In 2014, the Project Purpose Statement:

> The purpose of the proposed action is to improve operational flexibility of the Sacramento-San Joaquin Delta (Delta) watershed system to meet specified primary and secondary project objectives (USBR 2014).

The SLWRI Environmental Scoping Report (USBR 2006d) lists two primary objectives for the SLWRI: (1) to increase the survival of anadromous fish populations in the Sacramento River—primarily upstream from the RBPP, and (2) to increase water supplies and water supply reliability for agricultural, municipal, industrial and environmental purposes to help meet future water demands (with a focus on enlarging Shasta Dam and Lake). To the extent possible, the following secondary objectives would be met: (1) preserve and restore ecosystem resources in the Shasta Lake area and along the upper Sacramento River; (2) reduce flood damages along the Sacramento River; (3) develop additional hydropower capabilities at Shasta Dam; and (4) preserve outdoor recreation opportunities at Shasta Lake. The DEIS (USBR 2013) added water quality improvement in the Sacramento River and the Sacramento - San Joaquin River Delta (Delta) as a fifth secondary objective. The administrative draft of the Final EIS (USBR 2014) added an additional action alternative (CP4A) in June 2014, which was also designated by Reclamation as the preferred alternative (USBR 2014).

In June 2008, the Service released the first draft FWCAR for the SLWRI. The report was based primarily on the Administrative Draft EIS/EIR, dated September 2008 (USBR 2008), and the Plan Formulation Report, dated March 2007 (USBR 2007), along with additional information available to the Service. The modeling information available was based on the Service's 2005 OCAP BO (USFWS 2005), and the NMFS 2004 Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (OCAP BO 2004). In 2013 Reclamation revised their modeling using the revised criteria of the Service's 2008 OCAP BO (USFWS 2008a) and the 2009 NMFS BO (NMFS 2009). In response to changes in the modeling results and additional environmental information, including Reclamation's selection of a new alternative, CP4A, in June 2014, the Sacramento Fish and Wildlife Office revised the FWCAR and released the Draft Final in September 2014. After receiving comments from Reclamation, the Service released a revised Draft Final FWCAR in November 2014. In December 2014 the Director of the Service's Pacific Southwest Regional Office withdrew the Draft Final FWCAR for further internal review. This revision addresses input from the additional internal review.

SLWRI planning principles have been framed such that "[P]rimary consideration should be given to recommendations in the CALFED ROD," and "[A]lternatives should be formulated to neither preclude nor enhance development and implementation of other elements of the CALFED program or other water resources programs and projects in the Central Valley." (USBR 2006a).

PROJECT SETTING

Project Area

Shasta Dam and Shasta Lake are located on the upper Sacramento River in northern California, about 9 miles northwest of the City of Redding; the entire reservoir is within Shasta County. At gross pool, Shasta Lake stores 4.55 million acre-feet (af), covers an area of about 29,500 acres, and has a shoreline of about 400 miles. The reservoir controls runoff from about 6,420 square miles. The four major tributaries to Shasta Lake are the Sacramento River, McCloud River, Pit River, and Squaw Creek, in addition to numerous minor tributary creeks and streams.

The EIS (USBR 2014) defines the primary study area for the SLWRI as Shasta Dam and Shasta Lake; the lower portions of all contributing major and minor tributaries affected by increasing storage in the reservoir, including the Sacramento River, McCloud River, Pit River, and Squaw Creek; the Sacramento River from Shasta Dam downstream to the RBPP, including tributaries at their confluence; and Trinity and Lewiston Reservoirs. The RBPP was chosen as the downstream boundary of the primary study area because it is the point at which releases from Shasta Dam begin to have a negligible effect on Sacramento River water temperatures, and the river landscape changes to a broader, alluvial stream system (USBR 2007; 2013). For the purposes of this report, the Service includes within the primary study area the terrestrial and riparian areas surrounding Shasta Lake that would be directly or indirectly impacted by inundation, construction activities, or the relocation of facilities associated with the raising of Shasta Dam. The Service also includes within the primary study area the lower reaches of the tributaries to the Sacramento River between Keswick Dam and the RBPP that would be affected by a reduction in flood flows in the Sacramento River due to raising Shasta Dam.

Because of the potential influence of a modification of Shasta Dam on other resource programs and projects in the Central Valley, the extended study area primarily encompasses the following:

- Sacramento River downstream from the RBPP, including portions of major tributaries, namely the American and Feather River basins downstream from the Central Valley Project (CVP) and State Water Project (SWP) facilities;
- Sacramento – San Joaquin Delta;
- San Joaquin River basin at and downstream from CVP facilities (Friant and New Melones Reservoirs;
- Water service areas of the CVP and SWP that may be affected by changes at Shasta Dam and Shasta Lake.

Maps of the primary study area, Shasta Lake area, and the major CVP and SWP facilities are included in Plates 1 – 3 in Appendix A of this report. The Service believes that the extended study area should include the CALFED water storage projects currently being evaluated for construction in the future (*e.g.*, Sites Reservoir, Temperance Flat Reservoir, and San Luis Reservoir enlargement).

PROJECT DESCRIPTION

Alternatives

The following summarizes the SLWRI alternatives as described in the DEIS (USBR 2013). The CPs evaluate the primary objectives of increasing anadromous fish survival and water supply reliability by raising Shasta Dam 6.5 feet (CP1), 12.5 feet (CP2) or 18.5 feet (CP3, CP4, CP4A, CP5). CP1, CP2, and CP3 focus on increasing water supply reliability while contributing to increased anadromous fish survival, actions which are consistent with the 2000 CALFED ROD. CP4 focuses on the primary objective of increasing anadromous fish survival, and CP4A focuses to a lesser extent on increasing anadromous fish survival and more on water supply reliability. CP5 addresses both primary and secondary objectives including restoration of aquatic habitat around Shasta Lake shoreline and tributaries. The No Action Alternative evaluates the likely "future without project" conditions as required by the National Environmental Policy Act (NEPA). The No Action Alternative and the CPs are discussed in detail below, detailed descriptions can be found in the SLWRI EIS (USBR 2014).

No Action Alternative

Under NEPA, the No Action Alternative is defined as the "most likely future conditions" without the Project. In the Draft EIS (USBR 2013), Reclamation defines the No Action Alternative as "...the Federal Government would continue to implement reasonably foreseeable actions, ..., but would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California." This definition does not include alternative management actions and operations without dam elevation. As discussed previously in the Service's Planning Aid Memorandum (see pp. 4-11, Appendix A; USFWS 2007a), certain actions for anadromous fisheries and associated habitats are already mandated by applicable regulations and policies (*e.g.*, Central

Valley Project Improvement Act [CVPIA] and ESA). Those actions, goals and objectives are already the responsibility of the Federal Government in the extended planning area, and are thus to be expected to occur under the No Action scenario.

The Service believes the following activities are expected to take place, or should occur, with or without Shasta Dam enlargement: (1) compliance with the Service's 2008 and the National Marine Fisheries Service (NMFS) 2009 OCAP Biological Opinions (USFWS 2008a, NMFS 2009), (2) continued implementation of water use efficiency and conservation (*e.g.*, increased irrigation efficiency in the Anderson Cottonwood Irrigation District [ACID]), (3) Joint Point of Diversion exchanges between the CVP/SWP, (4) supply augmentation via land retirement (*e.g.*, the San Luis Drainage Feature Re-Evaluation [USBR 2006c]), (5) water transfers, and (6) Banks Pumping Plant expansion. These ongoing and anticipated projects should be included in modeling for all SLWRI alternatives, including No Action.

CP1 – 6.5 Foot Dam Raise

CP1 focuses on water supply reliability while contributing to anadromous fish survival. CP1 raises Shasta Dam 6.5 feet, an elevation change that increases the reservoir's gross pool by 8.5 feet, and enlarges the total storage space in the reservoir by 256,000 af. Under this plan, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for increased agricultural and municipal and industrial (M&I) water supply reliability on average and during dry and critical years. The increased pool depth and volume would also contribute to maintaining lower seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP2 – 12.5-Foot Dam Raise

As with CP1, CP2 focuses on water supply reliability while contributing to anadromous fish survival. CP2 raises Shasta Dam 12.5 feet, an elevation change that increases the reservoir's gross pool by 14.5 feet, and enlarges the total storage space in the reservoir by 443,000 af. Like CP1, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for agricultural and M&I water supply reliability. The increased pool depth and volume would also contribute to the existing requirements for maintaining lower seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP3 – 18.5-Foot Dam Raise

CP3 focuses on the greatest practical enlargement of Shasta Dam and reservoir. CP3 raises Shasta Dam 18.5 feet, an elevation change that increases the reservoir's gross pool by 20.5 feet, and enlarges the total storage space in the reservoir by 634,000 af to 5.19 million af. Like CP1 and CP2, Shasta Dam operational guidelines would continue unchanged, with the additional storage retained for agricultural water supply reliability. The increased pool depth and volume would also contribute to the existing requirements for maintaining lower seasonal water temperatures for anadromous fish on the upper Sacramento River.

CP4 – 18.5-Foot Dam Raise

The primary function of CP4 is to increase anadromous fish survival, while still improving water supply reliability. It focuses on increasing the volume of cold water available through increased storage and reservoir operations, and on raising Shasta Dam by 18.5 feet. As with CP3, this raise would increase the reservoir's gross pool by 20.5 feet and enlarge the total storage space in the reservoir by 634,000 af to 5.19 million af. The Draft Environmental Impact Statement (DEIS) (USBR 2013) states, "Reserving 378,000 acre-feet of increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival." The additional 378,000 af of cold-water pool (60 percent of increased storage) would be allocated at the discretion of Reclamation based on the recommendations of the Sacramento River Temperature Task Group (SRTTG). It is our understanding that in current CALSIM hydrological modeling analysis for the SLWRI that CP4 is assumed to be the same as CP1 (6.5-ft dam raise alternative) with the remaining increased storage of 256,000 af to be reserved for M&I water supply deliveries during dry to critical water years (USBR 2013). CP4 would increase both agricultural and M&I water supply deliveries both on average and in dry and critical years. CP4 would also include spawning gravel augmentation in the upper Sacramento River for a period of 10 years, after which the action would be re-evaluated to assess the need (USBR 2013). Additionally, CP4 would include the proposed restoration of riparian, floodplain, and/or side channel habitat in the upper Sacramento River (USBR 2013).

CP4A – 18.5-Foot Dam Raise, Preferred Alternative

The focus of CP4A is improving water supply reliability while still increasing anadromous fish survival. To a lesser extent, it focuses on increasing the volume of cold water available through increased storage and reservoir operations, and on raising Shasta Dam by 18.5 feet. As with CP3, this raise would increase the reservoir's gross pool by 20.5 feet and enlarge the total storage space in the reservoir by 634,000 af to 5.19 million af. The EIS (USBR 2014) states, "Reserving 191,000 acre-feet of increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival." The additional 191,000 af of cold-water pool (30 percent of increased storage, and half that designated for CP4) would be allocated at the discretion of Reclamation based on the recommendations of the SRTTG. It is our understanding that in current CALSIM hydrological modeling analysis for the SLWRI that CP4A is assumed to be the same as CP2 (12.5-ft dam raise alternative) with the remaining increased storage of 443,000 af to be reserved for M&I water supply deliveries during dry to critical water years (USBR 2014). CP4A would also include spawning gravel augmentation in the upper Sacramento River for a period of 10 years, after which the action would be re-evaluated to assess the need (USBR 2014). Additionally, CP4A would include the proposed restoration of riparian, floodplain, and/or side channel habitat in the upper Sacramento River (USBR 2014).

CP5 – 18.5-Foot Dam Raise

CP5 would address both the primary and secondary objectives. Like CP3 and CP4, CP5 includes enlarging Shasta Dam 18.5 feet. Like CP3, CP5 would have an increase of 634,000 af, and like CP4 it would include 10 years of augmentation of spawning gravel and proposed restoration of riparian, floodplain, and/or side channel habitat. However, CP5 would also include: (1) implementing environmental restoration features along the lower reaches of major tributaries to Shasta Lake, (2) constructing shoreline fish habitat around Shasta Lake, (3) constructing either additional or improved recreation features at various locations around Shasta Lake to increase the values of the recreational experience. The additional storage would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. During dry years, 150,000 acre-feet of the increased storage would be reserved for increasing M&I deliveries, however, CP5 would increase both agricultural and M&I water supply deliveries both on average and in dry and critical years. It is uncertain how much of increased storage would be reserved for anadromous fish survival (USBR 2013).

Project Construction Activities

Construction activities under all CPs would include land-based construction activities associated with the following:

- Clearing vegetation from portions of the inundated reservoir area.
- Constructing the dam, appurtenant structures, reservoir area dikes, and railroad embankments.
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure.

CP4, CP4A, and CP5 would also include construction activities associated with gravel augmentation and potential riparian, floodplain, and side channel habitat restoration. Additional construction activities associated with Shasta Lake and tributary shoreline enhancements are included under CP5.

A portion of the acreage inundated at the new reservoir full pool would need to be cleared of vegetation. This would involve removing trees and other vegetation from around the reservoir shoreline at select areas. Willows, cottonwoods, and buttonbush would not be removed in and along riparian areas. Manzanita removed in cleared areas would be stockpiled and used for fish habitat structures placed in designated locations. Structures, utilities, and other infrastructure would also need to be removed and/or relocated.

Fifteen vegetation management areas have been delineated to facilitate efficient removal of vegetation around the reservoir perimeter, including 15 areas of complete vegetation removal and 12 areas of overstory removal. The acreages of each vegetation management area affected by identified reservoir clearing treatments are summarized in Table 2.
Vegetation management activities would need to be complete before inundation of new areas created by enlarging the reservoir. A single staging area (landing) would serve each vegetation management area. Access for vegetation removal activities would most likely be limited to late summer and fall, when water levels are low and recreation use has decreased. Vegetation removal would also be limited during bird nesting season, typically early spring through mid-summer. Breeding bird surveys in suitable habitats would be performed to determine the appropriate time frame for vegetation removal activities.

Complete vegetation removal would clear all existing vegetation from the designated treatment area and would generally be applied to locations along and adjacent to developed recreation areas, including boat ramps, day use areas, campgrounds, marinas, and resorts. Exceptions would be made in areas with high shoreline erosion potential, or habitat for special-status species.

Overstory removal involves removing all trees from the treatment area that are greater than 10 inches in diameter at breast height, or 15 feet in height, generally in houseboat mooring areas or narrow arms of the reservoir where snags pose the greatest risk to boaters. The remaining understory vegetation would be left in place.

Table 2. Vegetation Clearing By Action Alternative (Acres)

Landing Location	Dam Raise Alternatives					
	CP1		CP2		CP4A	
	Overstory Removal (acres)	Complete Removal (acres)	Overstory Removal (acres)	Complete Removal (acres)	Overstory Removal (acres)	Complete Removal (acres)
Antlers	5	8	8	12	12	17
Bailey Cove	7	17	11	26	15	37
Beehive Point	24	3	38	4	54	6
Bridge Bay	0	9	0	14	0	20
Digger Bay	31	8	49	13	70	19
Hirz Bay	22	22	34	35	49	49
Jones Valley	51	17	81	26	116	38
Lakeshore East	2	17	4	27	5	39
Lower Salt Creek	15	14	24	22	35	31
McCloud Arm	0	4	0	7	0	10
Packers Bay	22	7	35	11	50	16
Pit Arm	0	2	0	3	0	4
Shasta Marina	13	1	21	2	30	2
Silverthorn	18	17	29	26	41	37
Turntable	8	5	13	8	19	11
Total	220	150	347	236	495	337

(CP4A = CP3, CP4, CP5)

Designated areas of the inundation zone would be left untreated with no vegetation removed. This prescription would generally be applied to stream inlets, the upper end of major drainages, the shoreline of wider arms of the reservoir, and special habitat areas. This treatment is intended to maximize the habitat benefits of inundated and residual vegetation.

Before any enlargement of Shasta Dam, existing structures on the dam crest would need to be removed. These structures include the gantry crane, existing spillway drum gates and frames, the spillway bridge, concrete in the spillway crest and abutments, upstream parapet walls, sidewalks, curbing, crane rails, and control equipment. Modifications to the TCD would be performed to minimize impacts to reservoir operations to the extent possible, but supplemental cold water releases would likely be required through the river outlets during portions of the construction period. This preparatory work would be similar for all comprehensive plans.

Zoned embankment wing dams were originally constructed on both abutments of the main dam to protect the contact between the concrete and the excavated foundation surface. The left wing dam would be raised to maintain the same height above the top of joint-use storage. This would involve extending the existing reinforced-concrete core wall to the raised dam crest, and placing a thick layer of large rockfill downstream from the core wall.
Modifications to the TCD would be needed for all action alternatives. Modifications would primarily involve extending the main steel structure to the new full pool elevation; raising the TCD operating equipment, including gate hoists, electrical equipment, miscellaneous metalwork, and hoist platform above the new top of joint-use elevation; installation of additional cladding on the existing and raised sections of the TCD; and lengthening/replacing shutter operating cables.

Table 3. Site Clearing and Grubbing Below Dike (acres)

Dike Features	CP1	CP2	CP3, CP4, CP4A, CP5
Lake Shore Dikes / Railroad Embankments			
Doney Creek Dike			
Site clearing and grubbing below dike	-	1.5	7.2
Antlers Dike			
Site clearing and grubbing below dike	-	-	0.9
North Railroad Embankment			
Site clearing and grubbing below dike	1.2	1.2	1.2
Middle Railroad embankment			
Site clearing and grubbing below dike	2.9	2.9	2.9
South Railroad Embankment			
Site clearing and grubbing below dike	6.2	6.2	6.2
Bridge Bay Dikes			
West Dike			
Site clearing and grubbing below dike	0.8	1.4	2.2
East Dike			
Site clearing and grubbing below dike	0.4	0.6	1.1
Total	11.5	13.8	21.7

The proposed reservoir area dikes and railroad embankment would be constructed using common earthmoving equipment and methods. Additional excavation to provide working surfaces and keys for the embankment fill would be required along the slope of the upstream foundation for some of the proposed dikes. Ground treatment and/or over-excavation may be necessary in some areas to remove and/or treat pervious material. Riprap would be placed on the upstream face of each dike to the crest of the dike to protect against wave run-up and erosion (Table 3).

Relocations

As a result of the proposed Shasta Dam raise under the CPs, the following major features would be inundated by the increase in full pool elevation:

- Roadways
- Vehicle bridges
- Railroad bridges
- Recreation facilities
- Utilities and miscellaneous minor infrastructure

Existing infrastructure affected by enlarging Shasta Dam and reservoir under any of the comprehensive plans would need to be removed and/or relocated.

Roadways

The action alternatives would result in as many as six roadway relocations; CP1 would result in four roadway relocations and the other alternatives would all account for six relocations (Table 4).

Roadway construction activities would involve, but not be limited to, demolition of existing roadways as required; clearing, grubbing, and site preparation of work areas, as required; grading road alignments to meet finished grades; placing road subgrade; paving operations; installing storm drain culverts; constructing retaining wall systems; installing road appurtenances such as guardrails; performing construction-related traffic control; and establishing and maintaining a Stormwater Pollution Prevention Plan. Typical noise would result from trucks and diesel-powered equipment.

Replacement roadways would be constructed by excavating the existing up-grade slope to provide fill material for the embankment fill portion of road construction; bench-excavating into the up-grade slope above the existing roadway to establish the new road finished grade; building the new road on an engineered fill embankment from imported borrow material; or building the new road directly above the existing road on an engineered fill embankment from imported borrow material. A road alignment may either use a single method of construction for the entire alignment, or use all four methods at different locations along an alignment.

Estimated work limits for road segment depend on the surrounding terrain, and vary from a minimum of 5 feet to 30 feet wide, measured from the extent of earthwork. Where the road would be constructed as an embankment fill against an existing steep hillside, a 5-foot-wide minimum work area would be used. Where the terrain beyond the limit of earthwork was flat enough to be used as work areas for construction equipment, the work limits would range from 15 feet to 30 feet wide.

Vehicle Bridges

As a result of raising Shasta Dam for any of the action alternatives, the following local road vehicle bridges would be replaced:

- Charlie Creek Bridge
- Doney Creek Bridge
- McCloud River Bridge
- Didallas Creek Bridge

Construction would take place during the low-water season, and is expected to last about 12 months. The waterway would remain clear for navigation during construction. Bridge construction would begin with piers and abutments. To allow underwater construction of pier foundations, steel pile shells would be driven into the lake bed to create a temporary cofferdam. A hole would then be drilled to the specified foundation depth. Reinforcing steel would be installed within the shells before concrete was poured. After completion of the piers and abutments, construction of the superstructure and bridge deck would begin via the balanced cantilever method. This process entails forming and constructing the horizontal structure outward from the piers in each direction, in equal (balanced) proportions, until the superstructure/deck segments meet at midspan.

Table 4. Physical Features for Proposed Road Relocations for Action Alternatives

Road Relocation Features	CP1	CP2	CP3, CP4, CP4A, CP5
Lakeshore Drive			
Number of Road Segments Affected	4	6	8
Length (linear feet)	8,100	13,100	13,700
Clearing and Grubbing (acres)	4	7	7
Excavation to Embankment (cubic yards)	46,100	55,100	55,500
Embankment Fill (cubic yards)	122,800	171,800	174,900
Turntable Bay Area			
Number of Road Segments Affected	3	3	3
Length (linear feet)	6,200	6,200	6,200
Clearing and Grubbing (acres)	2	2	2
Excavation to Embankment (cubic yards)	19,000	19,000	19,000
Embankment Fill (cubic yards)	76,200	76,200	76,200
Gillman Road			
Number of Road Segments Affected	-	3	3
Length (linear feet)	-	1,200	1,200
Clearing and Grubbing (acres)	-	1	1
Excavation to Embankment (cubic yards)	-	0	0
Embankment Fill (cubic yards)	-	22,800	22,800
Jones Valley and Silverthorn Area			
Number of Road Segments Affected	-	-	3
Length (linear feet)	-	-	1,600
Clearing and Grubbing (acres)	-	-	1
Excavation to Embankment (cubic yards)	-	-	1,500
Embankment Fill (cubic yards)	-	-	13,200
Salt Creek Road			
Number of Road Segments Affected	-	4	5
Length (linear feet)	-	4,300	5,100
Clearing and Grubbing (acres)	-	1	1
Excavation to Embankment (cubic yards)	-	4,100	5,500
Embankment Fill (cubic yards)	-	31,700	33,100
Remaining Road Relocations			
Number of Road Segments Affected	3	5	8
Length (linear feet)	2,500	3,500	5,200
Clearing and Grubbing (acres)	0.4	1	2
Excavation to Embankment (cubic yards)	15	120	600
Embankment Fill (cubic yards)	36,400	70,000	81,000

- = not applicable

Barges would be used extensively for vehicular bridge foundation construction, bridge assembly, transport of materials, workers, and equipment, and demolition of the existing bridges. Concrete would be poured from barges. A staging area would be required on the lakeshore, from which barges could be loaded and unloaded.

Fender's Ferry Bridge would not need to be replaced as a result of the Shasta Dam raises. However; modifications to the bridge would be necessary, as at the proposed full pool elevation, the eastern pier steel tower would be inundated. The existing reinforced concrete pier and footing would be enlarged and extended, and the existing steel tower modified to prevent inundation as a result of the higher full pool levels associated with the dam raise alternatives under consideration. Construction activities would likely be completed from the existing embankment without constructing cofferdams around the pier because average water surface elevations are below the existing eastern pier bottom-of-footing elevation for all months, with the exception of April and May. Construction of temporary bents to support the superstructure would be necessary to facilitate construction of the pier modifications.

Railroad Bridges

Pit River Bridge Pier Modification

The Pit River Bridge is a multipurpose structure, carrying both Union Pacific Railroad (UPRR) and I-5 traffic. The new full pool elevations would inundate the existing bridge bearings and low-chord steel truss members. To prevent the existing steel bearings and lower portions of the steel truss members from being submerged, a watertight concrete tub structure (bearing protection structure) would be required. The reinforced concrete structure would be attached to the top of two existing concrete piers. The structure footprint would be rectangular, with the top of the structure above the full pool elevation.

Union Pacific Railroad Bridges

The superstructures for the existing Sacramento River Second Crossing and Doney Creek railroad bridges consist of deck truss bridges with a single track. Portions of both bridges would be submerged for any reservoir raise and would need to be replaced with new, higher superstructures. The proposed new bridge superstructures would be composite superstructures consisting of steel plate girders and a reinforced concrete deck, with a requirement for 16 feet of vertical clearance between the two westernmost piers for the Sacramento River Second Crossing railroad bridge (with a minimum width of 30 feet), to allow for the passage of houseboats (No minimum clearance for houseboat traffic would be required for the Doney Creek railroad bridge). The Sacramento River Second Crossing railroad bridge would require nine spans, with a total length of 982 feet between concrete abutments. The Doney Creek railroad bridge would require five spans, with a total length of 537.5 feet between concrete abutments.

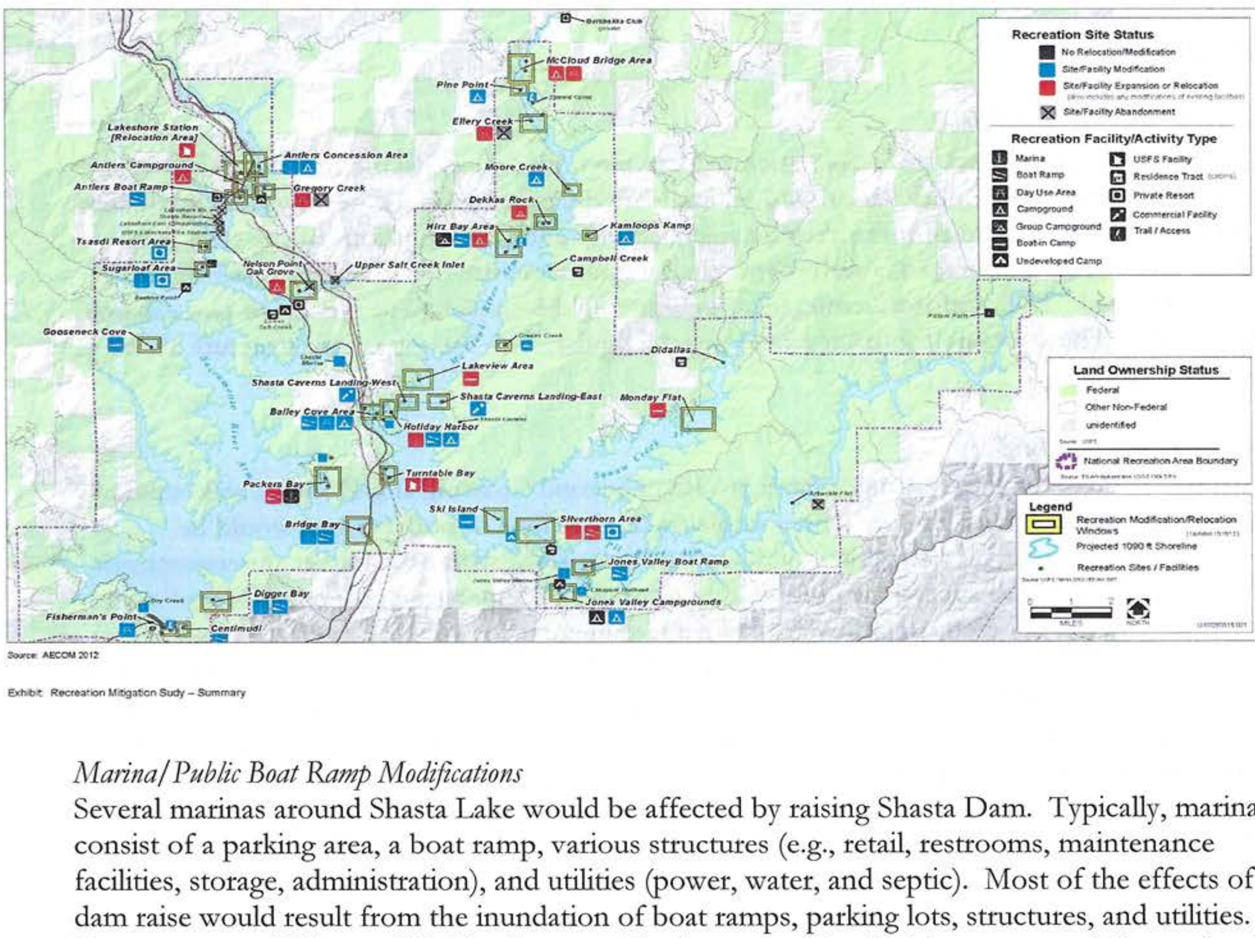
The proposed relocation of the UPRR bridges would require that the railroad tracks be realigned between the two bridges. This realignment would parallel the existing tracks with a 25-foot offset to the east.

Recreation Facilities

Any raise of Shasta Dam would have some effect on the many recreation features found along the reservoir shoreline. These features include marinas/boat ramps, resorts, campgrounds/day use areas, and cabins, trails, and U.S. Forest Service (USFS) facilities (Figure 1). Areas for potential recreation relocations (referred to as windows) and corresponding relocation plans for each window have been developed.

Action alternatives would, at minimum, maintain the existing recreation capacity at Shasta Lake. Inundated recreation facilities and associated utilities would be relocated before demolition to the extent practicable (Table 5).

Figure 1. Recreation Study Windows



Source: AECOM 2012

Exhibit: Recreation Mitigation Sudy – Summary

Marina/Public Boat Ramp Modifications

Several marinas around Shasta Lake would be affected by raising Shasta Dam. Typically, marinas consist of a parking area, a boat ramp, various structures (e.g., retail, restrooms, maintenance facilities, storage, administration), and utilities (power, water, and septic). Most of the effects of the dam raise would result from the inundation of boat ramps, parking lots, structures, and utilities. Boat ramps would be modified in place, on fill, where possible. Parking areas would be replaced on fill, or relocated above the new reservoir elevation. Existing structures that would be inundated would be demolished, and either replaced above the reservoir elevation (upslope or on placed fill), or moved to a floating structure on the water to provide better access for recreational users. Any access roads would be relocated above the new full pool for continued access around the marinas. Existing septic systems that would be inundated would be demolished and removed from the area or relocated. New facilities could also be connected to new localized wastewater treatment facilities. Power lines would be installed to accommodate new structure.

Marinas and public boat ramps that could not be modified in place would be relocated to adjacent areas that can provide the necessary grade and access for ramps. To maintain current recreation capacity of public boat ramps and/or marinas, the following potential new or expanded areas could be used:

- Antlers Boat Ramp and Adjacent Marina Area
- Silverthorn Marina Area
- Turntable Bay Area
- Holiday Harbor

Table 5. Recreation Facilities to be Modified or Relocated under Action Alternatives

Recreation Facilities	CP1	CP2	CP3,CP4, and CP4A	CP5
Marinas/Public Boat Ramps				
Number of Affected Facilities (marinas/boat ramps)	9/6	9/6	9/6	9/6
Relocation Needed[1] (acres)	8.5	8.5	8.5	8.5
Replacement Structures (square feet)	49,900	49,900	49,900	49,900
Campsites and Day-Use Sites				
Number of Affected Facilities (resorts/campsites and day-use sites)	202	261	328	328
Relocation Needed[1] (acres)	32	34	39	39
Replacement Structures (square feet)	6,200	6,200	6,200	6,200
Resorts/USFS Facilities				
Number of Affected Facilities (resorts/USFS facilities)	6/2	6/2	6/2	6/2
Relocation Needed[1] (acres)	19	19	19	19
Replacement Structures (square feet)	41,000	52,800	68,900	68,900
Trailheads/Trails				
Number of Affected Facilities[2] (trails/trailheads)	2/9	2/9	2/9	2/9
Relocation Needed[1] (miles)	8.1	9.9	11.6	11.6
Replacement Enhancement[3] (square feet)	-	-	-	6/18

Note:
[1] Does not include on-site modifications of facilities.
[2] For some trails, trailheads are integrated into other recreation facilities. Estimates for standalone trailheads only.
[3] Additional recreation facilities for Alternative CP5 only.

Resort Modifications
Raising Shasta Dam would affect six resorts around the reservoir to some degree. Inundated structures and structures within 3 vertical feet of the new full pool would be demolished. Septic systems would also be demolished, and remaining structures would either be connected to new localized wastewater treatment facilities or would be relocated to other septic systems.

Campground/Day Use Area Modifications
Four undeveloped areas have been identified as potential campgrounds to replace capacity lost because of inundation. Some inundated campgrounds would be reestablished on fill at their existing location, others would be moved around the reservoir to new locations identified as potential campground sites. To maintain the current recreation capacity of campgrounds, the following potential new or expanded areas could be used:

- Antlers Campground
- Oak Grove Campground
- Hirz Bay Campground
- McCloud Bridge Area

The following potential new or expanded areas could be used to meet the need for boat-in campgrounds:

- Former Lakeview Marina Area
- Monday Flat Boat-In Camp

The following potential new or expanded areas could be used to meet the need for day-use areas:

- Ellery Creek Campground
- Gregory Creek Campground
- McCloud Bridge Area

U. S. Forest Service (USFS) Facilities Modifications
Recreation within the Whiskeytown-Shasta-Trinity National Recreation Area is managed by USFS, which has several facilities located throughout the reservoir area. USFS facilities consist of various storage and maintenance buildings and equipment, fire protection equipment, customer service facilities, office space, and employee living facilities. Two USFS facilities would be inundated and would require relocation or replacement. The station located in the Lakeshore area would be inundated by a Shasta Dam raise, and would be relocated to an area above the new full pool. The inundated facility would be demolished, and hauled to waste. The USFS facility at Turntable Bay would also be inundated by a Shasta Dam raise. Space at Turntable Bay would allow the facility to be relocated on fill in its current location.

Nonrecreation Structures

Under all SLWRI CPs, nonrecreational residential and commercial structures affected by inundation would require demolition. Asbestos material, if discovered, would be removed and taken to an approved landfill for disposal per permit requirements. General demolition waste would also be removed and trucked to an approved landfill.

Utilities and Miscellaneous Minor Infrastructure

Gas/petroleum facilities, potable water facilities, power and telecommunications infrastructure, and wastewater facilities (Table 6) would be relocated if affected physically by inundation or if the facilities (such as septic systems) would no longer meet Shasta County Development Standards.

Table 6 . Physical Features for Proposed Utilities Relocations for Action Alternatives

Utility Type	CP1	CP2	CP3, CP4, CP4A, and CP5
Potable Water facilities			
Length of Waterlines relocated (linear Feet)	7,200	8,500	11,000
Wells/Tanks relocated (number)	12	13	10
Pump Stations Relocated (number)	2	2	3
Length of Waterline Demolished (liner Feet)	8,900	11,200	14,800
Wells/Tanks Demolished (number)	16	28	25
Pump Stations Demolished (number)	2	2	3
Gas/Petroleum Facilities			
Tanks Relocated (number)	7	10	10
Tanks Demolished (number)	7	10	10
Wastewater Facilities			
Septic Systems Relocated[1] (number)	14	19	19
Vault/Pit Toilets Relocated (number)	2	2	2
Pump Stations Relocated (number)	1	1	1
Length of Wastewater Pipe Relocated (linear feet)	400	400	430
Septic Systems Demolished[2] (number)	211	239	266
Vault/Pit Toilets Demolished (number)	2	2	2
Pump Stations Demolished (number	2	2	2
Length of Wastewater Pipe Demolished (linear feet)	2,300	2,300	2,400
Package Wastewater Treatment Plants[3] (number)	Up to 6	Up to 6	Up to 6
Power Distribution Facilities			
Power Lines Relocated (linear feet)	34,520	40,565	42,050
Power Towers Relocated (number)	11	11	11
Power Lines Demolished (linear feet)	33,227	40,565	43,045
Power Towers Demolished (number)	26	26	26
Telecommunications			
Copper Wire Relocation (linear feet)	27,900	30,200	33,400
Fiber-Optic Cable Relocation (linear Feet)	4,300	5,800	5,800
Copper Wire Demolished (linear feet)	23,600	27,800	31,200
Fiber-Optic Cable Demolished (linear feet)	3,600	5,200	5,200

Notes:

[1] Does not include septic systems replaced with new sewer connections.

[2] Includes demolition of septic systems to be relocated, replaced with new sewer connections, and removed without relocation or replacement.

3 Includes additional lift stations, force main, laterals, and holding tank pumps/valves not shown.

Relocated facilities would be of the same types, sizes, and materials as existing facilities where feasible. For relocation of wastewater treatment facilities, new septic systems may be constructed on the property if they meet Shasta County requirements for separating septic systems from the lake. Otherwise, the CPs include facilities for pressurized sewer collection systems to transport wastewater flows to centralized package wastewater treatment plants.

Spawning Gravel Augmentation under CP4, CP4A, and CP5

Under CP4, CP4A, and CP5, gravel augmentation would occur at one to three locations between Keswick Dam and the RBPP every year for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. Construction activities would vary significantly by location, but generally would include clearing, grubbing, and some grading of new access routes to allow construction vehicles to access the river. At several locations, clearing and grubbing of the riverbank would be required to allow gravel to be placed on the bank for recruitment. Gravel would be delivered to the locations by dump trucks. In most cases, gravel would be stockpiled in a staging area and moved with bulldozers, loaders, and/or excavators. Dust control trucks would be present during all construction activities.

Several locations would require in-water construction work. This would involve building gravel out into the river channel "step-wise," meaning that gravel is dumped and leveled, and the leveled area serves as a working platform for the next step of construction. This practice is common for spawning gravel placement, and minimizes the extent to which construction vehicles drive directly through an active river channel. One or two locations, however, would require construction activity in the active river channel, where construction vehicles would deposit gravel and raise the grade of the river near existing riffles.

Riparian, Floodplain, and Side Channel Habitat Restoration under CP4, CP4A, and CP5

Under CP4, CP4A, and CP5, riparian, floodplain, and side channel habitat restoration would be constructed at one or more suitable locations along the upper Sacramento River to benefit anadromous fish and other aquatic and riparian species. Several potential sites exist along the upper Sacramento River between Keswick Dam and RBPP that would be suitable for restoration measures, but no site has been committed to. In addition, all of the sites included and described are already included in the Upper Sacramento River Anadromous Fish Habitat Restoration Program (USBR 2015) as restoration sites and projects under the CVPIA. Construction activities for riparian, floodplain, and side channel habitat restoration would vary depending on the location or locations selected and type of restoration measure to be implemented at the site. In general, construction activities would include earth moving activities with bulldozers, loaders, excavators, and/or compactors. Vegetation removal may also be necessary at some sites, either for channel deepening/widening, or where water with aquatic vegetation is present in a channel pending modification.

Special precautions for restoration at these sites would primarily involve:

- Maintaining the active spawning areas in proximity to the site

- Avoiding the creation of habitat for predacious fish
- Minimal disruptions to navigability of the river
- Preventing the spread of invasive, non-native plant species
- Ensuring the safety of homes located along the Sacramento River downstream of the sites

Following are the potential sites and construction measures proposed for restoration of riparian, floodplain, and side channel habitat at each. It is currently uncertain which, or if any of the following restoration projects would be included in a final project, and whether or not they would be beyond the mitigation requirements for the downstream effects from an enlargement of Shasta Dam and the corresponding changes in water management.

Henderson Open Space

An existing side channel to the main stem of the Sacramento River would be enhanced to activate the frequency and duration of flows for Chinook salmon spawning habitat within a portion of Henderson Open Space Park. The enhancement would involve modifying the northern opening to the existing side channel to restore connectivity with the river at flows greater than 8,000 cubic feet per second (cfs). Minor grading and channel slope modification would be necessary to rework the existing (sometimes inundated) channel to the point at which flows may be activated for spawning habitat.

The existing Henderson Open Space side channel is heavily vegetated. Floodplain terraces and adjacent riparian areas would be replanted with native vegetation after the completion of earth-moving activities. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. To varying degrees, temporary fencing and irrigation would be necessary to protect and sustain newly established riparian vegetation.

Tobiasson Island

A regularly flowing side channel would be created to increase spawning habitat for all runs of Chinook salmon at Tobiasson Island. Creating this side channel would involve excavating a trapezoidal-shaped channel, the base of which would correspond to an elevation that would allow flows of 5,000 cfs or greater to enter the side channel, hence hydraulically connecting it to the Sacramento River. If created, this new side channel would add about 1,350 linear feet of salmonid spawning habitat to this section of the Sacramento River.

The potential site for the channel to be cut does not currently have flowing water or riparian vegetation; therefore, vegetation removal would not be necessary. However, upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is not feasible because the site lacks water supply and electricity.

Shea Island Complex

Restoration at the Shea Island Complex would involve lowering a section of the upstream end of the major side channel through the site. The objective would be to keep water moving through the channel when the Sacramento River reaches flows of 10,000 cfs or greater, thus enhancing salmonid spawning habitat.

Additionally, removal of vegetation and debris would be necessary in both the excavated portion of the channel and other portions of the channel to insure the connectivity of flows. Minor grading activity could increase channel complexity along the length of the corridor. Upon completion of earth-moving activities, it would be necessary to establish native vegetation throughout the side channel on the newly created floodplain terraces. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary irrigation and fencing for vegetation planting at this site is not feasible because the site lacks a water supply and electricity.

Kapusta Island
An existing side channel on Kapusta Island would be enhanced to increase spawning habitat for winter-run and spring-run Chinook salmon in the Sacramento River. This enhancement would involve lowering the channel bed so that the channel may be hydraulically connected to the Sacramento River when the river is flowing in excess of 10,000 cfs.

A trapezoidal cut would need to occur along the course of the side channel, which is inundated only infrequently; in addition, vegetation and debris would need to be removed. Upon completion of earth-moving activities, establishing vegetation on new floodplain terraces and adjacent riparian areas with native plants would be necessary. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings. Temporary fencing or irrigation at this site for newly established riparian vegetation is infeasible and a planting mix would need to be selected with this limitation in mind.

Anderson River Park
Restoring floodplain, riparian and side channel habitat at Anderson River Park would involve altering a relic Sacramento River side channel located in the southeastern portion of the park at river flows at, or above 8,000 cfs. The side channel rearing habitat would be created by altering the upstream end of the side channel to capture flows. At present, the side channel is seasonally inundated, but likely by way of seepage from the river through alluvial material. Riparian vegetation and appurtenant biota are at this site; therefore, removal of vegetation to lower the channel bed would be necessary, followed by post excavation replanting of native riparian vegetation.

Reading Island
Restoring floodplain, riparian, and side channel habitat at Reading Island would involve hydraulically reconnecting Anderson Creek with the Sacramento River at flows ranging between 4,000 cfs and 6,000 cfs. To restore Sacramento River flows through Anderson Creek, it would be necessary to breach the levee that creates Anderson Slough, then clearing and excavating the side channel to ensure flows through the channel. This would involve removing vegetation and debris and deepening the existing channel.

After excavation, floodplain terraces and adjacent riparian areas would need to be vegetated with native plants. This would require temporary irrigation and fencing to sustain plantings and keep livestock off site. A more detailed site analysis would determine the mix, composition, and density of the riparian vegetation plantings.

All of the above proposed, potential restoration sites would require adaptive, long-term management plans, including appropriate funding in perpetuity, to ensure that any restoration efforts made would not be allowed to degrade and become dysfunctional as habitat for salmonids and riparian wildlife.

Shasta Lake Tributary and Shoreline Enhancement under CP5

Structural enhancements associated with CP5 include placing brush structures constructed from whiteleaf manzanita (*Arctostaphylos manzanita*) in the Shasta Lake littoral zone (Table 7). Because of manzanita's density, installation would not require using anchor or cabling techniques that could result in ancillary negative impacts (e.g., maintenance, hazards to boaters). The brush structures would be assembled in the drawdown zone of the reservoir in an area that would be inundated as the reservoir surface elevation rises in fall. The brush structures are expected to be about 1,800 cubic feet in size. The establishment period would be the first year after construction; life span of the brush structures is projected to be 10 years. Currently no information has been provided as to what benefit these structures would provide after their 10-year life span.

Selection of specific locations has been deferred so that enhancement locations are consistent with other project objectives. The level of proposed treatment is based on the proportion of available manzanita surrounding Shasta Lake. In general terms, these locations would incorporate available material at locations with preferred topographic features; preferred locations are coves that offer steep drawdown areas during the primary use period (spring, early summer). This proposal is of relative short-term environmental benefit to the littoral zone, and currently there is no provision for maintaining these structures or expectations of benefits beyond their 10-year life span.

Vegetative enhancements associated with CP5 include planting willows to enhance nearshore fish habitat, and aerial and hand seeding of native grasses to treat shoreline areas at Shasta Lake.

Little more than 30 acres could be available to enhance the willow recruitment adjacent to Shasta Lake. Rooted willows would be planted in draws and other moist sites, such as springs, to provide live cover. The establishment period for willows would be the first year after construction; life span is projected to be 5 to 50 years. The establishment period for native grasses would also be the first year of construction, with the life span projected to be 1 to 3 years. This approach would require native seed and nursery stock; several years of advanced preparation would be needed before planting could take place. No information has been provided for a plan as to what is proposed as far as long-term environmental planning for the areas in which these short-term enhancement actions are proposed.

Table 7. Proposed Vegetative Enhancement Treatments of Shasta Lake under CP5

Area	Willow Planting (acres)	Native Grass Seeding (acres)
Main Body	1	2
Pit Arm	1	4
Sacramento Arm	7	4
McCloud Arm	1	2
Big Backbone Arm	3	2
Squaw Arm	1	2
Total	14	16

Construction Staging

Reclamation would establish staging areas for equipment storage and maintenance, construction materials, fuels, lubricants, solvents, and other possible contaminants in coordination with the resource agencies. Staging areas would be located within disturbed areas or at existing facilities that are expected to be inundated, such as campgrounds, recreation parking facilities, the top of Shasta Dam, and the parking area along the left wing dam, where feasible.

Staging areas would have a stabilized entrance and exit and would be located at least 100 feet from bodies of water, if possible. Should an off-road site be chosen, qualified biological and cultural resources personnel would survey the selected site to verify that no sensitive resources would be disturbed by staging activities. Should sensitive resources be found, an appropriate spatial and temporal buffer zone would be staked and flagged to avoid impacts. Where possible, no equipment refueling or fuel storage would take place within 100 feet of a body of water.

Construction Schedule, Equipment, and Workforce

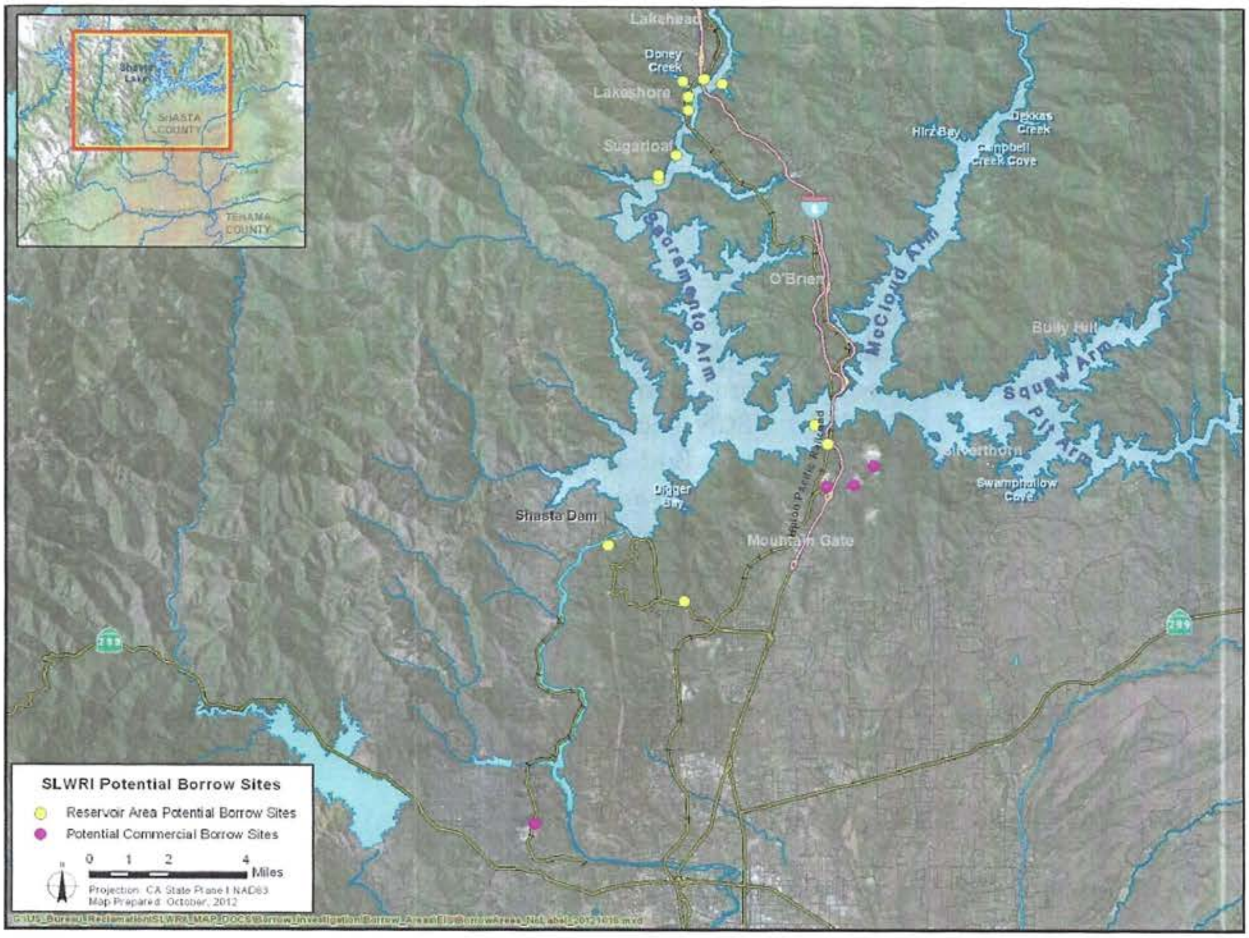
The total duration of construction for major facilities is estimated to range from 4.5 to 5 years. An overlap is expected in the timing of some of the construction components. Construction would be phased, when feasible, to avoid environmental impacts.

Construction would typically occur during daylight hours, Monday through Friday. However, construction contractors may extend these hours and schedule construction work on weekends, if necessary, to complete aspects of the work within a given time frame. Construction would require typical heavy construction equipment including excavators, backhoes, bulldozers, scrapers, graders, water trucks, front-end loaders, dump trucks, drill rigs, pump trucks, truck-mounted cranes, pickup trucks, barges, helicopters, and miscellaneous equipment. Daily highway truck trips would be required to bring construction material to the site, and carry construction debris and waste material to a suitable landfill.

Borrow Sources

Multiple borrow sources are available to meet project needs for concrete, sand and gravel, core and homogenous fill, shell fill, riprap, and filter and drain materials for reservoir area embankments. Potential borrow sources were examined at a preliminary level and would need further sampling and testing to determine suitability and refine quantity estimates. Potential borrow sources include areas of the dike construction sites, areas located below the reservoir's inundation zone, and commercial sources. Commercial sources are located within 2 to 30 miles of the Bridge Bay site, and within 15 to 43 miles of the Lakeshore site (Figure 2).

Figure 2. Potential Borrow Sources



Conservation Measures

The Service has provided recommendations for conservation measures in the "Recommendations" section of this report. Also, conservation measures identified for Multi-Species Conservation Strategy (MSCS) species and habitats in the CALFED Programmatic documents are included in Appendix C of this report. Further conservation measures may be identified through the ESA, section 7, formal consultation process. These should facilitate and aid in the development of future conservation measures by Reclamation.

EXISTING BIOLOGICAL RESOURCES

This section describes existing fish and wildlife resources and their habitat in the SLWRI project area that could be impacted by project construction activities, inundation, or changes in the operation of Shasta Dam. Because regulatory compliance documents for the SLWRI tier from the programmatic documents prepared for CALFED, the cover-types identified in the SLWRI project area (and described in the EIS [USBR 2014]) are based on the cover-types described in the CALFED MSCS document. Cover-types and habitat descriptions included in this report are generally based on those identified in the EIS (USBR 2014). These habitats and cover-types support many common and special-status wildlife species. The following briefly describes the typical biotic elements of the project area. A list of the species- and cover-type-specific conservation measures identified for MSCS species in the CALFED programmatic documents is provided in Appendix C of this report.

Special-status species are plants and wildlife that are: (1) federally-listed as endangered or threatened or a candidate for listing under ESA; (2) State-listed as endangered, threatened, or a candidate for listing under the California Endangered Species Act (CESA); (3) a California Fully Protected Species; (4) a California Species of Special Concern or on the California Department of Fish and Wildlife (CDFW) Watch List; (5) a CALFED MSCS species; (6) protected under the Bald and Golden Eagle Protection Act; (7) listed by the Service as a Bird of Management Concern under the Migratory Bird Treaty Act (50 CFR 10.13) (*e.g.*, Bird of Conservation Concern at the National or Regional level or a Game Bird Below Desired Condition [USFWS 2008]; (8) on the United States Bird Conservation Watch List (i.e., Partners in Flight Watch List, the United States Shorebird Conservation Plan Watch List, or the Waterbird Conservation for the Americas Watch List); (9) a USFS Sensitive or Survey and Manage Species; (10) a U.S. Bureau of Land Management Sensitive Species; (11) a Western Bat Working Group High or Medium Priority Species; (12) on the California Native Plant Society (CNPS) List 1A, 1B, 2, 3, or 4; (13) a NMFS Species of Concern; or (14) considered endangered or threatened by the American Fisheries Society (AFS).

<u>Primary Study Area: Shasta Lake Vicinity and Tributaries</u>

Aquatic Resources in Shasta Lake and Tributaries

The primary study area for the SLWRI includes aquatic resources in Shasta Lake and its tributaries, Trinity and Lewiston Reservoirs, Keswick Reservoir, and the upper Sacramento River between Keswick Dam and the RBPP, including tributaries at their confluence. Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries enter the Sacramento River downstream from the dam. Stream gages located on various uncontrolled tributaries help the operators of Shasta Dam adjust releases to accommodate downstream peak flows. The influence of Shasta's operation on reducing peak flood flows on the Sacramento River diminishes with distance downstream, largely due to these uncontrolled tributaries. Operations of Shasta Dam are the primary factor controlling flow in the Sacramento River, although only the portions of the Sacramento River upstream of the RBPP are included in the primary study area. Table 8 shows fish species known to occur in the primary study area.

Shasta Lake and Keswick Reservoir fish species include warm and cold water species. Shasta Lake tributary species comprise planted and wild trout and several native species. Major non-fish aquatic animal species assemblages of the study area are the benthic macroinvertebrates of Shasta Lake, the Sacramento River, and tributaries to Shasta Lake, and the zooplankton of the reservoirs (USBR 2013).

The fisheries resources of Shasta Lake are greatly affected by the reservoir's thermal structure. During summer months, the epilimnion (warm surface layer) is 30 feet deep and up to 80°F. Water temperatures above 68°F favor warm water fishes such as bass and catfish. Deeper water layers, which include the hypolimnion and the metalimnion (transition zone between epilimnion and the hypolimnion), are colder and suitable for cold water species. Shasta Lake is classified as warm monomictic because it has one period of mixing per year. The warm water fish habitats of Shasta Lake occupy two ecological zones: the littoral (shoreline/vegetated) and the pelagic (open water) zones. The littoral zone lies along the reservoir shoreline down to the maximum depth of light penetration on the reservoir bottom, and supports populations of spotted bass, smallmouth bass, largemouth bass, black crappie, bluegill, channel catfish, and other warm water species.

The upper, warm surface layer of the pelagic (open water) zone is the principal plankton-producing region of the reservoir. Plankton comprises the base of the food web for most of the reservoir's fish populations. Operation of the Shasta Dam TCD, which helps conserve the reservoir's cold water pool by accessing warmer water for storage releases in the spring and early summer, may reduce zooplankton biomass, which resides primarily in the reservoir's warmer surface water layer (USBR 2011a).

The deeper areas of Shasta Lake, hypolimnion and metalimnion, support cold water species such as rainbow and brown trout and landlocked Chinook and kokanee salmon. Native species such as white sturgeon, Sacramento blackfish, hardhead, rough sculpin, Sacramento sucker, and Sacramento pikeminnow reside in cold water. Trout may congregate near the mouths of the reservoir's tributaries, including the upper Sacramento River, McCloud River, Pit River, and Squaw Creek, when inflow temperatures of these streams are favorable (USBR 2007). The lower reaches of the reservoir's tributaries also provide spawning habitat for reservoir fish populations, and have important resident fisheries of their own (rainbow trout is the principal game species). Most native

Table 8. Native Fish Species Known to Occur in the SLWRI Project Area.

Common Name	Scientific Name	Shasta Lake/ Tributaries	Sacramento River & Tributaries	Delta	Status[3]
Special-Status Fish Species					
Sacramento River Winter-run Chinook Salmon ESU[1]	*Oncorhynchus tshawytscha*		X	X	FE, CE, R
Central Valley Spring-run Chinook Salmon ESU[1]	*Oncorhynchus tshawytscha*		X	X	FT, CT, R
Central Valley Fall-run Chinook Salmon ESU[1]	*Oncorhynchus tshawytscha*		X	X	CSC, R
Central Valley Late Fall-run Chinook Salmon ESU[1]	*Oncorhynchus tshawytscha*		X	X	CSC, R
California Central Valley Steelhead DPS[2]	*Oncorhynchus mykiss*		X	X	FT, R
North American Green Sturgeon Southern DPS[2]	*Acipenser medirostris*		X	X	FT,CSC, R,AFE
White sturgeon	*Acipenser transpacificus*	X	X	X	AFT
Rough sculpin	*Cottus asperrimus*	X			CT,CFP,m
River lamprey	*Lampetra ayresi*		X	X	CSC
Sacramento splittail	*Pogonichthys macrolepidotus*		X	X	CSC, R
Hardhead	*Mylopharodon conocephalus*	X	X	X	CSC, m, USFS
Delta smelt	*Hypomesus transpacificus*			X	FT,CT, R
Longfin smelt SF Bay-Delta DPS[2]	*Spirinchus thaleichthys*			X	FC,CC,CSC,R,AFT
Sacramento perch	*Archoplites interruptus*			X	CSC,r
McCloud redband trout	*Oncorhynchus mykiss ssp.2*	X			CSC,m, USFS
River Lamprey	*Lampetra ayresi*		X	X	CSC

Table 8. Native Fish Species Known to Occur in the SLWRI Project Area (cont.).

Common Name	Scientific Name	Shasta Lake/ Tributaries	Sacramento River & Tributaries	Delta	Status[3]
Common Native Fish Species					
Chinook salmon (landlocked)	*Oncorhynchus tshawytscha*	X			
Tule perch	*Hysterocarpus traski*		X	X	
Rainbow trout	*Oncorhynchus mykiss*	X	X	X	USFS
Sacramento sucker	*Catostomus occidentalis*	X	X	X	
Sacramento pikeminnow	*Ptychocheilus grandis*	X	X	X	
California roach	*Lavinia symmetricus*		X	X	
Hitch	*Lavinia exilicauda*	X	X	X	
Sacramento blackfish	*Orthodon microlepidotus*	X	X	X	
Pacific lamprey	*Lampetra tridentata*		X	X	
Speckled dace	*Rhinichthys osculus*	X	X		
Riffle sculpin	*Cottus gulosus*	X	X	X	
Prickly sculpin	*Cottus asper*		X	X	
Threespine stickleback	*Gasterosteus aculeatus*		X	X	
Pacific staghorn sculpin	*Leptocottus armatus*			X	
Starry flounder	*Platichthys stellatus*			X	
Topsmelt	*Atherinops affins*			X	

[1] ESU = Evolutionarily Significant Unit [2] DPS = Distinct Population Segment

[3]Status Definitions:

State: CSC = California Species of Special Concern, CE = California Endangered, CT = California Threatened, CC = Candidate for Listing under California ESA, CFP = California Fully Protected Species

Federal: FT = Federal Threatened, FE = Federal Endangered, FSC = Federal Species of Concern, FC= Federal Candidate USFS = U.S. Forest Service Sensitive

American Fisheries Society (AFS): AFE = AFS Endangered, AFT = AFS Threatened

CALFED: m = CALFED MSCS Maintain goal species. Ensure that any adverse effects on the species that could be associated with implementation of CALFED actions will be fully offset through implementation of actions beneficial to the species; R = CALFED MSCS Recovery goal species. Recover species' populations within the MSCS focus area to levels that ensure the species' long-term survival in nature; r = CALFED MSCS Contribute to recovery goal species. Implement some of the actions deemed necessary to recover species' populations within the MSCS focus area.

species found in the reservoir also inhabit the lower reaches of the tributaries. One of the species, the hardhead, is classified as a State of California Species of Special Concern. The McCloud River once supported a population of bull trout, which is currently a Federal and State listed species. The free-flowing stretches of the McCloud River were protected in 1989 under the California Wild and Scenic River Act (Public Resources Code Section 5093.50). A few creeks on the western shore of the reservoir are devoid of biological life due to toxic effluent from local mines (USBR 2007). Shasta Lake contains about 420 miles of shoreline with 1,681 identified riverine features entering the lake. In 2002 – 2003, consultants from NSR conducted fluvial geomorphic assessments within the

Inundation Zone of 13 of the major tributaries entering Shasta Lake (NSR 2004). All of the reaches except Big Backbone Creek and the Sacramento River are underlain by shallow bedrock.

Keswick Reservoir, an afterbay to Shasta Lake, receives metal-laden acid mine drainage (aluminum, cadmium, copper, iron, and zinc) from abandoned mines in the Spring Creek drainage predominantly from the Iron Mountain Mine Superfund site (U.S. Environmental Protection Agency [USEPA] 1996). Remediation on the site since 1983 has reduced metal loading by more than 97 percent (EPA 2013). The discharge of the acid-mine-drainage into Keswick Reservoir produces sediments containing aluminum, cadmium, copper, iron, and zinc. Managing the reservoir and the power plant for peak hydroelectric power generation requires lowering Keswick Reservoir, which can expose the sediments to scouring action, potentially mobilizing metals in the water column and creating conditions toxic to aquatic organisms (Fujimara *et al.* 1995, Finlayson *et al.* 2000). Prior to remediation, uncontrolled discharge of acid-mine drainage from the Iron Mountain Mine resulted in at least 20 major fish-kill events in the Sacramento River since 1963 (CH2M-Hill 1992, USEPA 2006); 100,000 or more fish were killed by acid mine drainage from Iron Mountain Mine on three separate occasions in 1955, 1963, and 1964 (CH2M-Hill 1992, USEPA 2006). The only known spawning habitat for the endangered winter-run Chinook salmon occurs in the Sacramento River immediately downstream from Keswick Reservoir down to the RBPP (Moyle 2002). The EPA dredged contaminated sediments from the Spring Creek arm of Keswick Reservoir in 2009 – 2010, that has reduced risk of water quality impairment downstream and reduced constraints on management of Keswick Reservoir water levels (EPA 2013). However, the interim remedy still relies on Reclamation's water management actions to provide for the safe release of the continuing Iron Mountain Mine contaminant discharges from the Boulder Creek watershed (EPA 2013).

Special-status Aquatic Species in Shasta Lake and Tributaries

Special-status fish species in Shasta Lake and its tributaries that may be affected by the SLWRI are hardhead and rough sculpin. Special-status aquatic mollusks with the potential to occur near Shasta Lake are summarized below. A more detailed discussion of these special-status species is included in Appendix D of this report. The conservation measures recommended by the CALFED Programmatic Final EIR/EIS and ROD (CALFED 2000a,b) are included for the special-status CALFED MSCS species in Appendix C of this report.

Survey and Manage Aquatic Mollusks near Shasta Lake

There are seven USFS Survey and Manage aquatic mollusks with the potential to occur near Shasta Lake: canary duskysnail (*Lyogyrus sp. 3*), Shasta Springs pebblesnail (*Fluminicola sp. 16*) (now Shasta pebblesnail (*F. multifarious*)), flat-top pebblesnail (*Fluminicola sp. 15*) (now Shasta pebblesnail (*F. multifarious*)), disjunct pebblesnail (*Fluminicola sp. 17*) (now Shasta pebblesnail (*Fluminicola multifarious*)), Potem Creek pebblesnail (*Fluminicola potrmicus*) (prior to 2007 known as "Potem pebblesnail (*Fluminicola sp. 14*)"), globular pebblesnail (*Fluminicola sp. 18*), nugget pebblesnail (*Fluminicola seminalis*), cinnamon juga (*Juga (Orebasis) sp.3*), and knobby rams-horn (*Vorticifex sp. 1*). On March 13, 2008, the Center for Biological Diversity petitioned for listing under the ESA the 9 aquatic mollusks among 23 other snails and slugs in the Pacific Northwest (Center for Biological Diversity 2008a,b). On

September 18, 2012, the Service issued a 12-month Finding that 8 of the 14 aquatic mollusks were not listable entities because they have not been formally described as species or subspecies and that the remaining 6 did not warrant listing (USFWS 2012b).

Canary Duskysnail

The canary duskysnail is restricted to major springs of the Pit River Drainage in Shasta, Lassen, and Modoc counties, California. The snail occurs in shallow water in very large springs on the underside of loose but stable boulders and cobbles which often have encrusting red algae. Threats to the snail include mining, logging, grazing, chemical pollution, road and railroad construction, spring developments, water diversions, and dams (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the canary duskysnail under the ESA and the Service issued a 12-month Finding that the canary duskysnail was determined not to warrant listing (USFWS 2012b).

Potem Creek Pebblesnail

The Potem Creek pebblesnail is endemic to the upper Sacramento River and Pit River drainages in northern California. The species is known from only 12 locations with 3 on Federal land. There is one known occurrence in Shasta National Forest; however, the species has the potential to occur in the Shasta Unit of the National Recreation Area. The species occurs in small, shallow, perennial cold springs and spring runs that are shaded at elevations from 1440 – 3160 feet (ft). The species was negatively impacted by the 1991 Cantara spill of metam sodium into the Sacramento River. Other threats to the species include domestic livestock grazing, logging, mining, road construction, water pollution, water diversions, spring developments, and impoundments (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the Potem Creek pebblesnail under the ESA and the Service issued a 12-month Finding that the Potem Creek pebblesnail was determined not to warrant listing (USFWS 2012).

Shasta Pebblesnail

Three pebblesnails (Shasta Springs pebblesnail, flat-top pebblesnail, and disjunct pebblesnail) have been combined and are now known as the Shasta pebblesnail. The former Shasta Springs pebblesnail, the flat-top pebblesnail, and the disjunct pebblesnail were petitioned for listing by the Center for Biodiversity under the ESA and the Service issued a 12-month Finding that the Shasta pebblesnail did not warrant listing (USFWS 2012b).

Globular Pebblesnail

The globular pebblesnail (Goose Valley pebblesnail) is known from only three sites in the Upper Sacramento River and Pit River drainages where it occurs in small perennial springs and springs headwaters. The species was negatively impacted by the 1991 Cantara spill. Other threats to the species include domestic livestock grazing, logging, mining, road construction, water pollution, water diversions, spring developments, and impoundments (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the globular pebblesnail under the ESA and the listing status of the globular pebblesnail is still under review (http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=G0EU; 2013)

Nugget Pebblesnail
The nugget pebblesnail is endemic to the Sacramento River basin including the Pit and McCloud River drainages and a few large spring-fed tributaries in Shasta, Modoc, and Lassen counties, California. The species is now presumed to be extirpated on the mainstem Sacramento River due to the 1991 Cantara spill. The snail now is only known from 22 sites in the Pit River drainage. Other threats to the species include domestic livestock grazing, logging, mining, road construction, water pollution, water diversions, spring developments, and impoundments (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the nugget pebblesnail under the ESA and the Service issued a 12-month Finding that the nugget pebblesnail was determined not to warrant listing (USFWS 2012b).

Cinnamon Juga
The cinnamon juga is known from no more than eight sites in the Shasta Springs complex in the upper Sacramento River area in Siskiyou County, California, where it is found in large, cold springs and spring runs with sand-cobble substrate or exposed basalt bedrock. The sites are all within 1.5 miles of each other. The species been reported in Shasta Springs, Mossbrae Falls spring complex, Cantara Bend on the Sacramento River, Upper Soda Springs and downstream of McBride Springs on Willow Creek. The species habitat has been substantially modified by the Union Pacific railroad tracks. Other threats to the species are spraying, water diversions, water pollution, grazing, development, and recreation (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the cinnamon juga under the ESA and the Service issued a 12-month Finding that the cinnamon juga snail was determined to not be a listable entity (USFWS 2012b).

Knobby Rams-horn
The knobby rams-horn is endemic to spring complexes of the Pit River drainage in Shasta, Modoc, and Lassen counties. The species is known from only two sites in Shasta County where it occurs in a very large, cold, clear, and pristine spring complex (with high levels of dissolved oxygen) and its outflow. The species is found on the surface of cobbles and boulders mostly covered with encrusting red algae. Threats to the species include habitat loss and degradation due to logging, mining, chemical pollution, road and railroad construction, and water diversions. Most of the large Pit River spring complexes have been modified by water diversions for hatcheries and hydroelectric power projects (Center for Biological Diversity 2008b). The Center for Biological Diversity petitioned for listing the knobby rams-horn under the ESA and the Service issued a 12-month Finding that the knobby rams-horn snail was determined to not be a listable entity (USFWS 2012b).

Upland and Riparian Resources near Shasta Lake and Tributaries

The primary study area for the SLWRI includes the upland and riparian communities surrounding Shasta Lake within the Inundation Zone and areas that would be directly or indirectly affected by project-related construction and the relocation of campgrounds and other facilities. In 2004, NSR prepared a technical report for Reclamation evaluating upland habitats (Wildlife Habitat Relationship [WHR]) that occur within the 1,070 – 1,090 ft msl elevation range that would be inundated by the proposed maximum Shasta Dam raise of 18.5 ft. Upland habitats common within the Inundation Zone include ponderosa pine, montane hardwood, montane hardwood - conifer, mixed chaparral, closed-cone pine, blue oak – gray pine woodland, and montane riparian. Less common upland habitats are annual grassland, blue oak woodland, and Klamath mixed conifer. The quality of the WHR habitat types is evaluated in more detail in the draft Habitat Evaluation Procedures (HEP) Report appended to this report. The following sections discuss the plant and wildlife species found within each WHR type within the Inundation Zone as reported by NSR (NSR 2004). The evaluation species for each WHR type include focal bird species prioritized for conservation by California Partners in Flight (CalPIF) (CalPIF 2000, 2002a, 2002b, 2004, Riparian Habitat Joint Venture [RHJV] 2004) as well as some common and rare (but not federally-listed) species associated with each habitat type.

Upland and Riparian Communities near Shasta Lake and Tributaries

Annual Grassland

Annual grassland habitat is uncommon within the Inundation Zone, and occurs as small inclusions within woodland, hardwood, or hardwood-conifer habitats. Dominant species include wild oat, cheatgrass, ripgut brome, yellow starthistle, squirreltail, and European hairgrass (NSR 2004). Annual grassland provides habitat primarily for relatively common wildlife species including native species that require open space, such as the gopher snake, western fence lizard, western king bird, horned lark, red-tailed hawk, California vole, and black-tailed deer.

Barren

The barren habitat described in the DEIS is generally associated with infrastructures including boat ramps, parking lots, and roads (USBR 2013). Also included within the barren habitat type are a large gravel plain feature at the confluence of Butcher Creek and Shasta Lake and a sealed riprap feature adjacent to Interstate 5. Barren habitat by definition should also include bare rock escarpments and cliff faces, and rock outcroppings or other such features with less than 2 percent herbaceous vegetative cover and less than 10 percent cover by tree or shrub species. Wildlife species that utilize barren habitat include American peregrine falcon, killdeer, pallid bat and western fence lizard.

Blue Oak Woodland

Blue oak woodland habitat occurs mainly as small inclusions or moderate stands in scattered locations within the Pit River portion of the Inundation Zone. This habitat is characterized as open to moderate woodlands dominated by blue oak with occasional interior live oak and gray pine. The shrub layer is open or absent, and a moderate to dense forb layer dominates the understory (NSR 2004). Representative wildlife species include the gopher snake, western fence lizard, barn owl, oak titmouse, white-breasted nuthatch, ringtail, and coyote. Neotropical migrant birds include ash-throated flycatcher, blue-gray gnatcatcher, and orange-crowned warbler. Several wildlife species in blue oak woodland benefit from acorns as a food source (Schoenherr 1992), including native species such as the acorn woodpecker, western scrub jay, yellow-billed magpies, western gray squirrel, and non-native species such as wild turkey and feral pigs. Oak trees also provide shelter for cavity-nesting birds, such as woodpeckers and bluebirds. Blue oak is a slow growing, long lived species and is not regenerating in many parts of its range (Schoenherr 1992).

Blue Oak – Gray Pine

Blue oak – gray pine habitat also occurs as small inclusions and/or moderate stands and is found in the main body of Shasta Lake, Squaw Creek Arm and the Pit River Arm portions of the Inundation Zone. Species composition is similar to the blue oak woodland habitat; however, gray pine and a shrub component are more common. Shrub species include whiteleaf manzanita, poison oak, buckbrush, and western redbud (NSR 2004). Blue oak-gray pine woodland transitions into blue oak woodland at lower elevations and ponderosa pine forest at higher elevations and, consequently, wildlife species inhabiting blue oak-gray pine woodland resemble those found in the other two habitats.

Closed-Cone Pine – Cypress

Close-cone pine habitat consists of open to dense knobcone pine stands. This habitat occurs as delineated stands in all portions of the Inundation Zone except along the Big Backbone Creek Arm, where several small inclusions occur within larger habitat types. Closed-cone pine habitat often occurs at locations characterized by disturbances, including historic mining activities and past or recent wildfires. Dominant species include knobcone pine, with occasional ponderosa pine and gray pine. The shrub layer is moderate to dense and is dominated by whiteleaf manzanita, poison oak, and yerba santa. The ground layer varies and is dominated by various grasses and forbs (NSR 2004).

Douglas-fir

Douglas-fir habitat is uncommon within the Inundation Zone, occurring at scattered locations along the Squaw Creek Arm portion. This habitat is characterized by a complex mosaic of forest expression due to the geologic, topographic, and successional variation typical within its range. Dominant conifer species include Douglas-fir and ponderosa pine, with occasional sugar pine. Dominant hardwoods include tanoak, Pacific madrone, California black oak and canyon live oak. Understory vegetation varies and includes sparse to moderate shrub growth, such as Oregon grape, California blackberry, dwarf rose, and poison-oak, with a variable grass and forb layer. The presence of Douglas-fir along with several conifer tree species and a greater proportion of conifer tree species to hardwood species distinguish this habitat from montane hardwood-conifer habitat. Special-status species known to occur on limestone substrate within this habitat type include the Shasta salamander, Shasta chaparral snail, and Shasta hesperian snail (NSR 2004). CalPIF publishes a list of recommendations and focal species for conserving Sierra Nevada coniferous forest habitat that is essential for birds of California, a large portion of western North America's Neotropical migratory birds (Siegel and DeSante 1999).

Klamath Mixed Conifer

Klamath mixed conifer habitat is limited in occurrence within the Inundation Zone. It is typically composed of tall, moderately dense to open conifer forest with patches of evergreen and deciduous trees and shrubs. In favorable, mesic sites the habitat is dominated by tall (up to 200 feet) conifers with a rich shrub layer and well developed herbaceous layer. On more xeric sites, the habitat is generally open, with a well-developed shrub layer. The large conifers that dominate the habitat include white fir, Douglas-fir, ponderosa pine, incense cedar and sugar pine. The habitat may also include a diverse variety of conifers and broad-leaf species including canyon live oak, California black oak, and Pacific madrone. Associated understory species vary and include Pacific dogwood, mock orange, poison oak, and snowberry. These forest stands are generally complex structurally, tend to grow on cooler northerly aspect slopes, and support similar wildlife species as Douglas-fir habitat including flammulated owl, brown creeper, sharp-shinned hawk, western wood-pewee, and western tanager. Mammals found in this habitat include the long-eared myotis, western red bat, northern flying squirrel, and bobcat.

Mixed Chaparral
Mixed chaparral occurs as variable stands of moderate to dense shrubs, or as small inclusions within other woodland or forest habitats. Dominant species include whiteleaf manzanita, common manzanita, western redbud, buckbrush, deerbrush, poison oak, birch-leaf mountain mahogany, interior live oak (shrub form), silktassel, bush poppy, yerba santa, and brewer oak (NSR 2004). Typical wildlife of mixed chaparral include the gopher snake, western fence lizard, California quail, spotted towhee, lesser goldfinch, black-tailed deer, and gray fox. Neotropical migrant birds include the western tanager and orange-crowned warbler, among others. Mixed chaparral is relatively abundant on the project area and is associated with many common wildlife species, but also provides habitat to important native species, such as Neotropical migrant birds.

Montane Hardwood – Conifer
The montane hardwood – conifer habitat is the most abundant vegetation habitat within the Inundation Zone, occurring throughout the area. This habitat includes a variable mixture of conifer and hardwood overstory with an understory ranging from open to dense. Dominant conifer species include Douglas-fir, ponderosa pine, gray pine, and knobcone pine. Hardwood composition varies and includes California black oak, canyon live oak, and blue oak and occasional interior live oak. Shrub species and composition vary and include whiteleaf manzanita, western redbud, buckbrush, poison oak, birch-leaf mountain mahogany, brewer oak, and California buckeye. The ground layer varies and is dominated by various grasses and forbs. Wildlife species inhabiting montane hardwood – conifer habitat resemble those found in montane hardwood, ponderosa pine, and closed-cone pine habitats. The special-status Shasta snow-wreath was observed in montane hardwood - conifer habitat within the Inundation Zone along Blue Ridge on the main body of Shasta Lake immediately above the high water line (NSR 2004). Other special-status species known to occur in this habitat type within the Inundation Zone include Pacific fisher, Shasta chaparral snail, Shasta sideband snail, and Wintu sideband snail (Tables 13 - 17; NSR 2004).

Montane Hardwood
Montane hardwood habitat includes nearly pure to mixed stands dominated by various hardwood tree species with a variable understory. Dominant tree species include hardwoods, such as California black oak and canyon live oak, with occasional Douglas-fir and ponderosa pine. Shrub species and composition vary and are similar to species occurring in the montane hardwood-conifer habitat (NSR 2004).

Montane Riparian
Montane riparian habitat occurs throughout the Inundation Zone along the many streams and drainages tributary to Shasta Lake. Montane riparian habitat also occurs in isolated spring/seep features scattered throughout the Inundation Zone. Vegetation within this habitat is sparse to dense, mainly occurring in thin to moderate stringers or small patches. In many locations, the adjacent upland habitats often extend into the riparian areas. Dominant species include white alder,

black willow, red willow, shining willow, arroyo willow, sandbar willow, Oregon ash, big-leaf maple, buttonwillow, ninebark, mock orange, spice brush, California blackberry, sedges, and various other grasses and forbs. The special-status Shasta snow-wreath was found in montane riparian habitat within the Inundation Zone at five sites, including a very large population on both banks of Stein Creek (Pit River Arm) extending from near the Stein Creek-Shasta Lake confluence to 0.25 mile upstream (NSR 2004). Other special-status species that occur or have the potential to occur in montane riparian habitat within the Inundation Zone and adjacent habitat include foothill yellow-legged frog, northwestern pond turtle, tailed frog, osprey, bald eagle, northern goshawk, willow flycatcher, western purple martin, bank swallow, yellow warbler, yellow-breasted chat, Lawrence's goldfinch, Shasta hesperian snail, and several species of aquatic mollusks (Tables 13 - 17; NSR 2004). The northwestern pond turtle likely uses montane riparian habitat within the Inundation Zone for potential nesting sites (NSR 2004). Montane riparian habitat also provides significant shaded riverine aquatic (SRA) cover for migratory birds and fish.

Ponderosa Pine

Ponderosa pine habitat is fairly common in the Project Area and occurs throughout the Inundation Zone. Dominant species include open to moderate stands of ponderosa pine with occasional Douglas-fir, gray pine, and knobcone pine. Dominant hardwoods present include California black oak and canyon live oak. The shrub layer is open to dense and includes whiteleaf manzanita, Brewer oak, snowdrop bush, poison oak, western redbud, and buckbrush. The ground cover is dominated by open to moderate grass and forb cover (NSR 2004). Representative wildlife includes the common kingsnake, California slender salamander, sharp-shinned hawk, northern pygmy owl, hairy woodpecker, deer mouse, raccoon, and bobcat. Representative Neotropical migrant birds include olive-sided flycatcher, warbling vireo, and western tanager. The special-status Shasta snow-wreath was observed in ponderosa pine habitat within the Inundation Zone along Blue Ridge on the main body of Shasta Lake immediately above the high water line (NSR 2004).

Urban

Urban habitat is anthropogenic landscapes and commercial and residential zones, and includes infrastructures and parks, roadways, cemeteries, resorts, golf courses and green belts, and includes a portion of the visitor center complex at Shasta Dam (USBR 2013). Urban habitats typically include a greater proportion of non-native landscaping plants and controlled and maintained areas of human occupation. Many wildlife species have adapted to urban habitats including American crows, northern mockingbirds, Cooper's hawks, raccoons, striped skunks and western fence lizards.

Special-Status Species in Primary Study Area

Special-status upland, riparian, and wetland species with the potential to be affected by the SLWRI near Shasta Lake or along the Sacramento River are listed in Tables 9 through 16.

Table 9. Special-Status Invertebrate Species Known or with the Potential to Occur in the Primary Study Area, Along the Sacramento River from Shasta Dam to Red Bluff Pumping Plant.

Common Name	Scientific Name	Status	General Habitat and potential for Occurrence
Invertebrates			
Vernal pool tadpole shrimp	*Lepidurus packardi*	FE, CH	Vernal pools and swales; unlikely to occur, no suitable habitat present along river corridor. Critical habitat does not occur within the river corridor.
Vernal pool fairy shrimp	*Branchinecta lynchi*	FT, CH	Vernal pools and swales; unlikely to occur, no suitable habitat present along river corridor. Critical habitat does not occur within the river corridor.
Valley longhorn elderberry beetle	*Desmocerus californicus dimorphus*	FT	Riparian; requires elderberry shrubs with base diameters ≥1-inch. Present along Sacramento River corridor where elderberry shrubs occur.
Western bumble bee	*Bombus occidentalis*	USFS	Various habitats with abundant flowering vegetation from spring through fall.

Key to Table 11:
FE = Federal endangered CH = Critical habitat designated
FT = Federal threatened
USFS = U.S. Forest Service Sensitive Species

Special-Status Floral Species

Special-status floral species are those that are: 1) federally-listed as endangered or threatened or a candidate for listing under the ESA; 2) State-listed as endangered, threatened, or rare or a candidate for listing under CESA; 3) on the CNPS List 1A, 1B, 2, 3, or 4; 4) a CALFED MSCS species; or 5) a USFS Sensitive or Survey and Manage Species. The location and habitat preference of special-status vascular plant species near Shasta Lake is summarized in Table 10. The location and habitat preference of special-status fungal, lichen, and bryophyte species with the potential to occur near Shasta Lake is summarized in Table 11.

Based on habitat present and the elevation range of the dam, 42 special-status vascular plant species, 5 sensitive fungi species, 2 sensitive lichen species, and 5 sensitive bryophyte species were identified as having the potential to occur near Shasta Lake. Thirteen of the vascular plant species are on

CNPS List 1B (plants that are rare, threatened, or endangered in California and elsewhere): Butte County morning-glory, Castle Crags harebell, Shasta ageratina, Shasta clarkia, northern clarkia, silky cryptantha, Red Bluff dwarf rush, Cantelow's lewisia, Bellinger's meadowfoam, Shasta snow-wreath, thread-leaved beardtongue, Sanford's arrowhead, Canyon Creek stonecrop, and English Peak greenbriar. Shasta ageratina is a Shasta County endemic that occurs only within a 15 square mile area in northeastern Shasta County; there are only 18 known occurrences of Shasta ageratina (Nelson *in litt.* 2008b). Four of the vascular plant species are on CNPS List 2 (plants that are rare, threatened, or endangered in California, but more common elsewhere): bristly sedge, brown fox sedge, brownish beaked-rush, and oval-leaved viburnum. The remaining vascular plant species are on CNPS List 3 (a review list of plants that require more information on their distribution and abundance) or CNPS List 4 (a watch list for species of limited distribution). Mountain lady's slipper is considered rare or threatened in the Northwest Forest Plan and is a Survey and Manage species (USBR 2007).

Nine plant species are CALFED MSCS species: bristly sedge, Shasta clarkia, silky cryptantha, Bellinger's meadowfoam, Shasta snow-wreath, thread-leaved beardtongue, Sanford's arrowhead, English Peak greenbriar, and four-angled spikerush. The CALFED Final Programmatic EIS/EIR includes Bellinger's meadowfoam, bristly sedge, Hendersons' bent grass, Shasta clarkia, and Shasta snow-wreath among a list of "evaluated species for which direct mortality as a result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy [MSCS] . . . .The MSCS requires CALFED to avoid all actions that could result in the mortality of any species identified in this table. This conservation measure was developed because these species are extremely rare. For many of the plants identified, fewer, than a dozen known populations exist" (see Table 4-5 in MSCS section of CALFED 2000b). Conservation measures recommended by the CALFED MSCS are identified in Appendix C of this report.

Shasta Snow-Wreath

The Shasta snow-wreath (*Neviusia cliftonii*) is an understory shrub in the rose family that was recently discovered in 1993 (Taylor 1993). The species is endemic to the southeastern Klamath Mountains in northern California (Ertter 1993), occurring in the vicinity of Shasta Lake within an elevational range from 1,070 feet (lake level) to 1,900 feet (Lindstrand 2007). *N. cliftonii* is one of only two known species of the genus *Neviusia*; the other species, Alabama snow-wreath (*N. alabamensis*), is a rare shrub that occurs only in the southeastern United States (Shevock *et al.* 1992). There are 24 known occurrences of Shasta snow-wreath (Lindstrand and Nelson 2005a,b; CDFG 2007a; Lindstrand 2007; L. Lindstrand and J. Nelson, Shasta-Trinity National Forest, pers. comm. 2011; USBR 2013; USBR 2014). The species occurs primarily along drainages in dense, shady montane hardwood-conifer and ponderosa pine forests, but also in foothill pine-blue oak woodland habitat (Lindstrand and Nelson 2005a,b, 2006). Populations occur within the Whiskeytown-Shasta-Trinity National Recreation Area, Shasta-Trinity National Forest, and on private land (Shevock 1993). Likely due to the initial construction of Shasta Dam, the remaining populations of Shasta snow-wreath are highly

Table 10. Potential Special-status Vascular Plant Species near Shasta Lake, California (continues on next pages).

Scientific Name	Common Name	Status[1]	Habitat/Occurrence
Ageratina shastensis	Shasta ageratina	List 1B.2, USFS	Exposed limestone outcrops in chaparral, lower montane coniferous forest. Elevation 1,300-5,910 feet. Endemic to 15 square-mile area in NE Shasta County. 18 known occurrences; 2 along McCloud River Arm near or within Inundation Zone (Nelson *in litt.* 2008b).
**Agrostis hendersonii*	Henderson's bent grass	List 3.2,	Mesic valley and foothill grassland, vernal pools.
Allium sanbornii var. sanbornii	Sanborn's onion	List 4.2	Chaparral, cismontane woodland, lower montane coniferous forest (usually serpentinite, gravelly).
Arctostaphylos malloryi	Mallory's manzanita	List 4.3	Chaparral, lower montane coniferous forest (volcanic); elevation 2,625-3,940 feet.
Arnica venosa	Shasta County arnica	List 4.2 USFS	Cismontane woodland, lower montane coniferous forest (often in disturbed areas and roadcuts); elevation 1,300-4,900 feet. Three populations found around Shasta Lake; one found at Bridge Bay Resort, and 2 found on the Sacramento River Arm at Salt Creek inlet and north of Slaughterhouse Island.
Asarum marmoratum	Marbled ginger	List 2B.3	It is native to the Klamath Mountains of northern California and southern Oregon, as well as adjacent slopes of the Cascade Range. It is a plant of moist high-elevation forests and rocky mountainsides.
Astragalus pauperculus	Depauperate milk-vetch	List 4.3	Chaparral, cismontane woodland, valley and foothill grassland (vernally mesic, volcanic); elevation 200-3,675 feet.
Botrychium virginianum	Rattlesnake fern	List 2.2, USFS	Bogs and fens, lower montane coniferous forest (mesic), meadows and seeps, riparian forest (streams); elevation 2,388-4,265 feet.
Bulbostylis capillaris	Thread-leaved beakseed	List 4.2	Lower and upper montane coniferous forest; meadows and seeps; elevation 1,295-6,800 feet.
Calochortus syntrophus	Callahan's mariposa lily	List 3.1	Cismontane woodland, lower montane coniferous forest, valley and foothill grassland (vernally mesic); elevation 1,722-2,910 feet.
Calystegia atriplicifoua ssp. *buttensis*	Butte County morning-glory	List 1B.2, USFS	Lower montane coniferous forest (rocky, sometimes roadside); chaparral; elevation 1,970-4,920 feet.
Campanula shelteri	Castle Crags harebell	List 1B.3, USFS	Lower montane coniferous forest (rocky, granite and diorite cliffs; north and northwest exposures); elevation 3,600-6,000 feet.
Carex buxbaumii	Buxbaum's sedge	List 4.2	Bogs and fens, meadows and seeps (mesic), marshes and swamps; elevation 10-10,825 feet.

Scientific Name	Common Name	Status[1]	Habitat/Occurrence
**Carex comosa*	Bristly sedge	List 2.1, MSCS	Marshes and swamps (lake margins), valley and foothill grassland, coastal prairie; elevation 0-2,050 feet.
Carex vulpinoidea	Brown fox sedge	List 2.2	Freshwater marshes and swamps; riparian woodland; elevation 100-3,940 feet.
**Clarkia borealis* ssp. *arida*	Shasta clarkia	List 1B.1, MSCS	Cismontane woodland, lower montane coniferous forest (openings); elevation 1,608-1,952 feet. Occurs only in Shasta and Tehama Counties; known from only 6 sites (CDFG 2008b).
Clarkia borealis ssp. *borealis*	Northern clarkia	List 1B.3, USFS	Chaparral, cismontane woodland and lower montane coniferous forest; road cuts; elevation 1,300-4,400 feet; Shasta and Trinity Counties. Two occurrences within Inundation Zone along Sacramento and McCloud River Arms.
Cryptantha crinita	Silky cryptantha	List 1B.2, MSCS	Cismontane woodland, lower montane coniferous forest, riparian forest, riparian woodland, and valley and foothill grassland habitats (gravelly streambeds); elevation 200-3,990 feet.
Cypripedium californicum	California lady's-slipper	List 4.2	Bogs and fens; lower montane coniferous forest (seeps and streambanks, usually serpentinite); elevation 100-9,025 feet.
Cypripedium fasciculatum	Clustered lady's-slipper	List 4.2, USFS	Lower montane coniferous forest; North Coast coniferous forest (usually serpentinite seeps and streambanks); elevation 980 -7,990 feet.
Cypripedium montanum	Mountain lady's-slipper	List 4.2, USFS	Broadleafed upland forest; cismontane woodland; lower montane coniferous forest; North Coast coniferous forest. Elevation 600-7,300 feet.
Eleocharis quadrangulata	Four-angled spikerush	List 2, MSCS	Marshes and swamps; not native to California.
Eriogonum congdonii	Congdon's buckwheat	List 4.3	Lower montane coniferous forest on serpentinite; elevation 3,280-7,700 feet.
Erythranthe taylori	Shasta limestone monkeyflower	List 1B.1	Limestone cliffs and outcrops in hardwood-conifer forest. Three occurrences were found within the inundation zone (USBR 2014) along the McCloud River Arm, and nineteen additional occurrences were found outside the project area.
Fritillaria eastwoodiae	Butte County fritillary	List 3.2, USFS	Dry benches and slopes, chaparral, cismontane woodland, lower montane coniferous forest (openings, sometimes serpentinite); elevation 160-4,900 feet; Squaw Creek and Pit River Arm.

Juncus leiospermus var. leiospermus	Red Bluff dwarf rush	List 1B.1	Chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland, vernal pools. Elevation 115-3,350 feet.
Lathyrus sulphureus var. argillaceus	Dubious pea	List 3	Cismontane woodland, lower and upper montane coniferous forest; elevation 492-1,000 feet.
Leptosiphon latisectus	Broad-lobed leptosiphon	List 4.3	Broadleafed upland forest, cismontane woodland. Elevation 550-4,930 feet.
Lewisia cantelovii	Cantelow's lewisia	List 1B.2, USFS	Moist rock outcrops in broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest (mesic, granitic, sometimes serpentinite seeps); elevation 500-3,000 feet. One population found during the 2003 botanical surveys in the Upper Sacramento River Inundation Zone (NSR 2004) and 3 more were found along the Sacramento River Arm in 2010 (USBR 2014).
Lewisia cotyledon var. howellii	Howell's lewisia	List 3.2	Broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest (rocky). Elevation 492-6,600 feet.
**Limnanthes floccosa* ssp. *bellingeriana*	Bellinger's meadowfoam	List 1B.2	Cismontane woodland, meadows and seeps (mesic). Elevation 950-3,610 feet.
Limnanthes floccosa ssp. *floccosa*	Woolly meadowfoam	List 4.2	Chaparral, cismontane woodland, valley and foothill grassland, vernal pools. Elevation 200-3,600 feet.
Minuartia rosei	Peanut sandwort	List 4.2, USFS	Lower montane coniferous forest (serpentinite); elevation 2,500-5,800 feet.
Navarretia subuligera	Awl-leaved navarretia	List 4.3	Chaparral, cismontane woodland, lower montane coniferous forest (rocky, mesic). Elevation 490-3,610 feet.
**Neviusia cliftonii*	Shasta snow-wreath	List 1B.2, USFS, MSCS	Cismontane woodland, lower montane coniferous forest, riparian woodland; along streamsides or lower one-third of slopes; sometimes carbonate, volcanic or metavolcanic. Elevation 980-1,640 feet. Shasta County endemic; 11 of 24 known populations occur within Inundation Zone (USBR 2014).
Penstemon filiformis	Thread-leaved beardtongue	List 1B.3, USFS, MSCS	Rocky openings in cismontane woodland, lower montane coniferous forest; ultramafic soils; elevation 2,000-6,000 feet.
Piperia leptopetala	Narrow-petaled rein orchid	List 4.3	Cismontane woodland, lower montane coniferous forest, upper montane coniferous forest; elevation 1,246-7,300 feet.

Polygonum bidwelliae	Bidwell's knotweed	List 4.3	Chaparral, cismontane woodland, alley and foothill grassland (volcanic). Elevation 200-3,940 feet.
Rhynchospora capitellata	Brownish beaked-rush	List 2.2	Lower and upper montane coniferous forest, meadows and seeps, marshes and swamps. Elevation 1,490-6,560 feet.
Sagittaria sanfordii	Sanford's arrowhead	List 1B.2, MSCS	Shallow freshwater marshes and swamps. Elevation 0-2,140 feet.
Sedum paradisum	Canyon Creek stonecrop	List 1B.3, USFS	Broadleaf upland forest, chaparral, lower montane coniferous, subalpine coniferous forest; elevation 960-6,500 feet.
Smilax jamesii	English Peak greenbriar	List 1B.3, USFS	Broadleafed upland forest, lower montane coniferous forest, marshes and swamps, North Coast coniferous forest, upper montane coniferous forest; streambanks and lake margins; northeast of Shasta Lake; elevation 2,900-7,500 feet.
Stellaria obtusa	Obtuse starwort	List 4.3	Lower montane coniferous forest, riparian woodland, upper montane coniferous forest (mesic, streambanks); elevation 492-7,005 feet.
Streptanthus longisiliquis	Long-fruit jewel-flower	List 4.3	Cismontane woodland, lower montane coniferous forest (openings). Elevation 2,346-4,921 feet.
Thermopsis gracilis var. gracilis	Slender false lupine	List 4.3	Chaparral, cismontane woodland, lower montane coniferous forest, meadows and seeps, North Coast coniferous forest (sometimes roadsides). Elevation 328-4,500 feet.
Trifolium siskiyouense	Siskiyou clover	List 3.2	Meadows and seeps (mesic). Elevation 2,885-4,920 feet.
Viburnum ellipticum	Oval-leaved viburnum	List 2.3	Chaparral, cismontane woodland, lower montane coniferous forest. Elevation 705-4,600 feet. Reported near Jones Valley boat ramp, Shasta Lake, along Pit River Arm (CDFG 2008b) and Pine Point Campground, McCloud River Arm.
Vaccinium sp. nov.	Shasta huckleberry	TBD	All locations within area known as "Copper Belt", area of traditional copper mining. 23 occurrences at 13 locations; 4 locations within inundation zone.
Botrychium subgenus Botrychium	Moonwort, grape fern	USFS S&M	Most populations are associated with riparian zones and old-growth western red cedar (*Thuja plicata*) in dense shade, sparse understory, an alluvium substrate, and often a duff layer of *Thuja* branchlets. However, some sites are located in subalpine meadows, ski slopes, mossy boulder fields under bigleaf maple, road cuts, shrublands, and alder thickets. Two known sites in California, located in Fresno and Tehama counties.
Bryoria tortuosa	Yellow-twist horsehair	BLM	A pendent, filamentous lichen, 4 to 12 inches long. On trunks and branches of trees in well-lit, open stands, most frequently on oaks and pines. Found in the Northwestern California.
Potamogeton zosteriformis	Eelgrass pondweed	List 2.2, MSCS	An annual, aquatic herb. Found in ponds, lakes, 3 – 8 feet deep.

Scientific Name	Common Name	Status[1]	Habitat/Occurrence
Ribes roezlil var. *amictum*	Sierra gooseberry	List 4.3	Endemic California shrub, found in the Sierra Nevada and throughout much of California, on dry, open forest slopes, and chaparral woodlands at elevations of 3500-8000 ft.
Scutellaria galericulata	Marsh skullcap	List 2.2, MSCS	Found in pine forest, wetland-riparian meadows, and freshwater-marshes. A perennial herb that is native to California and is also found elsewhere in North America and beyond. Occurrences in northeastern Shasta County.

Sources: NSR 2004, CNPS 2007, CDFG 2008b, and Nelson *in litt.* 2008a,b [1]Status Definitions: USFS = U.S. Forest Service Sensitive Species, S&M = USFS Survey & Manage Species, BLM = U.S. Bureau of Land Management Sensitive Species, MSCS = CALFED Multi-species Conservation Strategy species
California Native Plant Society (CNPS): List 1B.= Rare, threatened, or endangered elsewhere 0.1 = Seriously endangered in California. List 2= More common elsewhere (CNPS). 0.2 = Fairly endangered in California. List 3.= More information needed (Review List) 0.3 = Not very endangered in California. List 4= Limited distribution worldwide (Watch List)

Table 11. U.S. Forest Service Sensitive and Survey and Manage Fungus, Lichen, and Bryophytes Known or Suspected to Occur within the Shasta National Recreation Area Unit of Whiskeytown-Shasta-Trinity National Forest (Nelson *in litt.* 2008a).

Common Name	Scientific Name	Habitat/Occurrence
	Fungi	
red-pored bolete	*Boletus pulcherrimus*	Occurs in humus in association with the roots of Douglas-fir and grand fir in coastal forests.
no common name	*Cudonia monticola*	Occurs on spruce needles and coniferous debris generally in coastal areas.
branched collybia	*Dendrocollybia racemosa*	Small groups or colonies on old decayed or blackened mushrooms or occasionally in coniferous duff in the Coast and Klamath Ranges of western Trinity and Siskiyou Counties.
olive phaeocollybia	*Phaeocollybia olivacea*	Scattered to densely gregarious, often in rings on the ground in mixed woods and under conifers; fruiting in fall and winter. Coast and Klamath Ranges.
Stalked orange peel fungus	*Sowerbyella rhenana*	Moist, undisturbed, older conifer forests. Generally coastal. Coast and Klamath Ranges.
	Lichen	
veined water lichen	*Hydrothyria venosa*	Aquatic, in spring-fed streams that never flood.
Bay horsehair lichen	*Sulcaria badia*	Usually on hardwoods (white oak), sometimes conifers. Known from Mendocino County. Pollution sensitive.
	Bryophytes	
green bug-on-a-stick moss	*Buxbaumia viridis*	Large diameter, advanced decay logs in in riparian habitat in conifer forest. Low elevation to alpine.
three-ranked hump-moss	*Meesia triquetra*	Bogs and fens, meadows and seeps, subalpine coniferous forest and upper montane coniferous forest.
broad-nerved hump-moss	*Meesia uliginosa*	Bogs and fens, meadows and seeps, subalpine coniferous forest and upper montane coniferous forest.
elongate copper moss	*Mielichhoferia elongata*	Mesic, exposed soil or rock containing copper minerals; road cuts; elevation 1,260 – 4,260 feet. Known to occur in western Trinity County but not Shasta County.
Pacific fuzzwort	*Ptilidium californicum*	Larger white fir trees, stumps and logs in relatively undisturbed old growth/late seral habitats. Elevation 3,500 – 5,500 feet.

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (continued on next pages)

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Aleutian Canada goose	*Branta canadensis leucopareia*	MSCS	Winters in California. Lacustrine, fresh emergent wetlands, and moist grasslands, croplands, pastures, and meadows. Breeds in Alaska.
American peregrine falcon	*Falco peregrinus anatum*	CFP BCC, MSCS	Year-round resident. Breeds early March-late August. Woodland, forest, coastal, riparian, lacustrine, wetlands. Nest in high cliffs near lakes, rivers, or wetlands or in tall buildings or bridges. Eyries occur adjacent to Inundation Zone along McCloud and Sacramento River Arms. Observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008). 4 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
American wigeon	*Anas americana*	GBB	Common September-April. Lacustrine, fresh emergent and nearby herbaceous and croplands. Rarely nests in California. 258 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Bald eagle	*Haliaeetus leucocephalus*	CE,BGE CFP,USFS, MSCS	Lacustrine, riverine. Shasta Lake has the largest concentration of breeding bald eagles in California. 28 pairs at Shasta Lake. 4 known nests within Inundation Zone. Observed during USGS Breeding Bird Survey near Shasta Lake (Sauer *et al.* 2008). 16 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Band-tailed pigeon	*Columba fasciata*	GBB	Year-round. Breeds February to mid-October (peak in May). Hardwood and hardwood-conifer habitats. Closely associated with oaks and acorns. Observed during USGS Breeding Bird Survey near Shasta Lake and Redding (Sauer *et al.* 2008). 4 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Bank swallow	*Riparia riparia*	CT, MSCS	Early March–early August. Nest in riparian, lacustrine, or riverine habitats with vertical cliffs or banks composed of sandy or loamy soils near water. Foraging habitat throughout Inundation Zone. Many nesting colonies downstream along the banks of the Sacramento River.
Barrow's goldeneye	*Bucephala islandica*	CSC	Winters October-March in riverine and lacustrine waters with rocky bottoms. Formerly nested in California, near alkaline lakes or slow moving rivers with abundant submerged aquatic vegetation and open water. 75 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Bell's sage sparrow	*Amphisiza belli belli*	WL	Year-round resident. Breeds from late March to mid-August with a peak in May and June. Chaparral dominated by chamise, coastal scrub dominated by sage.
Black swift	*Cypseloides niger*	CSC,BCC	Breeds very locally early June-late August in the Sierra Nevada and Cascade Range. Coniferous forest, conifer/woodland, and riparian habitats with waterfall or other mist-zone features. Steep, rocky, often moist, cliffs. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
California gull	*Larus californicus*	WL, MSCS	Lacustrine, estuarine, salt ponds, coastal, fresh and saline emergent wetland, riverine, cropland. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008). 51 observed near Redding during Audubon Christmas Count (Audubon 2006-2008).
California spotted owl	*Strix occidentalis occidentalis*	CSC,BCC	Year-round resident. Dense, old-growth, multi-layered mixed conifer, redwood, and Douglas-fir habitats in northern California. Oak and oak-conifer in southern California.
California thrasher	*Toxostoma redivivum*	USBCW	Year-round resident. Breeds early December-early August (peak in mid-April-mid-June). Moderate to dense chaparral habitats; less commonly, extensive thickets in young or open valley foothill riparian habitat, especially California blackberry and wild grape. Observed during USGS Breeding Bird Survey near Shasta Lake, Redding, and Red Bluff (Sauer *et al.* 2008). 5 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Calliope hummingbird	*Stellula calliope*	BCC, USBCW	March-August. Breeds early May-early August in wooded habitats from ponderosa pine and montane hardwood-conifer up through lodgepole pine, favoring montane riparian, aspen, and other open forests near streams. Commonly feeds in montane chaparral and wet meadow habitats. Observed during USGS Breeding Bird Survey near Shasta Lake (Sauer *et al.* 2008).
Canvasback	*Aythya valisineria*	GBB	Winters September-May. Estuarine, lacustrine. 56 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Cassin's finch	*Carpodacus cassinii*	BCC	Breeds at higher elevations in tall, open coniferous forests, in lodgepole pine, red fir, and subalpine conifer habitats. Most numerous near wet meadows and grassy openings; also frequents semi-arid forests. Winters at lower elevation and arid eastern slopes.
Clark's grebe	*Aechmophorus clarkii*	BCC/c, CSC/c, USBCW	Winters October-May along coast and inland lakes at low elevations. Breeds May-September on large marshy lakes (e.g., Sacramento River NWR, Lake Havasu, Salton Sea, Goose Lake, Sweetwater Reservoir). Require large, open waters for courtship, feeding, and flocking, and frequent extensive beds of tall, emergent vegetation such as tules or cattails for nesting.
Common loon	*Gavia immer*	CSC	September-May. Deep freshwater lakes, estuarine, subtidal. 2 observed during Audubon Christmas Count near Redding (Audubon 2007).
Cooper's hawk	*Accipiter cooperii*	WL, MSCS	Year-round resident. Breeds March-August. Dense stands of live oak, riparian deciduous, and other woodland. Eight observed during Audubon Christmas Count near Redding (Audubon 2008). Observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Double-crested cormorant	*Phalacrocorax auritus*	WL, MSCS	August-May in Central Valley lacustrine, riverine habitat. Breeds April-August along coast, inland lakes, estuaries. No known rookery sites within Inundation Zone. 155 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Ferruginous hawk	*Buteo regalis*	WL, BCC	September- mid-April. Open grasslands, sagebrush flats, desert scrub, low foothills surrounding valleys, and fringes of pinyon-juniper habitats.
Flammulated owl	*Otus flammeolus*	BCC, USBCW	Summer resident April-October. Breeds May-October (peak in June-July). Variety of coniferous habitats from ponderosa pine to red fir forests. Favors small openings, and edges and clearings with snags for nesting and roosting.
Golden eagle	*Aquila chrysaetos*	WL,CFP, BG, MSCS	Year-round resident. Breeds late January-August (peak in March-July). Grassland, savanna, desert, early-successional forest and shrub. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008). 1 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Greater scaup	*Aythya marila*	GBB	October-May. Bays, estuaries, lakes, emergent wetlands. Does not breed in California. 2 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Greater white-fronted goose	*Anser albifrons frontalis*	GBB	Early September-early April in Sacramento Valley. Moist and wet grasslands, rice fields, pastures, croplands, meadows, fresh emergent wetlands, lacustrine habitat and, less commonly, in estuarine and saline (brackish) emergent habitats. 34 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Green-tailed towhee	*Pipilo chlorurus*	BCC	April-October. Breeds April-late August (peak in late May-July). Optimal breeding habitat is relatively arid, moderately open chaparral with low canopy about 0.6 to 1.3 m (2-4 ft) high; favors stands of mixed species (Gaines 1977). Occurs in montane chaparral, sagebrush, low sagebrush, and bitterbrush habitats, and sparse coniferous forests with an understory of these shrubs.
Hermit warbler	*Dendroica occidentalis*	USBCW	April-September. Breeds in mature ponderosa pine, montane hardwood-conifer, mixed conifer, Douglas-fir, redwood, red fir, and Jeffrey pine habitats. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer et al. 2008).
Lawrence's goldfinch	*Carduelis lawrencei*	BCC	April-September. Breeds in open oak or other arid woodland and chaparral, near water, valley foothill hardwood, valley foothill hardwood-conifer. Forages in grasslands. Observed near Redding during USGS Breeding Bird Survey (Sauer et al. 2008).
Lesser scaup	*Aythya affinis*	GBB	September-May in estuarine, lacustrine habitat in California. 60 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Lewis's woodpecker	*Melanerpes lewis*	BCC	Breeds May-July eastern slope Coast Ranges, Sierra Nevada, Klamath Mtns, Cascades. Winter migrant in Central Valley. Open oak savannahs, broken deciduous, and coniferous habitats. 1 observed during Audubon Christmas Count near Redding (Audubon 2006-2008). Observed near Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Little willow flycatcher	*Empidonax trailii brewsteri*	CE,USFS, BCC, MSCS	May-August. Breeds in extensive, dense, ungrazed stands of willow near slow moving water and meadow edge. Peak egg laying in June.
Loggerhead shrike	*Lanius ludovicianus*	CSC, BCC	Year-round resident. Lays eggs March-May, young become independent July-August. Open-canopied valley foothill woodland, valley foothill riparian, hardwood-conifer, pinyon-juniper, desert riparian. Observed near Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Long-eared owl	*Asio otus*	CSC, MSCS	Year-round resident or winter visitor. Breeds early March-late July. Riparian habitat required; also uses live oak thickets and other dense stands of trees.
Mallard	*Anas platyrhynchos*	GBB	Year-round resident. Nest late February-June (peak in early April). Young fly 40-60 days after hatching. Fresh emergent wetlands, estuarine, lacustrine, and riverine habitats, ponds, pastures, croplands, and urban parks. Observed during USGS Breeding Bird Surveys near Shasta Lake and Redding (Sauer *et al.* 2008). 588 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Merlin	*Falco columbarius*	WL	September-May. Coast, open grassland, savannah, woodland, lacustrine, wetland. 3 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Mountain quail	*Oreortyx pictus*	USBCW	Year-round resident. Breeds late March-late August (peak May – July). Montane habitats, open, brushy stands of conifer and deciduous forest and woodland, and chaparral. Requires brushy vegetation interspersed with grass/forb areas; steep slopes and thickets for cover. Frequently observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Northern goshawk	*Accipiter gentilis*	CSC,BCC, USFS	Year-round resident. Begins breeding mid-June. Middle and higher elevations, and mature, dense conifer forests, riparian areas. Usually nests on north slopes, near water, in densest parts of stands, but close to openings. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Northern harrier	*Circus cyaneus*	CSC, BCC, MSCS	Year-round or winter resident. Breeds April-September. Riparian, wetland, grassland, shrubland, agricultural. Observed near Redding during Audubon Christmas Count and USGS Breeding Bird Survey (Audubon 2006-2008, Sauer *et al.* 2008).
Northern pintail	*Anas acuta*	GBB	July-April. Lacustrine and estuarine habitats, fresh and saline emergent wetlands, and wet croplands, pastures, grasslands, and meadows. 1 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Northern spotted owl	*Strix occidentalis caurina*	FT,CSC, MSCS	Year-round resident. Dense, old-growth, multi-layered mixed conifer, redwood, and Douglas-fir habitats.

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Nuttall's woodpecker	*Picoides nuttalli*	BCC	Year-round resident. Breeds late March-early July. Low-elevation riparian deciduous and oak habitats. Requires snags and dead limbs for nest excavation. Observed during USGS Breeding Bird Survey near Shasta Lake and Redding (Sauer *et al.* 2008). 58 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Oak titmouse	*Baeolophus inornatus*	BCC	Year-round resident. Breeds March-June (peak in April-May). Montane hardwood-conifer, montane hardwood, blue, valley, and coastal oak woodlands, and montane and valley foothill riparian habitats. Frequently observed during near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Olive-sided flycatcher	*Contopus cooperi*	BCC,CSC	Early May-September. Peak egg-laying in June. Preferred nesting habitats include mixed conifer, montane hardwood-conifer, Douglas-fir, redwood, red fir, and lodgepole pine. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Osprey	*Pandion haliaetus*	WL, MSCS	Year-round or summer visitor. Breeds March-September. Lacustrine, riverine, estuarine. Common at Shasta Lake; several nests within Inundation Zone. 3 observed during Audubon Christmas Count near Redding (Audubon 2006-2008). Observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Prairie falcon	*Falco mexicanus*	WL, BCC	Year-round resident. Breeds mid-February-mid-September (peak in April-early August). Distributed from annual grasslands to alpine meadows, but associated primarily with perennial grasslands, savannahs, rangeland, some agricultural fields, and desert scrub areas. Nests in open terrain with canyons, cliffs, escarpments, and rock outcrops.
Purple finch	*Carpodacus puppureus*	BCC	Permanent resident. For breeding, prefers moist, shady coniferous forest, oak woodland, or riparian woodland near forest openings, and usually near water. Often forages in forest openings and along forest edges.
Redhead	*Aythya americana*	CSC,GBB	Winter or year-round resident. Breeds April-August. Nests in fresh emergent wetland bordering open water. 28 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Ring-necked duck	*Aythya collaris*	GBB	September-May. Freshwater lacustrine. 308 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Rufous hummingbird	*Selasphorus rufus*	BCC	Migrant, summer resident. Habitats with nectar-producing flowers; valley foothill hardwood, valley foothill hardwood-conifer, riparian, chaparral, aspen and high mountain meadows. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Sharp-shinned hawk	*Accipiter striatus*	WL	Migrates to mountains for summer and downslope to foothills and valleys for winter. Breeds April-August (peak in late May-July). Riparian, ponderosa pine, black oak, deciduous, mixed conifer. 4 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Swainson's hawk	*Buteo swainsoni*	CT,BCC, MSCS	March-October. Breeds late March-late August. Riparian, wetlands, grassland, agricultural. Nests in riparian zone along Sacramento River.
Tricolored blackbird	*Agelaius tricolor*	CSC, BCC, MSCS	Year-round resident. Breeds mid-April-late July. Riparian, wetlands, ponds, grasslands, croplands. Nests in grain crops, rice fields, and riparian habitat along the Sacramento River. Observed near Redding during USGS Breeding Bird Survey (Sauer et al. 2008).
Varied thrush	*Ixoreus naevius*	USBCW	Breeds in dense, coniferous forests of Del Norte, Humboldt, Trinity, and Siskiyou counties only (extreme northwestern coastal California). More widespread fall – early spring; occurs in valley foothill hardwood, valley foothill hardwood-conifer, and a variety of coniferous and chaparral habitats in low and middle elevation of Cascade Range and Sierra Nevada, interior lowlands, and coast. 20 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Vaux's swift	*Chaetura vauxi*	CSC	Summer resident. Breeds early May-mid August. Prefers redwood and Douglas-fir habitats with nest-sites in large hollow trees and snags, especially tall, burned-out stubs. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Western burrowing owl	*Athene cunicularia hypugea*	CSC, BCC, MSCS	Year-round resident. Breeds March-August with peak April-May. Nests in small mammal burrows. Open, dry grassland and desert habitats, and in grass, forb and open shrub stages of pinyon-juniper and ponderosa pine habitats.
Western grebe	*Aechmophorus occidentalis*	BCC, CSC/c	Winters October-May along coast, estuaries, and large inland lakes at low elevations. Breeds May-September on large marshy lakes (e.g., Sacramento River NWR, Lake Havasu, Salton Sea, Goose Lake, Sweetwater Reservoir). Prefer large, open waters for courtship, feeding, and flocking, and frequent extensive beds of tall, emergent vegetation such as tules or cattails for nesting, but some nests reported in open water or on shore. 16 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Western purple martin	*Progne subis arboricola*	CSC	Late March-late September. Nests April-August (peak in June). Riparian, valley foothill and montane hardwood, valley foothill and montane hardwood-conifer, closed-cone pine-cypress, ponderosa pine, Douglas-fir, and redwood. Forages throughout Inundation Zone. 18 pairs nesting in inundated snags in the Pit River arm (Lindstrand 2007). Observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer *et al.* 2008).
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	CE,FC, BCC, MSCS	June-early September. Most eggs laid mid-June-mid-July. Nests in large (>40 acres) cottonwood forests along Sacramento River. Only 100 breeding pairs in California; 40 pairs along Sacramento River (Greco 2008).
White-headed woodpecker	*Picoides albolarvatus*	BCC	Year-round resident. Breeds mid-April to late August (peak in mid-June-mid-July). Montane coniferous forests up to lodgepole pine and red fir habitats. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer et al. 2008).

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
White-tailed kite	*Elanus leucurus*	CFP, MSCS	Year-round resident. Breeds February-October with peak May-August. Open grassland, open woodland, agriculture, emergent wetland. Observed near Redding during USGS Breeding Bird Survey (Sauer et al. 2008).
Wood duck	*Aix sponsa*	GBB	Year-round resident. Breeds April-August. Lacustrine, slow-moving riverine, and emergent wetland habitats bordered by willows, cottonwoods, or oaks. Nests in cavities in trees, pileated wood pecker nest-cavities, or old, rotted flicker cavities near water. 94 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Wrentit	*Chamaea fasciata*	USBCW	Year-round resident. Prefers dense stands of chaparral, coastal scrub. Sometimes found in sparse or open conifers or other woodlands with a heavy shrub understory. Observed near Shasta Lake during USGS Breeding Bird Survey (Sauer et al. 2008). 14 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Yellow warbler	*Dendroica petechia brewsteri*	CSC, BCC, MSCS	April-October. Breeds mid-April-early August (peak in June). Nests in low open-canopy riparian woodlands, montane chaparral, open ponderosa pine and mixed conifer habitats with substantial amounts of brush. Observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer et al. 2008).
Yellow-billed magpie	*Pica nuttalli*	BCC	Year-round resident. Breeds late February-mid July (peak in May-June). Valley foothill hardwood, valley foothill hardwood-conifer, valley foothill riparian, orchard, vineyard, cropland, pasture, and urban habitats. Population numbers have dropped by 49% over two years since the West-Nile virus was established in California in 2004 (Crosbie et al. 2008). Frequently observed during USGS Breeding Bird Survey near Redding (Sauer et al. 2008). 75 observed during Audubon Christmas Count near Redding (Audubon 2006-2008).
Yellow-breasted chat	*Icteria virens*	CSC, MSCS	April-late September. Breeds early May-early August (peak in June). Nests in dense riparian understory and other dense shrub habitats (willows and blackberry especially) near water. Frequently observed near Shasta Lake and Redding during USGS Breeding Bird Survey (Sauer et al. 2008).
Black-crowned night heron (rookery)	*Nycticorax nyticorax*	BLM S, MSCS	Riparian and wetland areas; riparian forests for nesting and roosting; likely along the river corridor where suitable habitat exists.
Black tern	*Childonias niger*	CSC	Marsh lands with open water; unlikely, there is potential for foraging within the Primary Study Area.
Great blue heron (rookery)	*Ardea hernodius*	MSCS	Marsh, wetland, riparian habitats, including irrigated pastures. Copse of larger trees for nesting, particularly riparian forest; could nest in trees adjacent to river corridor.
Great egret (rookery)	*Casmerodius albus*	CSC	Marsh, wetland, riparian habitats, including irrigated pastures. Copse of larger trees for nesting, particularly riparian forest; could nest in trees adjacent to river corridor.
Snowy egret (rookery)	*Egretta thula*	MSCS	Marsh, wetland, riparian habitats, including irrigated pastures. Copse of larger trees for nesting, particularly riparian forest; could nest in trees adjacent to river corridor.

Table 12. Special-Status Avian Species with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Least bittern	*Ixobrychus exilis*	MSCS	Wetlands with emergent vegetation; could nest along Sacramento River where suitable habitat is present.
Lesser sandhill crane (wintering)	*Grus Canadensis canadensis*	CSC	Wetlands with emergent vegetation; could nest along Sacramento River where suitable habitat is present.
Short-eared owl (nesting)	*Asio falmmeus*	CSC, MSCS	Open areas, grassland, and irrigated pasture; may occur where suitable habitat exists.

Sources: (Zeiner *et al.* 1988-1990; North State Resources [NSR] 2004; Sauer *et al.* 2008; National Audubon Society [Audubon] 2006-2008; CDFG 2008b).

[1] STATUS

Federal

FC = Federal Candidate
FE = Federal Endangered
FT = Federal Threatened
BGE = Bald and Golden Eagle Protection Act
USFS = U.S. Forest Service Sensitive Species
BCC = Bird of Conservation Concern at the National or Regional Scale (USFWS Bird of Management Concern)
FPD = Federal Proposed Delisting
S&M = U.S. Forest Service Survey & Manage Species
MSCS = CALFED Multi-species Conservation Strategy species
BCC/c = recommended Bird of Conservation Concern (Ivey 2004)
GBB = Game Bird Below Desired Condition (USFWS Bird of Management Concern)
USBCW = United States Bird Conservation Watch List (American Bird Conservancy and National Audubon Society [Audubon] 2007)
-- = No special-status but protected by the Migratory Bird Treaty Act.

State

CE = California Endangered, CT = California Threatened, CFP = California Fully Protected Species, CPD = California Proposed Delisting,
CSC = California Species of Special Concern
WL = CDFW Watch List

Table 13. Special-Status Reptiles and Amphibians with the Potential to Occur in the SLWRI Primary Study Area.

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
			Reptiles and Amphibians
California red legged frog	*Rana aurora draytonii*	FT, CSC, MSCS	Dense, shrubby, or emergent riparian habitat near deep, still or slow moving water lacking bullfrogs. Shasta County is at the northern extent of range.
Foothill yellow-legged frog	*Rana boylii*	CSC, USFS, MSCS	Potentially occurring in stream habitats. Known occurrences scattered throughout the Inundation Zone and vicinity. The Center for Biodiversity petitioned the Service in July 2012 to list the foothill yellow-legged frog as threatened under the ESA, currently no action has been taken (Center for Biodiversity 2012).
Giant garter snake	*Thamnophis gigas*	FT, CT, MSCS	Emergent wetlands, rice fields, and adjacent uplands; unlikely to occur, no suitable habitat present along river corridor. Is present in Extended Study Area.
Northwestern pond turtle	*Actinemys (Emys) marmorata marmorata*	CSC, USFS, MSCS	Potentially occurring in stream or other wetland habitats. Adjacent upland habitats are potential nesting areas. Known occurrences scattered throughout the Inundation Zone and vicinity. The Center for Biodiversity petitioned the Service in July 2012 to list the western pond turtle under the ESA, currently no action has been taken (Center for Biodiversity 2012).
Shasta salamander	*Hydromantes shastae*	CT, m, USFS, S&M, MSCS	Potentially occurring in mixed conifer, woodland, and chaparral habitats, especially in the vicinity of limestone. Known occurrences within and in the vicinity of the Inundation Zone. Found within the Inundation Zone near Big Backbone Creek Arm (NSR 2004). The Center for Biodiversity petitioned the Service in July 2012 to list the Shasta salamander as endangered under the ESA, currently no action has been taken (Center for Biodiversity 2012).
Tailed frog	*Ascaphus truei*	CSC	Potentially occurring in stream habitats. Known occurrences in McCloud and Upper Sacramento Arm tributaries.
Western spadefoot toad	*Spea hammondii*	CSC, MSCS	Open areas with sandy or gravelly soils in mixed woodlands, grasslands, chaparral, sandy washes, lowlands, river floodplains, alluvial fans, playas, alkali flats, foothills, and mountains. Rainpools which do not contain bullfrogs, fish, or crayfish are necessary for breeding. The Center for Biodiversity petitioned the Service in July 2012 to list the Shasta salamander as endangered under the ESA, currently no action has been taken (Center for Biodiversity 2012).

Sources: (Zeiner *et al.* 1988-1990; North State Resources, Inc. [NSR] 2004; CDFG 2008).

[1] STATUS

Federal
FC = Federal Candidate
FE = Federal Endangered
FT = Federal Threatened

USFS = U.S. Forest Service Sensitive Species
S&M = U.S. Forest Service Survey & Manage Species

State
CE = California Endangered, CT = California Threatened, CFP = California Fully Protected Species, CPD = California Proposed Delisting, WL = CDFG Watch List
MSCS = CALFED Multi-species Conservation Strategy species

Table 14. Special-Status Mammals with the Potential to Occur in the SLWRI Primary Study Area.

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Mammals			
American badger	*Taxidea taxus*	CSC	Drier open stages of most shrub, forest, and herbaceous habitats, with friable soils.
American marten	*Martes americana*	USFS	Optimal habitats are various mixed evergreen forests with more than 40% crown closure, with large trees and snags. Important habitats include red fir, lodgepole pine, subalpine conifer, mixed conifer, Jeffrey pine, and eastside pine.
California wolverine	*Gulo gulo luteus*	CT, CFP, USFS, MSCS	Mixed conifer, red fir, lodgepole, subalpine conifer, alpine dwarf-shrub, wet meadow, and montane riparian habitats. Use caves, hollows in cliffs, logs, rock outcrops, and burrows for cover, generally in denser forest stages.
Fringed myotis	*Myotis thysanodes*	BLM, WBH	Pinyon-juniper, valley foothill hardwood and hardwood-conifer. Roosts in caves, mines, buildings, and crevices. Uses open habitats, early successional stages, streams, lakes, and ponds as foraging areas.
Gray wolf	*Canis lupus*	FE, CE	Found in grassland, scrub, and forest habitats. Currently expanding range and has recently been recorded in California from established population in Oregon.
Greater western mastiff-bat	*Eumops perotis californicus*	CSC, BLM, WBH, MSCS	Broad open areas in floodplains, washes, chaparral, oak woodland, grassland, and agricultural areas. Roosts in cliffs and rocky crevices.
Long-eared myotis	*Myotis evotis*	BLM, WBM	Brush, woodland, and forest. Widespread throughout California except Central valley and hot deserts. Roosts in buildings, crevices, spaces under bark, snags, and caves.
Long-legged myotis	*Myotis volans*	WBH	Forages in early successional forests and woodlands, chaparral, coastal scrub, Great Basin shrub mostly above 4,000 feet. Roosts in rock crevices, buildings, under tree bark, in snags, mines, and caves.
Pacific fisher	*Martes pennanti pacifica*	CSC, FC, USFS	Intermediate to large-tree stages of coniferous forests and deciduous-riparian habitats with a high percent canopy closure. Detected during 2003 forest carnivore surveys in Big Backbone and Squaw Creek Arms (NSR 2004).
Pallid bat	*Antrozous pallidus*	CSC, USFS, WBH	Grasslands, shrublands, woodlands, and forests from sea level up through mixed conifer forests. Open, dry habitats with rocky areas for roosting.
Ringtail	*Bassariscus astutus*	CFP, MSCS	Widely distributed in various riparian habitats, and in brush stands of most forest and shrub habitats at low to middle elevations. Detected at numerous sites during 2003 forest carnivore surveys in Big Backbone and Squaw Creek Arms (NSR 2004).
Spotted bat	*Euderma maculatum*	CSC, WBH	Arid deserts, grasslands and mixed conifer forests. Roost in rock crevies, cliffs, caves. Forages over water and along washes. Foraging habitat throughout the Inundation Zone.
Townsend's big-eared bat	*Plecotus townsendii*	CSC, USFS, WBH	Found in all but subalpine and alpine habitats. Most abundant in mesic habitats. Requires caves, mines, tunnels, buildings, or other human-made structures for roosting. Requires permanent water source. Foraging habitat throughout the Inundation Zone.

Table 14. Special-Status Mammals with the Potential to Occur in the SLWRI Primary Study Area (cont.).

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Mammals			
Western red bat	*Lasiurus blossevillii*	CSC, USFS S, WBH	Roosts in wooded and riparian areas. Forages in grasslands, shrublands, open wooded, and agricultural areas. Foraging habitat throughout Inundation Zone.
Western small-footed myotis	*Myotis ciliolabrum*	BLM, WBM	Open stands in arid wooded and brushy uplands near water. Roosts in caves, buildings, mines, crevices, and occasionally under bridges and under bark.

Sources: (Zeiner *et al.* 1988-1990; North State Resources, Inc. [NSR] 2004). [1] STATUS: FC = Federal Candidate, USFS = U.S. Forest Service Sensitive Species, BLM = Bureau of Land Management Sensitive Species, CT = California Threatened, CFP = California Fully Protected Species, MSCS = CALFED Multi-species Conservation Strategy species, WBH = Western Bat Working Group High Priority Species, WBM = Western Bat Working Group Medium Priority Species

Table 15. Special-Status Terrestrial Mollusks with the Potential to Occur in the SLWRI Primary Study Area.

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
			Terrestrial Mollusks
Shasta sideband snail*	*Monadenia troglodytes troglodytes*	USFS, S&M, PF, MSCS	Terrestrial mollusk endemic to limestone substrates in rocky areas or along talus slopes in open, brush covered, or pine-oak woodlands near Shasta Lake.
Wintu sideband snail*	*Monadenia troglodytes wintu*	USFS, S&M, PF	Terrestrial mollusk endemic to limestone substrates in rocky areas or along talus slopes in open, brush covered, or pine-oak woodlands near Shasta Lake.
Shasta chaparral snail*	*Trilobopsis roperi*	USFS, S&M, PF	Terrestrial mollusk endemic to limestone, rocky/gravelly, and general forest floor habitats in conifer, hardwood-conifer, hardwood, and chaparral near Shasta Lake. Potentially occurring in mixed conifer and conifer/woodland habitats. Found within the Big Backbone Creek and Squaw Creek Arm Inundation Zone during 2003 terrestrial mollusk surveys (NSR 2004).
Shasta hesperian snail*	*Vespericola shasta*	USFS, S&M, PF	Terrestrial mollusk endemic to old-growth riparian zones, cool and shady forests, springs, seeps, marshes, and the mouths of caves near Shasta Lake. Found within Squaw Creek Inundation Zone during 2003 terrestrial mollusk surveys, also several incidental detections during 2003 in the Pit and McCloud River Arms (NSR 2004).
Oregon shoulderband snail	*Helminthoglypta hertleini*	S&M	Terrestrial mollusk potentially occurring in basaltic talus and other rocky substrates where permanent groundcover, woody debris, and moisture is available. Found along the Big Backbone Creek Inlet, McCloud River Arm, and Pit River Arm (CDFG 2008b).
Klamath or Church's sideband snail	*Monadenis churchi*	S&M	Potential occurring in mixed conifer and conifer/woodland habitats; found in limestone outcrops, caves talus and lava rockslides, especially riparian areas. Many known occurrences in the Shasta Lake and vicinity portion of the study area

Sources: (Center for Biological Diversity 2008b, North State Resources, Inc. [NSR] 2004).
[1] STATUS
Federal: FC = Federal Candidate PF = Petitioned for Federal listing FPD = Federal Proposed Delisting FE = Federal Endangered FT = Federal Threatened USFS = U.S. Forest Service Sensitive Species S&M = U.S. Forest Service Survey & Manage Species BLM = Bureau of Land Management Sensitive Species
State: CE = California Endangered, CT = California Threatened, CFP = California Fully Protected Species, CPD = California Proposed Delisting, WL = CDFG Watch List
MSCS = CALFED Multi-species Conservation Strategy species
* species included in the May 10, 2011 stipulated settlement agreement (WildEarth Guardians 2011)

Table 16. Special-Status Aquatic Mollusks with the Potential to Occur in the SLWRI Primary Study Area.

Common Name	Scientific Name	Status[1]	Habitat/Occurrence
Aquatic Mollusks			
Nugget pebblesnail*	*Fluminicola seminalis*	USFS, S&M,	Aquatic mollusk endemic to large, cold, clear, well-oxygenated streams and rivers with stable gravel-boulder substrate; large spring pools with soft, mud substrates in Sacramento River basin including the Pit and McCloud River drainages and a few large spring-fed tributaries in Shasta, Modoc, and Lassen Counties, CA. Presumed to be extirpated on the main stem of the Sacramento River due to the 1991 spill of the pesticide metam sodium into the river (Hershler and Frest 1996).
Potem pebblesnail*	*Fluminicola potemicus*	USFS, S&M,	Aquatic mollusk endemic to small, shallow, perennial, cold springs and spring runs that are shaded in the upper Sacramento River and Pit River drainages of northern California.
Flat-top pebblesnail†	*Fluminicola sp. 15*	USFS, S&M,	Aquatic mollusk endemic to cold perennial springs in Upper Sacramento River, Shasta County, CA. Known at four spring sites on both sides of the Sacramento River at Shasta Springs and Mossbrae Falls (Center for Biological Diversity 2008b).
Shasta springs pebblesnail*†	*Fluminicola sp. 16*	USFS, S&M,	Aquatic mollusk endemic to lower portions of large cold springs in the Shasta Springs area, Shasta County, CA (Center for Biological Diversity 2008b).
Disjunct pebblesnail†	*Fluminicola sp. 17*	USFS, S&M,	Aquatic mollusk endemic to 2-3 cold perennial springs in the Shasta Springs area, Shasta County, CA (Center for Biological Diversity 2008b).
Goose Valley pebblesnail+	*Fluminicola anserinus*	USFS, S&M,	Aquatic mollusk endemic to small perennial springs and spring headwaters in the upper Sacramento and Pit River drainages. Known from only 3 sites (Center for Biological Diversity 2008b).
Cinnamon juga*	*Juga (Orebasis) sp.3*	USFS, S&M,	Aquatic mollusk endemic to large, cold springs and spring runs with sand-cobble substrate or exposed basalt bedrock at 4 - 8 sites in the Shasta Springs complex on the upper Sacramento River (Center for Biological Diversity 2008b).
Canary duskysnail*	*Colligyrus convexus*	USFS, S&M,	Aquatic mollusk endemic to shallow water in very large springs of the Pit River Drainage in Shasta, Lassen, and Modoc counties, CA (Center for Biological Diversity 2008b).
Knobby rams-horn*	*Vorticifex sp. 1*	USFS, S&M,	Aquatic mollusk endemic to a large spring complexes of the Pit River drainage in Shasta, Modoc, and Lassen Counties, CA (Center for Biological Diversity 2008b).

Sources: (Center for Biological Diversity 2008b, North State Resources, Inc. [NSR] 2004).
[1] STATUS
Federal
S&M = U.S. Forest Service Survey & Manage Species
USFS = U.S. Forest Service Sensitive Species
* species included in the May 10, 2011 stipulated settlement agreement; 12- month finding FY 2012 (WildEarth Guardians 2011). † species combined to become Shasta pebblesnail (*Fluminicola multifarious*) (USFWS 2012b) + formerly Globular pebblesnail (*Fluminicola* sp.18).

fragmented. Shasta snow-wreath exhibits low overall genetic diversity and may reflect a recent bottleneck resulting from the erection of Shasta Dam (NFGEL 2010; DeWoody *et al.* 2012). Three clusters of genetically similar populations have been identified, and should be considered in management and restoration activities (NFGEL 2010; DeWoody *et al.* 2012).

Potential threats to the species include logging, mining, wild fires, prescribed burns, invasive species, and the proposed enlargement of Shasta Dam in SLWRI (Shevock *et al.* 1992, CNPS 2007). Shasta snow-wreath is a slow growing species with a tendency to occur in relatively disturbed areas along the edge of the forest thus making the species especially vulnerable to invasive species (*i.e.*, blackberry) and human-related threats (J. Nelson, Shasta-Trinity National Forest, pers. comm, 2007). There is no published information available at this time on the effects of fire on Shasta snow-wreath, but preliminary evidence indicates that Shasta snow-wreath may not survive hot burns (J. Nelson, Shasta-Trinity National Forest, pers. comm., 2014).

Shasta snow-wreath is a USFS sensitive species, a CALFED MSCS species, and a CNPS 1B.2 species. The CALFED Final Programmatic EIS/EIR included Shasta snow-wreath among a list of "evaluated species for which direct mortality as a result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy [MSCS]." This conservation measure was developed because these species are extremely rare. For many of the plants identified, fewer, than a dozen known populations exist" (see Table 4-5 in MSCS section of CALFED 2000b). Conservation measures recommended by the CALFED MSCS are identified in Appendix C of this FWCA report.

During botanical and habitat mapping surveys (NSR 2004, Lindstrand and Nelson 2005a,b, Lindstrand 2007, L. Lindstrand and J. Nelson, Shasta-Trinity National Forest pers. comm. 2011; USBR 2014), Shasta snow-wreath was found at 11 sites within the Inundation Zone of the SLWRI. Therefore, as much as 46 percent (11 of 24 populations) of the entire known Shasta snow-wreath would be impacted by the proposed raising of Shasta Dam; other populations would be disturbed by the relocation of roads, bridges, campgrounds, and other facilities due to the SLWRI (Lindstrand 2007; USBR 2013). Some of the populations found within the Inundation Zone include: (1) a single, relatively large population occurring in riparian habitat along the Ripgut Creek riverine reach (Pit River Arm); (2) a large, previously known population along Campbell Creek (McCloud River Arm); (3) a very large population in riparian habitat along both sides of Stein Creek (Pit River Arm) extending from near the Stein Creek/Shasta Lake confluence to 0.25 mile upstream; (4) a small population found at an unnamed stream south of Cove Creek in riparian and mixed woodland habitat on the right bank, at the confluence with Shasta Lake; (5 and 6) one moderate and one large population along Blue Ridge on the main body of Shasta Lake in hardwood-conifer and ponderosa pine habitats immediately above the Shasta Lake high water line; and (7) a moderate-sized population in riparian habitat along both banks of Keluche Creek (McCloud River Arm) near the Keluche Creek/Shasta Lake confluence (NSR 2004, Lindstrand 2007). Shasta snow-wreath is a rhizomatous shrub; "thousands" of Shasta snow-wreath stems occur within the Inundation Zone (J. Nelson; Shasta-Trinity National Forest, pers. comm. 2014.

In addition to the 11 populations within the Inundation Zone, and 1 population that may be impacted by relocation of the Ellery Creek Campground, another 11 populations of Shasta snow-wreath are potentially threatened by non-project related activities (*e.g.*, timber harvest plans, mining, development, prescribed burn plans, invasive species, and other human-related disturbances) due to their location adjacent to State highways, county roads, forest roads, trails, homes, and transmission lines (Lindstrand 2007; J. Nelson, Shasta-Trinity National Forest and L. Lindstrand, NSR, pers. comm. 2011). Therefore, 96 percent of all the known populations of Shasta snow-wreath (23 out of 24 populations) are currently threatened by SLWRI or non-project related activities (Lindstrand 2007; J. Nelson, Shasta-Trinity National Forest and L. Lindstrand, NSR, pers. comm. 2011; USBR *in litt.* 2014).

Shasta Huckleberry
Shasta huckleberry is currently known from 23 occurrences in 14 general locations in the upper Spring Creek, Dry Fork, (Little) Squaw Creek, Shoemaker Gulch, and Little Backbone Creek drainages. Other general locations include South Fork Mountain, Bohemotash Mountain, and the vicinity of Bully Hill. All locations occur in an area historically known as the Copper Belt of Shasta County and many in the immediate vicinity of historic copper mining activities. Shasta huckleberry occurs at four locations in the SLWRI project area: (Little) Squaw Creek, Shoemaker Gulch, Little Backbone Creek, and Horse Creek near Bully Hill.

The Shasta huckleberry most closely fits the description of red huckleberry (*Vaccinium parviflorum*) except that the berries of this taxon are dark blue (Nelson 2004). These inland populations are disjunct from the nearest known extant red huckleberry populations by about 40 miles, with the Trinity Alps and other Klamath Ranges lying between them (Nelson 2004). The Shasta huckleberry grows in a distinct, much less mesic habitat than does the coastal red huckleberry and apparently has adapted to grow on low pH soils with unique mineral compositions associated with abandoned mine sites (Nelson 2004; J. Nelson, Shasta-Trinity National Forest, pers. comm., 2014). Recent studies (NFGEL 2011) have shown that the populations from Shasta County are genetically distinct, and show greater similarity to distant Sierra Nevada populations than to the proximate coastal huckleberry species (NFGEL 2011).

Shasta huckleberry occurs at four locations in the SLWRI project area: (1) along the Little Backbone Creek drainage from the confluence with Shasta Lake upstream; (2) throughout the Bully Hill Mine area near the Squaw Creek Arm; (3) (Little) Squaw Creek drainage, and (4) the Shoemaker Gulch drainage (L. Lindstrand, NSR, pers. comm. 2014; USBR 2013). Shasta huckleberry shrubs in a number of locations throughout its range are currently threatened by non-project related ground-disturbing activities associated with remediation of acid mine drainage on private land (L. Lindstrand, NSR, pers. comm., 2014).

Based on the results of genetic studies combined with distinct morphologic and ecologic characteristics, the Shasta huckleberry appears to be an uncommon and geographically restricted species and warrants recognition as a new taxon. The taxonomic treatment is in preparation.

At this time, Shasta huckleberry has not been officially identified as a distinct taxon; thus Shasta huckleberry has no official special-status.

Migratory and Special-Status Bird Species near Shasta Lake

Special-status bird species are those that are: (1) federally-listed as endangered or threatened or a candidate for listing under ESA; (2) State-listed as endangered, threatened, or a candidate for listing under CESA; (3) a California Fully Protected Species; (4) a California Species of Special Concern or on the CDFG Watch List; (5) a CALFED MSCS species; (6) protected under the Bald and Golden Eagle Protection Act; (7) listed by the Service as a Bird of Management Concern under the Migratory Bird Treaty Act (50 CFR 10.13) (*e.g.*, Bird of Conservation Concern at the national or regional level or a Game Bird Below Desired Condition [USFWS 2008]); or (8) on the United States Bird Conservation Watch List (American Bird Conservancy and National Audubon Society [Audubon] 2007). Common migratory bird species are those that are protected by the Migratory Bird Treaty Act but are not special-status bird species as defined above. There are 60 special-status bird species that may be affected by the SLWRI (Table 12).

Because birds occupy a wide diversity of ecological niches, they serve as useful tools in the design of conservation efforts (Martin 1995, Askins 2000). Birds are relatively easy to monitor in comparison with other taxa and can serve as "focal species," whose requirements define different spatial attributes, habitat characteristics and management regimes representative of a healthy system. By managing for a group of species representative of important components in a specific functioning habitat type ecosystem, many other species and elements of biodiversity will also be conserved (CalPIF 2002b). Thus, CalPIF maintains a list of focal bird species in its Bird Conservation Plans to guide conservation efforts in grassland, riparian, oak woodland, chaparral, and coniferous forest habitats in California (CalPIF 2000, 2002a, 2002b, 2004, RHJV 2004). A discussion of the CalPIF focal bird species likely to be affected by the SLWRI is included in Appendix D of this report.

The western purple martin is the migratory bird occurring in the vicinity of Shasta Lake that is likely to be the most adversely affected by the SLWRI. Thus, western purple martin is discussed below. Other migratory and special-status bird species in the vicinity of Shasta Lake with the potential to be affected by the SLWRI include California yellow warbler, little willow flycatcher, bald eagle, osprey, American peregrine falcon, long-eared owl, great blue heron, and northern spotted owl. These special-status species that may be affected by the SLWRI are discussed in Appendix D of this report. The conservation measures recommended by the CALFED Programmatic Final EIR/EIS and ROD (CALFED 2000a,b) are included for the special-status CALFED MSCS species in Appendix C of this report.

Western Purple Martin

Western purple martins (*Progne subis arboricola*) are generally uncommon and very local throughout California so all breeding locations are of considerable importance to the species' California range. The Pacific Coast purple martin population has substantially declined in the last 50 – 100 years, and appears to be continuing to decline primarily due to coastal lowland urban and agricultural development, forest management and fire suppression that have reduced the availability of large snags for nesting use, and increased competition with introduced European starlings and house sparrows for a dwindling supply of natural nest cavities (Western Purple Martin Working Group 2005). The current population estimate for western purple martins in California, Oregon, Washington, and British Columbia is about 3,500 pairs (1,300 pairs in California) (Western Purple Martin Working Group 2005). Western purple martins nest in small colonies in large snags where there are multiple natural cavities or cavities made by the larger woodpeckers such as acorn and Lewis' woodpeckers and northern flickers (Siegel and DeSante 1999).

At Shasta Lake, there appears to be a stable, but fluctuating population of purple martins that nest in the inundated snags in the Pit River arm (Lindstrand 2007, Lindstrand *in litt.* 2014). This population of western purple martins recently expanded their nesting to include a limited number of upland snags that were a result of the recent Jones and Bear Fires (Lindstrand *in litt.*2012). The inundated snags were created when the Pit River arm was not logged prior to the initial construction of Shasta Dam and creation of Shasta Lake. Shasta Lake represents 14 – 51 percent of the total interior Northern California population of western purple martins (USBR 2014). In April and May, western purple martins begin to build their nests in the natural cavities of inundated snags in the Pit River. Western purple martins select for snags and, unlike the more widespread eastern purple martins, rarely use artificial structures for nesting. In California, about 85 percent of western purple martins nest in natural cavities with the remaining 15 percent nesting in bridges and power poles (Western Purple Martin Working Group 2005). The interim objective for recovery within California is to retain at least 75 percent of the population nesting in natural cavities (Western Purple Martin Working Group 2005).

A raise in Shasta Dam would likely submerge a large portion of current suitable nesting habitat for western purple martins, although there would remain a number of snag nest sites after inundation. New inundated snags would likely be created by the dam raise, but there would be a time lag on the order of decades before the newly inundated snags would provide suitable nesting habitat (Len Lindstrand, NSR, pers. comm. 2014). It is uncertain if the use of upland nesting sites will continue and if those snags will be preserved and be available to replace the inundated snags that would be lost. The western purple martin is a CDFW species of special concern.

Special-Status Amphibians and Reptiles near Shasta Lake

Special-status amphibians and reptiles are species are those that are: (1) federally-listed as endangered or threatened or a candidate for listing under ESA; (2) State-listed as endangered, threatened, or a candidate for listing under CESA; (3) a California Fully Protected Species; (4) a California Species of Special Concern or on the CDFG Watch List; (5) a CALFED MSCS species; or (6) a USFS Sensitive Species. Special-status amphibians and reptiles with the potential to occur near Shasta Lake are summarized in Table 13. These species include the California red-legged frog, foothill yellow-legged frog, northwestern pond turtle, Shasta salamander, tailed frog, and western spadefoot toad. These special-status species that may be affected by the SLWRI are discussed in Appendix D of this report. The conservation measures recommended by the CALFED

Programmatic Final EIR/EIS and ROD (CALFED 2000a,b) are included for the special-status CALFED MSCS species in Appendix C of this report. Shasta salamander is endemic to Shasta County, California, and thus is the special-status amphibian species likely to be the most adversely affected by the SLWRI. Thus, Shasta salamander is discussed below.

Shasta Salamander

The Shasta salamander (*Hydromantes shastae*) is an uncommon and highly restricted species with a somewhat discontinuous distribution of small, isolated populations occurring in limestone areas (and in some non-limestone areas) in valley-foothill hardwood-conifer, ponderosa pine and mixed conifer habitats in the vicinity of Shasta Lake generally at elevations of 800 – 2,000 ft with a few occurrences between 2,000 – 3,800 ft (Lindstrand 2000; Lindstrand 2007; Morey *et al.* 2005) up to 5,450 ft (Lindstrand, *et al.* 2012). Each population is unique and vulnerable because of highly restricted habitat requirements (Morey *et al.* 2005). Shasta salamanders feed on centipedes, spiders, termites, beetles, and adult and larval flies (Stebbins 1972, Gorman and Camp 1953). Individuals are active on the surface nocturnally during rainy periods of fall, winter, and spring. Shasta salamander was previously thought to be restricted to limestone fissures and caverns, or deep limestone talus (Morey *et al.* 2005); however, more recently, the species has been found in non-limestone habitat 2.4 – 6.4 km (1.5 – 4 miles) (Lindstrand 2000; Lindstrand 2007), up to about 10.6 miles (Lindstrand, *et al.* 2012) away from the nearest limestone formations. Limestone habitats may act as natural reserves for the species during fires depending on the size of the outcrop, intensity of the fire, depth of the refugia holes, and distance to the burning material (K. Wolcott, Shasta-Trinity National Forest, pers. comm., 2014). Shasta salamanders have seldom been recorded travelling greater than 100 meters (328 ft), with most individuals moving an average of only 15 m (50 feet) (K. Wolcott *in litt.* 2014). Shasta salamanders breed and lay clusters of 9 to 12 eggs on damp limestone cavern walls in late summer. Young salamanders are thought to hatch in late fall (Gorman 1956, Papenfuss and Carufel 1977). Commercial demand for limestone may jeopardize existing populations (Morey *et al.* 2005).

Shasta salamander surveys were conducted between January – March 2003 within the Inundation Zone in the Big Backbone Creek and Squaw Creek arms, in 2006 to 2007 along other selected portions of the Shasta Lake shoreline, and 2010 in relocation areas (USBR 2013). Shasta salamanders have been found at 38 locations as a result of the surveys conducted. The Shasta salamander occurs in all arms of Shasta Lake, and may be found in both limestone and nonlimestone habitats. Shasta salamanders were observed in at least five sites within the Inundation Zone, including the Big Backbone Creek survey area, but none were observed in the Squaw Creek survey areas. Shasta salamanders were also observed at two discovery sites during the terrestrial mollusk surveys performed within the Big Backbone Creek arm portion of the Inundation Zone (NSR 2004). The Shasta salamander is a California threatened species and an USFS Sensitive and Survey and Manage species. Conservation measures recommended by the CALFED MSCS are identified in Appendix C of this report. The Center for Biodiversity petitioned the Service in July 2012 to list the Shasta salamander as endangered under the ESA; currently no action has been taken (Center for Biodiversity 2012).

Special-Status Mammals near Shasta Lake

Special-status mammal species are those that are: (1) federally-listed as endangered or threatened or a candidate for listing under ESA; (2) State-listed as endangered, threatened, or a candidate for listing under CESA; (3) a California Fully Protected Species; (4) a California Species of Special Concern or on the CDFG Watch List; (5) a CALFED MSCS species; (6) a USFS Sensitive Species; or (7) a Western Bat Working Group High or Medium Priority Species. Special-status mammals with the potential to occur near Shasta Lake are summarized in Table 14.

NSR conducted one winter survey (January – February 2003) and one spring survey (March – April 2003) for forest carnivores (carnivore protocol, Zielinski and Kucera 1995) within the Big Backbone Creek Arm and Squaw Creek Arm Inundation Zones. The surveys targeted specific sensitive forest carnivores including Sierra Nevada red fox, American marten, Pacific fisher, and wolverine. Pacific fishers were detected at one survey station in each of the two survey areas. Additional surveys near Shasta Lake in 2004 – 2005 discovered a total of 13 detections of Pacific fisher near Shasta Lake along the main body of Shasta Lake and the arms of Big Backbone Creek, Sacramento River, Squaw Creek, and Pit River (Lindstrand 2006). The surveys revealed that the Pacific fisher occurs throughout all of Shasta Lake and to areas to the east (USBR 2013; Lindstrand, pers. comm., 2014). The Pacific fisher is a Federal Candidate species, a California Species of Special Concern, and an USFS Sensitive species.

Other special-status mammals likely to occur in the vicinity of Shasta Lake include ringtail, California wolverine, American badger, American marten, fringed myotis, greater western mastiff-bat, long-legged myotis, pallid bat, spotted bat, Townsend's big-eared bat, and western red bat. Additionally, a recent occurrence of a gray wolf in northeastern California from the Oregon population makes the potential of individuals of that species occurring in the Primary Study Area a reasonable likelihood. These special-status mammals are discussed in Appendix D of this report. The conservation measures recommended by the CALFED Programmatic Final EIR/EIS and ROD (CALFED 2000a,b) are included for the special-status CALFED MSCS species in Appendix C of this report.

Special-Status Terrestrial Mollusks near Shasta Lake

There are six USFS Sensitive/Survey and Manage terrestrial mollusks and one (Oregon sideband) is also a BLM Sensitive terrestrial mollusk with the potential to occur near Shasta Lake (Table 15). Survey and Manage terrestrial mollusk surveys were conducted by NSR during two rounds of surveys in both Big Backbone Creek and Squaw Creek arm portions of the Inundation Zone between December 2002 and February 2003, and in 2014 (USBR 2014). Six Survey and Manage terrestrial mollusk species were found: Shasta chaparral snail, Shasta hesperian snail, Shasta sideband, Wintu sideband, Oregon sideband, and Church's sideband (NSR 2004, Lindstrand 2007; USBR 2014). Four of these terrestrial mollusks are endemic to the vicinity of Shasta Lake, and, thus, are likely to be adversely affected by the SLWRI. The survey results, habitat requirements, and known locations of Shasta chaparral snail, Shasta hesperian snail, Shasta sideband snail, and Wintu sideband snail are discussed below. On March 13, 2008, the Center for Biological Diversity petitioned for listing under ESA the four terrestrial mollusks among 28 other snails and slugs in the Pacific Northwest (Center for Biological Diversity 2008a,b). A Stipulated Settlement Agreement was entered into between WildEarth Guardians and the Service (WildEarth Guadians 2011), which sets a schedule for listing findings on a number of petitioned species, including four of the Special-Status Terrestrial Mollusks with the potential to occur in the SLWRI Primary Study Area listed on Table 15.

Shasta Chaparral Snail
Shasta chaparral snail (*Trilobopsis roperi*) is a terrestrial mollusk endemic to the southeastern Klamath Mountains in the vicinity of Shasta Lake (Lindstrand 2007). The terrestrial mollusk is known from 146 sites in Shasta County, California, including 3 sites on non-Federal land and 1 site lost under Shasta Lake (Burke *et al.* 1999, Kelley *et al.* 1999). There are no currently protected occurrences of the species (Burke *et al.* 1999). Shasta chaparral snail is also expected to be found within the Whiskeytown-Shasta-Trinity National Recreation Area (Burke *et al.* 1999). The mollusk may be found within 100 meters (330 ft) of lightly to deeply shaded limestone rockslides, draws, or caves, with a cover of shrubs or oak (Kelley *et al.* 1999). During the wet season, it may be found away from refugia foraging for green vegetation and fruit, feces, old leaves, leaf mold, and fungi (Burke *et al.* 1999). Present knowledge of this species is based on limited collecting from known population areas in the 1930s. Significant data gaps exist in the knowledge of the species' biologic and environmental needs (Burke *et al.* 1999). Local and range-wide population trends are not known (Burke *et al.* 1999). Threats to the species include road building and substantial road maintenance, recreational usage, limestone quarrying, mining, and urbanization in the Redding area (Burke *et al.* 1999, Frest and Johannes 2000). Shasta chaparral snails were detected at 29 sites within the Inundation Zone along the Sacramento River, McCloud River, Squaw Creek, and Pit River arms (NSR 2004; Lindstrand 2007; USBR 2013). On March 13, 2008, the Center for Biological Diversity petitioned for listing the Shasta chaparral snail under the ESA (Center for Biological Diversity 2008a,b). The Service subsequently determined in its 90-day Finding (September 2011) that the Shasta chaparral snail may warrant listing under the ESA, the 12-month Finding has not been completed as of this report.

Shasta Hesperian Snail
Shasta hesperian snail (*Vespericola shasta*) is a small terrestrial mollusk endemic to Shasta County, California, primarily in the vicinity of Shasta Lake at an elevation of 244-853 meters (800-2,800 ft) (Kelley *et al.* 1999). The snail is known from only 78 sites, all within the watershed of the upper Sacramento River in Shasta County (Burke *et al.* 1999). The species has a discontinuous distribution becoming even more fragmented due to climate change, reservoirs, gold mining, and livestock grazing (Burke *et al.* 1999). The Shasta hesperian snail seems to be scarce to moderately common where it does occur, but the known locations are few and widely distributed; the snail species seems to be truly rare and vulnerable to extinction if there were adverse modifications of inhabited locations (Burke *et al.* 1999). Possible threats to the local survival of Shasta hesperian snail include loss of favorable microclimate through reduction or removal of riparian trees, the mechanical disruption of inhabited sites (by motor vehicles and earth-moving machinery), chemical pollution,

invasion of the local ecosystem by nonnative plants and animals, and extensive removal of vegetation from watersheds that results in destructive floods and the loss of surface flow (Burke *et al.* 1999). There are no known protected occurrences of the species. Six of the historic locations for this species are within the administrative boundaries of Shasta National Forest (administered as Shasta-Trinity National Forests), but only one current location is known to be on Federal land. The six non-Federal locations are all within 1.6 km (1 mile) of Federal lands (Burke *et al.* 1999).

Shasta hesperian snail has been found in moist bottom lands, such as riparian zones, springs, seeps, marshes, and in the mouths of caves (Kelley *et al.* 1999). The snail seems to be restricted to isolated locations along the margins of streams where perennial dampness and cover can be found. Limestone in the alluvium of the streams of the upper Sacramento River system may contribute to habitat quality for this species. The relatively polished appearance of the shell of this species could be consistent with life in a stony environment--in contrast to other species of Vespericola that have a "furry" appearance and live on the soft surfaces of leaves and rotten wood on damp forest floors (Burke *et al.* 1999).

Shasta hesperian was detected at 74 sites within the Inundation Zone (NSR 2004; Lindstrand 2007; USBR 2013). Shasta hesperian is currently designated as Category A species under the Northwest Forest Plan 2001 Survey and Manage Standards and Guidelines Category Assignment (USFS 2001). Taxa in this category are considered rare, and preservation of all known sites or population areas is likely to be necessary to provide reasonable assurance of species persistence. On March 13, 2008, the Center for Biological Diversity petitioned for listing the Shasta hesperian snail under ESA (Center for Biological Diversity 2008a, b). In September 2011, the Service determined in its 90-day Finding that the Shasta hesperian snail may warrant listing under the ESA; the 12-month Finding has not been completed as of this report.

Shasta Sideband

Shasta sideband (*Monadenia troglodytes troglodytes*) is a terrestrial mollusk endemic to the southeastern Klamath Mountains in the vicinity of Shasta Lake up to an elevation of 3,000 – 3,500 ft (Lindstrand 2007). Shasta sideband was known from only 9 sites (USFWS 2011), but 29 locations have been found in the Shasta Lake and vicinity portion of the primary study area during 2002 to 2003 and 2005 survey efforts, including protocol-level surveys of selected portions of the Shasta Lake shoreline and protocol-level efforts initiated in 2010 at the relocation areas. Shasta sideband occurs within conifer, hardwood-conifer, hardwood, and chaparral general habitat types but appears to be restricted to larger limestone outcrops with deep crevices along the McCloud River arm within the vicinity of Shasta Lake (Roth 1981, Lindstrand 2007). Four of the 29 known sites where Shasta sidebands were found are within the Inundation Zone along the McCloud River arm (Lindstrand 2007). It is not known at this time what percent of the population occurs within the Inundation Zone. Shasta sideband is a USFS Survey and Manage Species – Category A, a USFS Sensitive species, and a CALFED MSCS species. Conservation measures recommended by the CALFED MSCS are identified in Appendix C of this report. On March 13, 2008, the Center for Biological Diversity petitioned for listing the Shasta sideband snail under ESA (Center for Biological Diversity 2008a,b). In September 2011, the Service determined in its 90-day Finding that the Shasta sideband snail may warrant listing under the ESA; the 12-month Finding has not been completed as of this report.

Wintu Sideband

Wintu sideband (*Monadenia troglodytes wintu*) is a terrestrial mollusk endemic to the southeastern Klamath Mountains in the vicinity of Shasta Lake up to an elevation of 3,000 – 3,500 ft (Lindstrand 2007). Wintu sideband is known from only eight sites, and like Shasta sideband, occurs within conifer, hardwood-conifer, hardwood, and chaparral general habitat types but appears to be restricted to larger limestone outcrops with deep crevices in the vicinity of Shasta Lake between the Pit River and Squaw Creek, with one disjunct, outlying population south of Shasta Lake along the Pit River arm within the vicinity of Shasta Lake (Roth 1981, Lindstrand 2007). Wintu sidebands were found at two sites within the Inundation Zone along the Pit River arm (Lindstrand 2007). It is not known at this time what percent of the population occurs within the Inundation Zone. Wintu sideband is a USFS Survey and Manage Species – Category A and a USFS Sensitive species. On March 13, 2008, the Center for Biological Diversity petitioned for listing the Wintu sideband snail under ESA (Center for Biological Diversity 2008a,b). In September 2011, the Service determined in its 90-day Finding that the Wintu sideband snail may warrant listing under the ESA; the 12-month Finding has not been completed as of this report.

Klamath or Church's Sideband

Klamath or Church's sideband (*Monadenia churchi*) is a terrestrial mollusk found in Butte, Humboldt, Shasta, Siskiyou, Tehama, and Trinity counties (BLM 1999). Church's sideband is found in mixed conifer habitats in limestone outcrops, caves, talus slides, and lava rockslides. Church's sidebands are especially associated with riparian areas and under nearby forest debris in heavily shaded areas. Church's sideband are found around Shasta Lake in brush and pine-oak woodlands (BLM 1999), and were the most commonly occurring terrestrial mollusk found during project surveys; they were found in 325 sites within the Primary Study Area (USBR 2014).

Oregon Shoulderband

Oregon shoulderband (*Helminthoglypta hertleini*) is a terrestrial mollusk endemic to southwest Oregon and northern California including Shasta County (BLM 1999). In the Shasta Lake vicinity the Oregon sideband occurs along the Big Backbone Creek Inlet, McCloud River Arm, and Pit River Arm (USBR 2014). The Oregon shoulderband is associated with rocks and debris in rocky areas within forest habitats, often adjacent to areas with substantial grass or seasonal herbaceous vegetation. Seasonal refugia include talus deposits and limestone outcrops that provide protection from fire and predation during inactive periods. These areas of rocky habitat are associated with subsurface water, herbaceous vegetation and deciduous leaf litter, generally within 100 feet of stable talus deposits or rocky inclusions. Vegetation types where the species has been located include dry conifer and mixed conifer/hardwood, as well as oak forest habitats (USFS 2004). Oregon sideband was the second most commonly found terrestrial mollusk species, occurring in 220 locations within the Shasta Lake vicinity surveys (USBR 2014).

Special-Status Aquatic Mollusks near Shasta Lake

Special status aquatic mollusks are described above on pages 29 through 31, and are listed in Table 16.

Incidental Observations of Non-Status Wildlife near Shasta Lake

In 2003, NSR recorded incidental observation of non-status wildlife species observed during special-status species surveys within the Big Backbone Creek and Squaw Creek arms of the Inundation Zone (NSR 2004). Mammal species observed include gray fox, black bear, mountain lion, black-tailed mule deer, wild boar, and spotted skunk. Bird species observed include turkey vulture, Steller's jay, and common raven. Herpetofauna observed include the rough-skinned newt, ensantina, black salamander, western toad, western fence lizard, western skink, northern alligator lizard, sharp-tailed snake, garter snake, and ringneck snake. Non-Survey and Manage terrestrial mollusks observed include Church's sideband, shoulderband harpoon snail, and California megomphix (NSR 2004).

Primary-Study Area: Sacramento River and Tributaries from Keswick Dam to Red Bluff Pumping Plant

Aquatic Resources

The Sacramento River flows for about 59 miles between Keswick Dam and RBPP. The river in this reach has a stable, largely confined channel with little meander. Riffle habitat with gravel substrates and deep pool habitats are abundant in comparison with reaches downstream from RBPP. Immediately downstream of Keswick Dam, the river is deeply incised in bedrock with very limited riparian vegetation and no functioning riparian ecosystems. Water temperatures are generally cool even in late summer due to regulated releases from Shasta Lake and Keswick Reservoir. Near Redding, the river comes into the valley and the floodplain broadens. Historically, this area appears to have had wide expanses of riparian forests, but much of the river's riparian zone is currently subject to urban encroachment. This encroachment becomes quite extensive in the Anderson/Redding area with homes placed directly within or adjacent to the riparian zone (USBR 2007).

Noxious weeds such as giant reed (*Arundo donax*) (arundo) along the Sacramento River and tributaries displace native riparian vegetation that is important habitat for migratory birds. Also, unlike native riparian vegetation, arundo provides very little shade and cover for salmonids resulting in warmer water temperature and little juvenile rearing habitat (Bell 1997). Arundo also affects stream geomorphology, changing riparian areas from flood-dominated to fire-dominated ecosystems. It grows readily on gravel bars and in the streambed, changing flow regimes and directing erosive flows to opposite banks. The flows undercut and destabilize stream banks (habitat for bank swallows), causing tree loss, property damage, and siltation. The silt impairs fish spawning grounds, leading to further stress on threatened aquatic species (Bell 1997).

The Keswick to RBPP reach of the Sacramento River contains a large assemblage of resident and anadromous fish species, including commercially important species and species that are listed as threatened or endangered. Since construction of Shasta Dam, this reach continues to have a net loss of suitable gravel and large woody debris that are essential to the spawning and rearing of salmonids. This reach provides much of the remaining spawning and rearing habitat of several listed anadromous salmonids. As such, it is one of the most sensitive and important stream reaches in the State.

The upper Sacramento River system is unique in that it supports four separate runs of Chinook salmon. Each is recognized by its season of upstream migration: fall-, late fall-, winter-, and spring-run Chinook salmon. Runs of fall- and spring-run Chinook salmon also occur on several tributaries of the Sacramento River. The adult population of the four runs of salmon and other important fish species (including steelhead), which also spawn upstream from RBPP, has significantly declined since the 1950s. Today, fall-run, late fall-run and winter-run Chinook salmon stocks and steelhead stocks in the Keswick to RBPP are augmented by production from the Coleman Fish Hatchery on Battle Creek (USBR 2007).

Major factors that contribute to the decline in upper Sacramento River salmon populations include elevated water temperature; modification and loss of spawning and rearing habitat due to construction of water resources projects; predation; pollution; and entrainment in water diversions on the Sacramento River and in the Delta. Drought conditions in the late 1980s and early 1990s also significantly contributed to population declines. The construction of the TCD at Shasta Dam improved temperature conditions for anadromous fish spawning and rearing in the Sacramento River immediately downstream from Keswick Dam. However, thermal mortality of anadromous fish may still occur downstream from Keswick Dam during dry and critically dry water years when the cold water pool at Shasta Lake is exhausted. Improvements to the "leaky" TCD would prevent some of the thermal mortality of anadromous fish.

Temperature impacts vary according to life cycle. Maximum survival of incubating salmon and steelhead eggs and yolk-sac larvae occurs at water temperatures between 41°F and 56°F, with no survival occurring at 62°F or higher. After hatching, sac fry are completely dependent on the yolk sac for nourishment and may tolerate water temperatures up to 58°F. After juvenile salmon have emerged from the gravel and become independent of the yolk sac, the young salmon are able to tolerate water temperatures up to 67°F. Since winter-run and spring-run Chinook salmon spawn during late spring and summer; they are particularly vulnerable to warmer water temperature conditions in the river (USBR 2007).

For a period after Shasta Dam was constructed, the reservoir was kept relatively full and the cold water released from the hypolimnion provided cooler summer temperatures in the downstream reaches. The cold water releases created suitable conditions for winter-run and spring-run salmon to spawn in the mainstem Sacramento River downstream of Keswick dam. Since winter-run Chinook salmon spawning habitat is almost entirely restricted to the Sacramento River between Keswick Dam and the RBPP, winter-run Chinook salmon survival is strongly tied to habitat conditions in this reach. In the late 1980s and early 1990s, because of a series of dry year conditions, storage space in Shasta Lake was decreased to satisfy water demands for agricultural, M&I, and other environmental uses. This decrease in storage resulted in a depletion of the cold water pool, resulting in warmer water in the river and a higher mortality of salmon eggs (USBR 2007).

A NMFS biological opinion for winter-run Chinook established water temperature objectives for the river upstream of Jellys Ferry (upstream of RBPP) of 56°F from April 15 through September 30, and 60°F for October (NMFS 1993). Recent changes in reservoir operations, including greater carryover storage, and, most importantly, installation of a TCD on Shasta Dam, have substantially improved water temperature conditions in the reach.

The Plan Formulation Report (USBR 2007) describes the following problems in the Sacramento River affecting anadromous fish:

- Glenn-Colusa Irrigation District (GCID) pumps divert up to 3,000 cfs and approximately 1 million af (MAF) of water annually through inadequate fish screens. GCID recently replaced its cylindrical fish screens with a flat-plate screen.
- ACID's seasonal flashboard dam in Redding diverts up to 400 cfs, and impedes upstream migrating adults and downstream migrating juveniles. ACID constructed a new diversion facility with fish ladders in 2002.
- Access to historical spawning and rearing habitat is restricted.
- Hundreds of small unscreened diversions entrain fish.
- Bank protection projects reduce available remaining habitat.
- High water temperatures associated with reservoir storage decrease fish habitat. Reclamation constructed the Shasta TCD on the upstream face of Shasta Dam to access deeper and cooler water for downstream water temperature control and power generation.
- Discharges of chemical waste from M&I and agricultural sources decrease the quality of fish habitat; chronic contamination from numerous and widespread sources; remedial efforts at Iron Mountain Mine and the construction and operation of Spring Creek Debris Dam have helped to reduce heavy metal and acid waste from Iron Mountain Mine.

Numerous tributaries to the Sacramento River are important for the recruitment of gravel and large woody debris into the mainstem Sacramento River. These tributaries include colder perennial streams and warmer intermittent streams both of which provide important nonnatal rearing habitat for salmonids that emerged as fry in the mainstem Sacramento River. The perennial streams provide a constant flow of colder water from the higher elevations. The intermittent streams provide pulses of organic matter inputs and warmer temperatures which accelerate the growth rate of juvenile salmonids that emerged as fry in the mainstem Sacramento River (Maslin *et al.* 1996, 1997, 1998, 1999). Some of the tributaries also provide important spawning habitat for salmonids (*e.g.*, Battle Creek, Clear Creek, Cottonwood Creek, and Cow Creek). The tributaries also contribute flow during certain periods that encourage floodplain inundation events in the mainstem Sacramento River. Therefore, based on the importance of these tributaries to the survival of salmonids in the mainstem Sacramento River, the Service believes that the primary study area for the

SLWRI should be expanded to include the lower reaches of these tributaries and not just their points of confluence with the Sacramento River. Additionally, it is believed that the downcutting of the tributaries and current loss of riparian habitat is due to the reduction in flood flows in the Sacramento River since the construction of Shasta Dam. Thus, a further reduction in flood flows in the Sacramento River with the raising of Shasta Dam could result in further downcutting of the tributaries and loss of riparian habitat.

As stated above, the major factors that contribute to the decline in upper Sacramento River salmon populations include elevated water temperature; modification and loss of spawning and rearing habitat due to construction of water resources projects; predation; pollution; and entrainment in water diversions on the Sacramento River and in the Delta. Drought conditions in the late 1980s and early 1990s also significantly contributed to population declines. Of these influencing factors, water temperature is one of the most important.

Fortunately, cold water released from Shasta Dam significantly helps support spawning, incubation, and rearing of salmonids in the reach below Keswick Dam. Without these cold water releases, winter-run Chinook salmon would possibly have become extinct, otherwise dispossessed of their historic spawning streams. However, temperatures still rise to levels harmful to salmon and steelhead during some dry and critically dry water years.

Special-Status and Target Aquatic Species in the Sacramento River between Keswick Dam and RBPP

Four runs of Chinook salmon, steelhead, and green sturgeon compose the anadromous fishery in the Sacramento River between Keswick Dam and RBPP. Because increasing the survival of these fish is one of the primary goals of the Project, basic life history information is provided below. The generalized life history timing of the four runs of Central Valley Chinook salmon is summarized in Table 17 below. More-detailed life history patterns and the general timing of Chinook salmon and steelhead runs in the Sacramento River between Keswick Dam and the RBPP will be described in the SLWRI Project BA for consultation under section 7 of the ESA.

Special-status warmer water fish that occur in the Sacramento River between Keswick Dam and RBPP include hardhead. A discussion of the special-status salmonids and warmer water fish species in the Sacramento River between Keswick Dam and RBPP is provided in Appendix D of this report.

Table 17. Generalized Life History Timing of Central Valley Chinook Salmon Runs.

Run	Adult Migration Period	Peak Migration Period	Spawning Period (1)	Peak Spawning Period	Fry Emergence Period	Juvenile Stream Residency	Juvenile Emigration Period
Late fall	Oct – Apr	Dec	Early Jan - Mar	Feb - Mar	Apr - Jun	7-13 months	Apr - Dec
Winter	Dec - Jul	Mar	Late Apr - Oct	May - Jun	Jul - Oct	5-10 months	Jul - Apr
Spring	Mid-Feb - Jul	Apr - May	Late Aug - Dec	Mid-Sep	Nov - Mar	3-15 months	Oct - Mar
Fall	Jul - Dec	Sep - Oct	Late Sep - Mar	Oct - Nov	Dec - Mar	1-7 months	Dec - Jun

Sources:
(CDFG 1998; Moyle 2002; NMFS 2004a; Vogel and Marine 1991).

Note:
(1) The time periods identified for spawning include the time required for incubation and initial rearing, before emergence of fry from spawning gravels.

Upland and Riparian Resources

This section discusses the upland and riparian vegetation communities that occur within the primary study along the Sacramento River between Keswick Dam and RBPP. These vegetation communities may be affected by changes in the timing and duration of flood flows in the Sacramento River due to the SLWRI. Also, the restoration of riparian and oak woodland communities along the Sacramento River is being considered within CP4 and CP5.

Vegetation within the Sacramento River Valley includes a variety of both upland and lowland plant communities, including a number of communities that are considered sensitive. Common plant communities present within the primary study area include annual grassland, blue oak woodland/savanna, foothill pine-oak woodland, chaparral, and agricultural lands. The upper banks along steep-sided, bedrock constrained segments of the Sacramento River and its tributaries are characterized primarily by upland communities including blue oak woodland, foothill pine-oak woodland, and chaparral. These incised segments occur primarily between Shasta Dam and Redding (USBR 2007).

Historically, the Sacramento River was bordered by up to 500,000 acres of riparian forests, with valley oak woodland covering the higher river terraces (Katibah 1984). Approximately 23,000 acres (11 percent of the original amount) of riparian habitat and valley oak woodland remain within the Sacramento River corridor (Sacramento River Conservation Area Forum [SRCAF] 2003). By the 1980s less than 5 percent of the Sacramento River's riparian habitat remained (SRCAF 1989). State Senate Bill 1086, which passed in 1986, established the Upper Sacramento River Fisheries and Riparian Habitat Advisory Council and called for a management plan to protect, restore, and enhance fish and riparian habitat and associated wildlife of the upper Sacramento River. The management plan for the Sacramento River Conservation Area (SRCAF 1989) identifies specific actions that will help restore the Sacramento River fishery and protect and restore riparian habitat.

The Keswick - Red Bluff section of the Sacramento River Conservation Area encompasses 22,000 acres of the 100-year floodplain and contiguous valley oak woodland, ranging in width from more than one-mile wide in the broad alluvial area Bloody Island to only 500 feet in the confined canyon near Table Mountain and within Iron Canyon (SRCAF 2003). There are currently 4,674 acres of riparian habitat within the Keswick-Red Bluff section of the Conservation Area (SRCAF 2003). The broad alluvial portion of the reach between Redding and Balls Ferry has the potential to support significant tracts of riparian forest (SRCAF 2003).

Upland Communities

Oak Woodlands

Oak and other hardwood habitats at low- and mid-elevations are important for many wildlife species found along the upper Sacramento River. Oak woodland is one of the most biologically diverse communities in California (Merelender and Crawford 1998). Oaks provide shelter, through shading and within trunk cavities, for a variety of wildlife in an otherwise open, dry landscape. Large acorn crops and a diverse insect fauna provide high quality food for a wide variety of amphibians, reptiles, birds, and mammals (USBR 2008).

In the Oak Woodland Bird Conservation Plan (CalPIF 2002a), CalPIF focuses on the following bird species for conservation associated with oak woodland habitat within the primary study area along the Sacramento River: acorn woodpecker, blue-gray gnatcatcher, lark sparrow, Nuttall's woodpecker, oak titmouse, western bluebird, western scrub-jay, and yellow-billed magpie. But conservation recommendations, if implemented, should benefit many oak woodland associated species.

Riparian Communities

Much of the vast riparian habitat that once existed along the Sacramento River has been eliminated by agricultural clearing, flood control projects, and urbanization. Historically, belts of riparian forest over 5 miles wide occurred along the Sacramento River (Jepson 1893, Thompson 1961, Hunter *et al.* 1999). Only narrow remnants of these riparian forests remain in the Sacramento River Valley. Riparian communities present within the 100-year floodplain of the Sacramento River, within the study area, include blackberry scrub, Great Valley willow scrub, Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, and Great Valley valley oak riparian forest. Willow and blackberry scrub, and cottonwood and willow-dominated riparian communities are present along active channels and on the lower flood terraces whereas valley-oak dominated communities occur on higher flood terraces. Much of the Sacramento River from Shasta Dam to Redding is deeply entrenched in bedrock, which precludes development of riparian vegetation.

Riparian communities in the primary study area are subject to CDFW regulation under Section 1602 of the California Fish and Game Code because they are associated with stream banks and are identified as sensitive natural communities by CDFW because of their declining status statewide and because of the important habitat values they provide to both common and special-status plant and animal species. These habitat types are tracked in the CNDDB. In addition, areas containing riparian habitat may be subject to the Army Corps of Engineers (Corps) jurisdiction under Section 404 of the Clean Water Act (CWA).

In the Riparian Bird Conservation Plan (RHJV 2004), CalPIF and RHJV focus on the following bird species for conservation associated with riparian habitat within the primary study area along the Sacramento River: bank swallow, black-headed grosbeak, blue grosbeak, common yellowthroat, song sparrow, Swainson's hawk, tree swallow, tricolored blackbird, western yellow-billed cuckoo, yellow-breasted chat, and yellow warbler. But conservation recommendations, if implemented, should benefit many riparian associated species. Special-status bird species that are known to occur in riparian habitat along the Sacramento River include western yellow-billed cuckoo, California yellow warbler, yellow-breasted chat, tricolored blackbird, bank swallow, and Swainson's hawk. Each of these special-status bird species are discussed in Appendix D of this report. Species-specific conservation measures for CALFED MSCS bird species are included in Appendix C of this report.

Shaded Riverine Aquatic Cover

SRA cover is defined as the nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. The principal attributes of this valuable cover-type include: (a) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (b) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents (USFWS 1992). These attributes provide high-value feeding areas, burrowing substrates, escape cover, and reproductive cover for numerous regionally important fish and wildlife species, including the State- and federally-listed winter-run Chinook salmon and the State-listed bank swallow. However, this cover-type on the Sacramento River and its major tributaries has been rapidly lost over the past 30 years, primarily due to bank protection projects such as the Corps' Sacramento River Bank Protection Project. Since 1961, the Corps has constructed over 140 miles of riprapped riverbanks in the Sacramento River system. As a result, we estimate that only 7 percent of historic SRA cover remains in the lower Sacramento River and its four major sloughs (USFWS 1992). Recent snorkeling surveys show that due to the loss of SRA cover, less than 1 percent of the middle Sacramento River (*i.e.*, river miles 180 – 230 [a few miles downstream from Ord Ferry up to Elder Creek]) currently provides suitable rearing habitat for juvenile Chinook salmon (Cannon 2007).

Blackberry Scrub

Blackberry scrub is dominated by Himalayan blackberry, a species that is listed as invasive by the California Invasive Plant Council. There is a native California blackberry shrub, but its occurrence is sporadic on the valley floor. California blackberry gets outcompeted by the invasive Himalayan blackberry. Cover of Himalayan blackberry is extremely dense in this community leaving little opportunity for the establishment of native tree seedlings or shrubs beneath its canopy (USBR 2006a). Herbaceous cover is also very sparse. Scattered individual trees and shrubs may be interspersed through the blackberry scrub community. Himalayan blackberry generally establishes in gaps created by natural or human disturbances. Although Himalayan blackberry is an invasive species, this community does provide nesting habitat for some bird species and may be regulated under Section 1602 of the California Fish and Game Code when located within the bed, channel, or bank of a stream and may be subject to Corps jurisdiction under Section 404 of the CWA (USBR 2006a). The presence of Himalayan blackberry was found to positively influence yellow warbler abundance (RHJV 2004).

Great Valley Willow Scrub
Great Valley willow scrub is a deciduous broadleaved community with open to dense cover of shrubby willows. This community type may be dominated by a single species of willow or by a mixture of willow species. Dense stands have very little understory while more open stands have herbaceous understories, usually dominated by grasses characteristic of the annual grassland community. Characteristic plant species include sandbar willow, arroyo willow, shining willow, and California wild rose (USBR 2006a). Sandbar willow was found to positively influence the abundance of yellow-breasted chat (RHJV 2004). This community occupies point bars and narrow corridors along the active river channel that are repeatedly disturbed by high flows (USBR 2006a).
Great Valley Cottonwood Riparian Forest

Great Valley cottonwood riparian forest is a deciduous broadleaved forest community with a dense tree canopy dominated by Fremont cottonwood and often including a high abundance of black willow. This community also has a dense understory of seedlings, saplings, and sprouts of the canopy dominants and shade-tolerant species including box-elder and Oregon ash. Characteristic shrub species include California buttonbush and willows. Lianas such as California grape are typically present as well. This community occupies lower floodplain terraces that are flooded annually (USBR 2006a). It provides important breeding habitat for sensitive migratory birds including black-headed grosbeak, blue grosbeak, Swainson's hawk, yellow-breasted chat, and yellow-billed cuckoo (RHJV 2004). Fremont cottonwood has a positive influence on the abundance of black-headed grosbeak, while tree richness has a positive influence on black-headed grosbeak occurrence (RHJV 2004).

Great Valley Mixed Riparian Forest
Great Valley mixed riparian forest is a deciduous broadleaved forest community with a moderately dense to dense tree canopy that typically includes several species as codominates. Shrubs and lianas are also typically present. Mixed riparian forest is typically dominated by sycamore and valley oak with Fremont cottonwood, white alder, and willow, and Oregon ash also occurring frequently. Common shrub species in this community type include blue elderberry, California buttonbush, spicebush, and Himalayan blackberry. The herbaceous understory consists primarily of annual grasses and forbs similar to those found in the annual grassland communities but with a higher proportion of shade-tolerant species such as miner's lettuce, common bedstraw, bur-chervil, and meadow nemophila. At stream edges, the herbaceous understory of this community is characterized

by hydrophytic species such as tall flatsedge, common tule, cattail, sedges, deergrass, and common monkeyflower. This community occupies intermediate flood terraces that are subject to occasional high-flow disturbance (USBR 2006a). It provides important breeding habitat for sensitive migratory birds including black-headed grosbeak, blue grosbeak, Swainson's hawk, yellow-breasted chat, and yellow-billed cuckoo (RHJV 2004). Shrub richness has a positive influence on the occurrence of common yellowthroat (RHJV 2004).

Great Valley Valley Oak Riparian Forest

Great Valley valley oak riparian forest is a deciduous broadleaved forest community with a closed canopy. This community type is similar to the Great Valley mixed riparian forest community described above but is clearly dominated by valley oak. Characteristic species include many of the same associates found in the Great Valley mixed riparian forest community type but tree and shrub associates are more widely scattered. This community occupies upper floodplain terraces where flooding is infrequent but soil moisture is high (USBR 2007). The presence of valley oak has a positive influence on yellow warbler and song sparrow abundance (RHJV 2004).

Wetland Vegetation Communities

Similar to riparian communities, much of the wetland habitat that once occurred in the Sacramento River Valley has been eliminated as a consequence of land use conversion to agriculture and urbanization. It is estimated that nearly 1.5 million acres of wetlands once occurred in the Central Valley. Today, about 123,000 acres remain. Wetland communities that are likely to occur in the primary study area between Shasta Dam and RBPP include freshwater marsh, freshwater seep, northern hardpan vernal pools, northern volcanic mudflow vernal pools, and other seasonal wetlands. Wetland plant communities in the primary study area may be subject to Corps jurisdiction under Section 404 of the CWA, if they meet the three wetland criteria (hydric soils, evidence of wetland hydrology, and hydrophilic plants) or are contained within a jurisdictional water of the United States. Wetland communities that do not fall under Corps jurisdiction may still be regulated as waters of the State. In addition, wetland plant communities may be subject to CDFW regulation under Section 1602 of the Fish and Game Code if they are located within the bed, channel, or bank of a stream. Vernal pools are considered sensitive because they provide potential habitat for federally-listed species including slender Orcutt grass, vernal pool fairy shrimp, and vernal pool tadpole shrimp; provide important ecological values and functions; and are likely considered waters of the State subject to jurisdiction of the Central Valley Regional Water Quality Control Board under the Porter-Cologne Act (USBR 2006a).

Freshwater Marsh

Freshwater marshes are herbaceous wetland plant communities that occur along rivers and lakes and are characterized by dense cover of emergent vegetation. Marshes are typically perennial wetlands, but may dry out for short periods of time. Characteristic freshwater marsh species include common tule, narrowleaf cattail, broadleaf cattail, common reed, tall flatsedge, common spikerush, and sedges (USBR 2007). The presence of sedges has a positive influence on the abundance of yellow-breasted chat and the occurrence of common yellowthroat (RHJV 2004).

Freshwater Seep

Freshwater seep is a wetland plant community characterized by dense cover of perennial herb species usually dominated by rushes, sedges, and grasses. Freshwater seep communities occur on sites with permanently moist or wet soils resulting from daylighting groundwater. Species commonly observed in freshwater seeps in the area include rushes, sedges, flatsedges, deergrass, cattail, bull thistle, blue-eyed grass, and willow (USBR 2007). The presence of sedges has a positive influence on the abundance of yellow-breasted chat and the occurrence of common yellowthroat (RHJV 2004).

Seasonal Wetland

Seasonal wetlands are ephemeral wetlands that pond or remain flooded for long periods during a portion of the year, generally the rainy winter season, then dry up, typically in spring. They often occur in shallow depressions on flood terraces that are occasionally to infrequently flooded. Seasonal wetlands are herbaceous communities typically characterized by species adapted for growth in both wet and dry conditions, and may contain considerable cover of upland species as well. Species commonly present in seasonal wetlands include tall flatsedge, dallisgrass, Bermuda grass, Italian ryegrass, Mediterranean barley, and curly dock. Seasonal wetlands differ from vernal pools in that they do not have a restrictive hardpan layer and are usually dominated by nonnative plant species, especially nonnative grasses. Vernal pools are typically distinguished by a unique host of native and endemic plant species adapted to the extreme conditions created by the cycles of inundation and drying. Seasonal wetlands differ from freshwater marshes and seeps in that they are not permanently flooded or saturated. The seasonal wetland community type is not included in the Holland or Sawyer and Keeler-Wolfe classification systems, but is recognized by Corps and may be subject to their jurisdiction under Section 404 of the CWA (Reclamation 2006a).

Non-Status Wildlife

The variety and availability of habitats along the Sacramento River between Shasta Dam and RBPP support a wide range of wildlife species. The composition, abundance, and distribution of wildlife are directly related to the accessibility of these habitats. These habitats support a wide variety of wildlife including a variety of waterfowl, raptors, and migratory and resident avian species, plus a variety of mammals, amphibians, and reptiles that inhabit both aquatic and upland habitats within the study area. Overall, however, the quantity and variety of wildlife species now inhabiting the area are fewer than before agricultural and residential development permanently removed much of the native and natural habitat. Many of the wildlife species are unable to adapt to other habitat types or altered habitat conditions and are, therefore, most susceptible to habitat loss and degradation. Species that depended on riparian woodland, oak woodland, marsh, and grassland habitats have declined. The region also supports a variety of exotic species, some of which are detrimental to survival of native species (USBR 2006a). Existing native habitat, especially riparian corridors along the Sacramento River and associated sloughs and creeks, provides habitat for many native species. While riparian habitat is limited in this area, it supports the greatest abundance of wildlife, including a variety of avian species such as waterfowl and raptors; skunks; opossums; frogs, toads, and other amphibians; bats; coyote and fox; and garter snake and other reptiles. Riparian habitat provides shade, cover, and food supply to the immediate shoreline environment of large rivers, benefiting fish and wildlife species such as salmonids, river otter, beaver, heron, egret, and belted kingfisher (USBR 2006a). Riparian habitat along the Sacramento River is also important breeding habitat for sensitive migratory bird species including black-headed grosbeak, blue grosbeak, Swainson's hawk, yellow-breasted chat, and yellow-billed cuckoo (RHJV 2006a).

Grasslands and oak woodlands host a variety of seasonal game species and other wildlife, such as deer, jackrabbit, coyote, and raptors, gopher snake, pheasant, fox, raccoon, and California quail. The grasslands and foothills also support vernal pools and other seasonal wetlands that provide unique habitat for waterfowl, various small aquatic organisms, and breeding habitat for amphibians (USBR 2006a).

More arid chaparral habitat and scrub habitat support a variety of reptiles, weasel, feral pig, skunk, coyote, and larger mammals such as deer, bobcat, and mountain lion. Bird species that forage and nest in brush habitat within the area include wild turkey, pigeon, mourning dove, California thrasher, California towhee, and California quail (USBR 2006a).

Exotic and non-native wildlife species include brown-headed cowbird, Virginia opossum, feral pig, wild turkey, pheasant, chukar, and bullfrog. Some of these non-native species have been detrimental to native vegetation and wildlife, such as the cowbird (which parasitizes the nests of other birds) and feral pigs (which uproot native vegetation and destroy the nests of ground-nesting birds) (USBR 2006a).

Because animals are highly dependent on their choice habitats, changes in the quality and quantity of various habitat types have impacted area wildlife. The wildlife most affected in this area are those associated with riparian and grassland habitats, which have been highly impacted by land use, water resources development, and land management practices. Wildlife populations are also influenced by the age and density of the vegetation within the various habitat types. The general trend toward more dense underbrush in foothill habitats, due to fire suppression, has favored species that rely on dense vegetation for cover or foraging while negatively impacting raptors and other wildlife that require open areas for foraging. Conversion of grasslands to row crops has favored species that have adapted to the use of agricultural fields for foraging and species that can thrive in the altered landscape. Species that have adapted or thrived in the modified human environment include coyote, raccoon, and various late successional species. The introduction of non-native species has had both positive and negative effects on wildlife in riparian and grassland areas (USBR 2007).

Migratory and Focal Bird Species along the Sacramento River

CalPIF and RHJV published Bird Conservation Plans for the major habitat types in the state of California (CalPIF 2000, CalPIF 2002a, CalPIF 2002b, CalPIF 2004, RHJV 2004). The Bird Conservation Plans contain a list of focal bird species to be targeted for conservation for each major habitat type.

Special-Status Floral Species along the Sacramento River

There are six special-status plant species identified as having potential to occur near Shasta Dam and in the area along the Sacramento River between Shasta Dam and RBPP. These species are mountain lady's slipper, adobe lily, Red Bluff dwarf rush, dubious pea, Ahart's paronychia, and oval-leaved viburnum. Slender Orcutt grass, a species that is State and federally-listed as endangered, could also occur in the primary study area along the Sacramento River between Shasta Dam and RBPP if suitable vernal pool habitat is present. Bogg's Lake hedge hyssop, a species that is State listed as endangered could potentially occur in freshwater marsh habitat or vernal pools in the primary study area. Fox sedge, silky cryptantha, dwarf downingia, four angled spikerush, Ahart's dwarf rush, and Greene's legenere are additional CNPS List 1B or 2 species that have potential to occur in the primary study area. Henderson's bent grass, a CNPS List 3 species, could also occur in the primary study area if suitable vernally mesic habitat, such as vernal pools, is present.

Special-status Wildlife Species along the Sacramento River

Table 18 above lists special-status wildlife species that have the potential to occur near Shasta Dam and in the area along the Sacramento River between Shasta Dam and RBPP.

Extended Study Area: Aquatic Communities and Associated Special-Status Species

The extended study area includes all of the components of the CVP/SWP system that would be affected by the proposed changes in the operation of Shasta Dam. Therefore, aquatic habitat occurring within the extended study area includes the Sacramento River downstream from the RBPP to the Delta, Oroville Reservoir and the lower Feather River, Folsom Reservoir the lower American River Basin, the Yolo Bypass, the Delta, and the lower San Joaquin River. Table 18 shows additional aquatic and terrestrial special-status species that would occur in riparian and wetland communities along the Sacramento River from the RBPP to the Delta.

Middle and Lower Sacramento River

The Sacramento River is an important migration corridor for anadromous fishes moving between the Pacific Ocean or the Delta and upper river and tributary spawning and rearing habitats. Over 30 species of fish are known to use the Sacramento River. Of these, a number of both native and introduced species are anadromous. Anadromous species include Chinook salmon, steelhead, green and white sturgeon, striped bass and American shad.

An important component of aquatic habitat throughout the Sacramento River is referred to as SRA cover. SRA cover consists of the portion of the riparian community that directly overhangs or is submerged in the river. SRA cover provides high-value feeding and resting areas, as well as escape cover for juvenile anadromous salmonids and resident fishes. SRA cover also can provide some degree of local temperature moderation and refugia during summer months due to the shading it provides to nearshore habitats.

The importance of SRA cover to Chinook salmon was demonstrated in studies conducted by the Service (DeHaven 1989). In early summer, juvenile Chinook salmon were found exclusively in areas of SRA cover, and none were found in nearby riprapped areas (DeHaven 1989). Other studies have similarly found a decrease in the density of juvenile salmon along riprapped areas of the Sacramento River compared to natural bank areas (*e.g.*, Michny 1988, Schaffter *et al.* 1983). Stream banks with riprap have fewer undercut banks, less low-overhead cover and are less likely than natural stream banks to contribute large woody debris to the stream (Schmetterling *et al.* 2001, USFWS 2004). Snorkeling surveys of juvenile Chinook salmon in the middle Sacramento River (RM 180 – 230 [a few miles downstream from Ord Ferry up to the Elder Creek]) suggest that the lack of suitable juvenile rearing habitat may be the most limiting factor for anadromous fish survival; less than 1 percent of the middle Sacramento River is suitable juvenile rearing habitat (Cannon 2007).

The roughly 300 miles of the Sacramento River can be subdivided into distinct reaches. These reaches are discussed separately because of differences in morphology, water temperature, and aquatic habitat functions. This section focuses on the reaches of the mainstem Sacramento River from RBPP to Colusa, and Colusa to the Delta (USBR 2008).

Middle Sacramento River - Red Bluff Pumping Plant to Colusa

In this reach, the Sacramento River functions as a large alluvial river with active meander migration through the valley floor. The river is classified as a meandering river, where relatively stable, straight sections alternate with more sinuous, dynamic sections (SRCAF 2003). The active channel is fairly wide in some stretches and the river splits into multiple forks at many different locations, creating gravel islands, often with riparian vegetation. Historic bends in the river are visible throughout this reach and appear as scars of the historic channel locations with the riparian corridor and oxbow lakes still present in many locations. The channel remains active and has the potential to migrate in times of high water. Point bars, islands, high and low terraces, instream woody cover, early successional riparian plant growth, and other evidence of river meander and erosion are common in this reach. The channel takes on varying widths, and aquatic habitats consist of shallow riffles, deep runs, deep pools at the bends, glides in the straight reaches, and shallow vegetated floodplain areas that become inundated during high flows (USBR 2008).

Lower Sacramento River - Colusa to the Delta

The general character of the Sacramento River changes drastically downstream of Colusa from a dynamic and active meandering channel to a confined, narrow channel restricted of migration. While setback levees exist along portions of the river upstream from Colusa, the levees become much narrower along the river edge as the river continues south to the Delta. Surrounding agricultural lands encroach directly adjacent to the levees, which have cut the river off from the majority of its riparian corridor, especially on the eastern side of the river. The majority of the levees in this reach are lined with riprap, allowing the river no erodible substrate. The channel width is fairly uniform and river bends are static as a result of confinement by levees. Therefore, aquatic habitats are fairly homogenous because depth profiles and substrate composition are fairly uniform throughout the reach. Multiple water diversion structures in this reach move floodwaters into floodplain bypass areas during high-flow events. Primary floodplain bypass areas include the Butte

Basin, Sutter Bypass, and Yolo Bypass, all of which are fed by overflow weirs along the Sacramento River (USBR 2008).

Yolo Bypass

The 61-km (38 mile) long Yolo Bypass is a 24,000-hectare (59,305 acres) leveed floodplain in the lower Sacramento River that empties into the Delta (Sommer *et al.* 2001b). The Yolo Bypass floods seasonally in winter and spring in about 60 percent of years (Sommer *et al.* 2001b). The bypass is able to convey up to 80 percent (14,000 m^3 per second [494,405 cfs]) of the flow of the Sacramento River basin during high water events (Sommer *et al.* 2001b). The Fremont Weir can be operated to release flows into the Yolo Bypass at about 56,500cfs, although during a typical flood event, water spills into the Yolo Bypass via Fremont Weir when Sacramento River flows surpass about 2000 m^3 per second (70,629 cfs) (Sommer *et al.* 2001b). At higher levels of Sacramento River flow (*e.g.*, >5000 m^3 per second [176,573 cfs]), the Sacramento Weir is also frequently operated. The mean depth of the bypass is less than 2 m, except during high flow events (Sommer *et al.* 2001b). Agricultural lands and seasonal and permanent wetlands within the bypass provide key habitat for waterfowl migrating through the Pacific Flyway. One-third of the bypass is natural vegetation, including riparian habitat, upland habitat, emergent marsh, and permanent ponds (Sommer *et al.* 2001b). The bypass seasonally supports 42 fish species, 15 of which are native (Sommer *et al.* 2001a,b).

Seasonal long-duration inundation of floodplain habitat in the Yolo Bypass has been shown to be highly beneficial for outmigration, survival and growth of Sacramento basin Chinook salmon, spawning and recruitment of Sacramento splittail, and production and export of phyto- and zooplankton to the north Delta (Sommer *et al.* 1997; Sommer *et al.* 2001a,b). A study of juvenile fall-run Chinook salmon observed higher growth rates in the Yolo Bypass compared to the Sacramento River due to higher densities of dipteran insect prey associated with woody debris in the Yolo Bypass (Sommer *et al.* 2001b). At this time, Reclamation has not described any objectives for flow through, and discharges from, the Yolo Bypass into the Delta related to the water management associated with any of the action alternatives for the SLWRI.

Sacramento – San Joaquin Delta

San Francisco Bay (Bay) and the Delta make up the largest estuary on the west coast (USEPA 1992). The Delta, the most upstream portion of the Bay-Delta, is a triangle-shaped area composed of islands, river channels, and sloughs at the confluence of the Sacramento and San Joaquin rivers (CALFED 2000a). The Bay-Delta estuary provides habitat for a diverse assemblage of fish and macroinvertebrates. Many of the fish and macroinvertebrate species inhabit the estuary year-round, while other species inhabit the system on a seasonal basis as a migratory corridor between upstream freshwater riverine habitat and coastal marine waters, as seasonal foraging habitat, or for reproduction and juvenile rearing.

Migratory (*e.g.*, anadromous) fish species which inhabit the Bay-Delta system and its tributaries include, but are not limited to, white sturgeon, green sturgeon, Chinook salmon (including fall-run, spring-run, winter-run, and late fall-run), steelhead, American shad, Pacific lamprey and river lamprey (Moyle 2002). The Bay-Delta and tributaries also support a diverse community of resident fish which includes, but is not limited to, delta smelt, longfin smelt, Sacramento sucker, prickly and riffle sculpin, California roach, hardhead, hitch, Sacramento blackfish, Sacramento pikeminnow, speckled dace, Sacramento splittail, tule perch, inland silverside, black crappie, bluegill, green sunfish, largemouth bass, smallmouth bass, white crappie, threadfin shad, carp, golden shiner, black and brown bullhead, channel catfish, white catfish, and a variety of other species which inhabit the more estuarine and freshwater portions of the Bay-Delta system (Moyle 2002).

Many factors have contributed to the decline of fish species within the Delta (Moyle *et al.* 1995), including changes in hydrologic patterns resulting from water project operations, loss of habitat, contaminant input, entrainment in diversions, and introduction of non-native species. The Delta is a network of channels through which water, nutrients, and aquatic food resources are moved and mixed by tidal action. Pumps and siphons divert water for Delta irrigation and municipal and industrial use or into CVP and SWP canals. River inflow, Delta Cross Channel operations, and diversions (including agricultural and municipal diversions and export pumping) affect Delta species through changes in habitat conditions (*e.g.*, salinity intrusion), and mortality attributable to entrainment in diversions.

Seasonal and interannual variability in hydrologic conditions, including the magnitude of flows into the Bay-Delta estuary from the Sacramento and San Joaquin rivers and other tributaries and the outflow from the Delta into the Bay, have been identified as important factors affecting habitat quality and availability, and abundance for a number of fish and invertebrate species within the Bay-Delta estuary. Flows within the Bay-Delta system may affect larval and juvenile transport and dispersal, water temperatures, dissolved oxygen concentrations (e.g., during the fall within the lower San Joaquin River), and salinity gradients within the estuary. The seasonal timing and geographic location of salinity gradients are thought to be important factors affecting habitat quality and availability for a number of species (Baxter *et al.* 1999). Operation of upstream storage impoundments, in combination with natural hydrologic conditions, affects seasonal patterns in the distribution of salinity within the system. Water project operations, for example, may result in a reduction in Delta inflows during the late winter and spring with an increase in Delta inflows, when compared to historical conditions, during the summer months. Objectives have been established for the location of salinity gradients during the late winter and spring to support estuarine habitat for a number of species (X2 location), in addition to other salinity criteria for municipal, agricultural, and wetland benefits. Although a number of studies have focused on the effects of variation in salinity gradients as a factor affecting estuarine habitat during the late winter and spring (Kimmerer 2002), very little information exists on the effects of increased inflows into the Delta during summer months and the resulting changes in salinity conditions (e.g., reduced salinity when compared to historical conditions) on the abundance, growth, survival, and distribution of various fish and macroinvertebrates inhabiting the Bay-Delta system.

Table 18. Additional Special-Status Species of Riparian and Perennial Wetland Communities along the Sacramento River and in the Delta

Common Name	Scientific Name	Status	Habitat Description
Birds			
California black rail	*Laterallus jamaicensis coturniculus*	CT, CFP	Nests and forages in tidal emergent wetlands dominated by pickleweed, in the high wetland zones near upper limit of tidal flooding, or in brackish marshes supporting bulrushes and pickleweed. In freshwater, usually found in bulrushes, cattails, and saltgrass adjacent to tidal sloughs.
Suisun song sparrow	*Melospiza melodia maxillaries*	CSC	Forages the bare surface of tidally exposed mud among tules and along slough margins in brackish marshes. Nests along edges of sloughs and bays supporting mixed stands of bulrush, cattail, and other emergent vegetation. Present where suitable habitat exists.
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	CSC	Forages in in open riparian habitats, grasslands, wetlands, waterways, and cropland. Nests in dense emergent wetland vegetation such as cattails and tules, often along borders of ponds and lakes.
Mammals			
Townsend's big-eared bat	*Plecotus townsendii*	CSC	Forages along water edges in open areas near riparian and upland forests and woodlands. Roosts in caves, mines, tunnels, buildings, or other anthropogenic structures in woodlands. Prefers mesic habitats. Present where suitable habitat exists.
Salt-marsh harvest mouse	*Reithrodontomys raviventris*	FE, CE,CFP	Salt marsh dominated by pickleweed and salt grass. Generally requires nonsubmerged, salt-tolerant vegetation for escape during high tides. Present where suitable habitat exists.
Fish			
Delta smelt	*Hypomesus transpacificus*	FT, CE, MSCS	Spawns in tidally influenced freshwater wetlands and seasonally submerged uplands; rears in tidal marsh and Delta. Occurs year around in the Delta.
Longfin smelt	*Spirinchus thaleichthys*	FC, CT, MSCS	Primary habitat is the open water of estuaries, both fresh and saltwater, typically in middle or deeper areas of the water column; spawn in estuaries in fresh or slightly brackish water over sandy or gravel substrates. Occurs in the Delta.
San Joaquin roach	*Lavinia symmetricus* sp.	CSC	Spawning occurs in pools and side pools of small rivers and creeks; juveniles rear in pools of small rivers and creeks. Occurs in the San Joaquin River and tributaries and the Delta.

Federal: FT = Federal Threatened, FC = Federal Candidate State: CE = California Endangered, CT = California Threatened, CFP = California Fully Protected, CSC = California Species of Concern
MSCS = CALFED Multi-species Conservation Strategy species

Lower Feather River and Oroville Dam

The Feather River drainage is located within the Central Valley of California, draining about 3,600 square miles of the western slope of the Sierra Nevada. The reach between Honcut Creek and Oroville Dam is of low gradient. The river has three forks, the North Fork, Middle Fork, and South Fork, which meet at Lake Oroville. Lake Oroville, created by the completion of Oroville Dam in

1967, has a capacity of about 3.5 million acre-feet (maf) of water and is used for flood control, water supply, power generation, and recreation. The Lower Feather River below the reservoir is regulated by Oroville Dam, Thermalito Diversion Dam, and Thermalito Afterbay Outlet. Under normal operations, the majority of the Feather River flow is diverted at Thermalito Diversion Dam into Thermalito Forebay. The remainder of the flow, typically 600 cfs, flows through the historical river channel, the "low flow channel" (LFC). Water released by the forebay is used to generate power before discharge into Thermalito Afterbay. Water is returned to the Feather River through Thermalito Afterbay Outlet, then flows southward through the valley until the confluence with the Sacramento River at Verona. The Feather River is the largest tributary of the Sacramento River (Sommer *et al* 2001c).

Lower American River

The American River drains a watershed of approximately 1,895 square miles (USBR 2006b), and is a major tributary to the Sacramento River. The American River has historically provided over 125 miles of riverine habitat to anadromous and resident fishes. Presently, use of the American River by anadromous fish is limited to the 23 miles of river downstream of Nimbus Dam (the lower American River). Folsom Dam was built in 1955 creating Folsom lake with a maximum capacity of 1.01 maf.

Special-Status Aquatic Species of the Extended Study Area

Juvenile and adult Chinook salmon, steelhead, and green sturgeon use the Sacramento River and Sacramento-San Joaquin Delta as a migration corridor. Juvenile Chinook salmon and steelhead also use the Sacramento River, Delta, and Yolo Bypass for rearing (Sommer *et al.* 2001a,b). The lack of SRA and large woody debris for cover in this reach of the Sacramento River is thought to be a limiting factor for the survival of juvenile salmonids (Cannon 2007). Delta smelt, Sacramento splittail, and longfin smelt depend on the Delta estuarine ecosystem (Table 18). Juvenile Sacramento splittail prefer shallow-water habitat with emergent vegetation during rearing (Meng and Moyle 1995). Sommer *et al.* (2002) report juvenile splittail are more abundant in the Yolo Bypass floodplain in the shallowest areas of the wetland with emergent vegetation. The life-history and species account for the special-status aquatic species are included in Appendix D of this report.

Extended Study Area: Upland Communities and Associated Special-Status Species

Increasing water supply reliability with the SLWRI is likely to result in changes in land use throughout the CVP/SWP water service areas. Therefore, the extended study area for the SLWRI includes all of the water service areas for the CVP/SWP. The water service areas for the CVP/SWP include agricultural lands and M&I users throughout Northern and Southern California. Increasing water supply reliability with the SLWRI will likely result in the further conversion of rangelands and natural lands into urban areas and cultivated agriculture fields. Increased water supply reliability also will likely result in the conversion of agricultural lands into urban areas or into more intensively cultivated lands. The loss of rangeland, natural lands, and agricultural land will adversely affect common and special-status wildlife species throughout the Central Valley and Southern California. There is not enough information at this time to analyze the extent to which land use patterns would change as a result of the SLWRI. Section 7 consultation under ESA will address the impacts of the SLWRI to federally-listed species within the CVP-SWP water service areas.

FUTURE CONDITIONS WITHOUT PROJECT

The No Action Alternative is defined as the most likely future condition that could be expected to occur in the absence of the SLWRI. Hydrological and salmonid population modeling for the SLWRI use the No Action Alternative as a surrogate for the "Future Conditions Without Project." Therefore, in this report, the No Action Alternative is used to refer to the "Future Conditions Without Project."

Reclamation defines the No Action Alternative in the EIS (USBR 2014) as "…under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, including actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. However, the Federal Government would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River, nor help address the growing water supply and reliability issues in California."

The *reasonably foreseeable actions* the Federal Government would take to help increase anadromous fish survival in the upper Sacramento River include those identified in the CVPIA, the State Water Resources Control Board (SWRCB) Order 90-5 (which specifies terms and conditions for the maintenance of water quality in the Sacramento River downstream of Shasta Dam, Keswick Dam, and the Spring Creek Power Plant), the 1993 biological opinion for winter-run Chinook salmon (NMFS 1993), and Senate Bill 1086. This future condition includes actions found in the AFRP Restoration Plan (USFWS 2001), developed to comply with Section 3406(b)(1) of the CVPIA.

The AFRP Restoration Plan identifies several high priority actions for increasing anadromous fish survival in the upper Sacramento River including the following: (1) implementing a river flow regulation plan that balances carryover storage needs with instream flow; (2) maintaining water temperatures at or below 56°F from Keswick Dam to Bend Bridge; (3) creating a meander belt from Keswick Dam to Colusa to recruit gravel and large woody debris, to moderate temperatures and to enhance nutrient input; (4) restoring and replenishing spawning gravel, where appropriate, in the Sacramento River; (5) evaluate opportunities to incorporate flows to restore riparian vegetation from Keswick Dam to Verona that are consistent with the overall river regulation plan; and (6) identify opportunities for restoring riparian forests in channelized section of the upper mainstem Sacramento River that are appropriate with flood control and other water management constraints.

For the Keswick Dam – RBPP reach, SRCAF, as supported by Senate Bill 1086, recognizes the following restoration priorities: (1) protect physical processes where still intact; (2) allow riparian forest to reach maturity; (3) restore physical and successional processes; and (4) conduct reforestation activities. Therefore, in the likely future condition without the SLWRI, some restoration of the Sacramento River is to be expected in line with the goals and mandates of the CVPIA and SRCAF.

Therefore, based on goals and mandates from the CVPIA, SWRCB Order 90-5, the 1993 biological opinion for winter-run Chinook salmon as outlined in the AFRP Recovery Plan, and Senate Bill 1086, it can reasonably be assumed that in the "likely future conditions without the Project" the Federal and State government would still take actions to increase anadromous fish survival and restore riparian habitat in the upper Sacramento River. Current and foreseeable restoration projects include the Trinity River Restoration Program (TRRP), CALFED Ecosystem Restoration Program (ERP), and CVPIA AFRP (Koch *in litt.* 2006).

Through the efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas are estimated to generally remain as is under existing conditions or potentially increase. Although increases in anadromous and resident fish populations in the Sacramento River could continue through implementation of projects such as the Battle Creek Salmon and Steelhead Restoration Project, some degradation would likely occur through actions that reduce Sacramento River flows or elevate water temperatures. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions.

Table 19 illustrates the limiting factors in the upper main stem Sacramento River as per the AFRP Working Paper (USFWS 1995). Some of the identified solutions developed by AFRP have been implemented (e.g., correcting fish passage problems at the ACID and GCID dams, and maintaining water temperatures in the river) but many are still relevant (Koch *in litt.* 2006). Therefore, in the likely future condition without the SLWRI, some of the limiting factors in Table 19 would continue while others would be addressed through CVPIA and the AFRP.

Aquatic Species

In the No Action Alternative, reservoir operations would not change, nor would Sacramento River flow regimes or water temperatures. Therefore, no additional impacts would occur to fisheries resources (both anadromous and resident) beyond what currently occurs (*e.g.*, unsuitable water temperatures for some spawning fish, continued blockage of fish passage, continued blockage of coarse sediments necessary for spawning habitat). However, restoration projects identified and/or required through CVPIA, AFRP, and Senate Bill 1086 are expected to improve conditions for anadromous fish in the Sacramento River and tributaries.

Terrestrial/Wetland Vegetation and Wildlife

Vegetation

The No Action Alternative would not result in any changes to existing facilities or to the operation of Shasta Dam or any other CVP facilities. As a result, there would be no new disturbance, altered structure, species composition, or loss of vegetation or wetland communities. There would continue to be current, ongoing alteration of the structure and species composition of riparian vegetation resulting from the operations of the Shasta Dam. Prior to the construction of Shasta Dam, flow volume would decrease gradually in the late spring and early summer months, during the period of cottonwood and willow seed dispersal. This flow pattern would facilitate establishment of these early successional species along the Sacramento River throughout the primary study area. Operation of Shasta Dam has increased flow volumes in mid-spring to early summer, altering the flow regime that enables the recruitment of cottonwoods and willows.

Consequently, in most years, operation of the dam precludes or substantially reduces opportunities for establishment of cottonwoods and willows. As a result of this (and other alterations to the flow regime of the Sacramento River), the structure and species composition of riparian vegetation has been changing within the primary study area and in portions of the extended study area (Fremier 2003; Roberts *et al.* 2002). The extent of early-successional riparian communities (*e.g.*, cottonwood forest) has been decreasing while the extent of mid-successional communities (*e.g.*, mixed riparian forest) has been increasing. This change, which would continue under the No Action Alternative, would have consequences because early- and mid-successional riparian vegetation provide different habitat values. However, restoration projects proposed through CVPIA and Senate Bill 1086 are expected to help restore some riparian vegetation along parts of the Sacramento River and tributaries.

Wildlife

In the No Action Alternative, there would not be any changes to existing facilities or to the operation of Shasta Dam or any other CVP facilities. As a result, there would be no new disturbance, loss of wildlife habitat, or threats to nesting birds due to construction or operation of new facilities. There would continue to be an alteration of the structure and species composition of riparian vegetation resulting from continued operation of the existing Shasta Dam. This current and ongoing situation, which would continue under the No Action Alternative, has consequences for wildlife species. Restoration projects mandated through CVPIA, AFRP, and Senate Bill 1086 are expected to help improve some conditions for wildlife along the Sacramento River and tributaries.

Table 19. Upper Main Stem Sacramento River Limiting Factors as per the Anadromous Fish Restoration Program (AFRP) Working Paper (USFWS 1995)

Limiting Factors	Potential Solutions
Instream Flows	1. Regulate CVP flow releases to provide adequate spawning and rearing habitat. 2. Avoid flow fluctuations to avert dewatering redds or stranding or isolating adults and juveniles. 3. Consider all effects of flow on ecosystem.
Water Temperatures	Maintain water temperatures at or below 56°F to at least Bend Bridge to Keswick Dam except in extreme water years.
Passage at artificial impairments is inadequate	1. Correct migration problems at RBDD*. 2. Correct fish passage and other problems at the ACID's diversion dam. 3. Avoid entrapment of adults at Keswick Dam stilling Basin. 4. Correct unscreened pump diversions. 5. Correct problems at the GCID water diversions.
Contaminants	Remedy water quality problems associated with Iron Mountain Mine and other toxic discharges.
Effects of hatchery stocks on natural spawning stocks is unknown	1. Evaluate competitive displacement between hatchery and natural stocks. 2. Evaluate displacement of natural stocks by hatchery stocks. 3. Maintain genetic diversity in hatchery stocks. 4. Evaluate disease relationships between hatchery and natural stocks.
Loss of riparian forests	Restore and preserve riparian forests.

*=Red Bluff Diversion Dam; now Red Bluff Pumping Plant (RBPP)

Special-status Species

In the No Action Alternative, there would not be any changes to existing facilities or to the operation of Shasta Dam or any other CVP facilities. As a result, there would be no new disturbance or loss of special-status plant, wildlife and fish species, or additional changes to the structure or species composition from new construction or operation of facilities. There would, however, continue to be an ongoing alteration of the structure and species composition of riparian habitat resulting from the continued current operation of the existing Shasta Dam. As stated before, dam operations have led to the decrease in early successional riparian communities and an increase in the extent of mid-successional riparian communities in the Sacramento River, downstream. This change has consequences for special-status species because early- and mid-successional riparian vegetation provides different habitat values. Restoration projects mandated through CVPIA, AFRP, and Senate Bill 1086 are expected to help improve some conditions for special-status species along the Sacramento River and tributaries.

The No Action Alternative would result in no change to the Sacramento River flow regimes or water temperatures, and therefore there would be no new additional impacts to special-status fish (both anadromous and resident) beyond what currently occurs (*e.g.*, unsuitable water temperatures for some spawning fish, redd dewatering, continued blockage of fish passage, continued blockage of coarse sediments necessary for spawning habitat).

Climate change is expected to affect special-status salmonids in the future by increasing temperatures, changes in precipitation patterns, and decreases in snow melt. Lindley *et al.* (2007) evaluated the effects of increasing temperatures on the availability of suitable over-summer habitat for spring-run Chinook salmon in the Central Valley.

FUTURE CONDITIONS WITH PROJECT

Future conditions with the project are those conditions in the project study area that are expected to occur over the life of the project if the Project structural/physical and operational components were constructed and operated according to the elements of the proposed action.

Primary Study Area: Shasta Lake and Tributaries and Keswick Reservoir

Aquatic Habitat

The SLWRI dam raise alternatives would result in an increase in the size of Shasta Lake and the conversion of tributaries entering the lake from riverine to lacustrine. The effects of the dam raise on littoral habitat values would depend on whether, and to what extent, vegetation is removed from the Inundation Zone. Vegetation that is left in place and inundated would provide shelter for fish and other aquatic species. The increase in surface area of Shasta Lake would produce a greater volume of heated surface water in storage resulting in greater potential algae production. The larger lake volume would also result in additional habitat for lacustrine species.

Shasta Lake and Tributaries and Adjacent Habitat

Sedimentation and Turbidity

Construction activities could result in an increase in sedimentation and turbidity of the waters surrounding the construction site following storm events. These conditions, if prolonged, can affect the growth, survival, and reproductive success of aquatic organisms. Prolonged exposure to high levels of suspended sediment can create a loss of visual capability for fish species. This can lead to a reduction in feeding and growth rates; a thickening of the gill epithelium, potentially causing the loss of respiratory function; a clogging and abrasion of gill filaments, increased stress levels, and reduced tolerance to disease and toxicants (Waters 1995).

Also, high suspended sediment levels would cause the movement and redistribution of fish populations and can affect physical habitat. Once the suspended sediment is deposited, it can reduce water depths in pools, decreasing the water's physical carrying capacity for juvenile and adult fish (Waters 1995). Increased sediment loading can also degrade food-producing habitat downstream of the project area. Sediment loading can interfere with photosynthesis of aquatic flora and result in the displacement of aquatic fauna. Many fish, including juvenile salmonids, are sight feeders. Turbid waters reduce the fish's efficiency in locating and feeding on prey. Some fish, particularly juveniles, can get disoriented and leave areas where their main food sources are located, which can result in reduced growth rates.

Avoidance is the most common response by fish species as a result of increases in turbidity and sedimentation. Fish will not occupy areas that are not suitable for survival, unless they have no other option. Some fish, such as bluegill and bass species, will not spawn in excessively turbid water (Bell 1991). Therefore, habitat can become limiting in systems where high turbidity precludes a species from occupying habitat required for specific life stages.

Increased turbidity and sedimentation could be expected from increasing the size of Shasta Lake. Inundation and wave action along the new shoreline would increase erosion and mass wasting of sediments into the reservoir. Fluctuations in reservoir levels are expected from an enlarged Shasta Dam, resulting in increased erosion near the shoreline and more barren and exposed areas within the footprint of the enlarged reservoir.

Water Quality

The potential exists for contaminants to spill into the waterway during construction leading to a short-term degradation of water quality and fish habitat. Various contaminants, such as fuel oils, grease, and other petroleum products used in construction activities, could be introduced accidentally into the water system, either directly or through surface runoff. These contaminants may be toxic to fish or cause altered oxygen diffusion rates and acute and chronic toxicity to aquatic organisms, thereby reducing growth and survival.

The SLWRI alternatives would further inundate abandoned mines and contaminated tailing piles around Shasta Lake resulting in a potential increase in loading of acid mine drainage and toxic mercury into Shasta Lake. During a site visit to Shasta Lake, acid drainage with a pH of 2 was observed near the Bully Hill Mine within the Inundation Zone (P. Uncapher, NSR, pers. comm. 2014). Increased mercury loading into Shasta Lake could increase the levels of mercury in fish and invertebrates in the lake and then bioaccumulate in sensitive bird species that feed on fish in Shasta Lake. Increased loading of toxic metals into Shasta Lake may affect the ability of Keswick Reservoir to dilute the acid mine drainage from the Iron Mountain Mine Superfund site. This may result in increased loading of heavy metals into spawning habitat in the Sacramento River and further downstream into the Delta.

Littoral Habitat

Snags and large woody debris are important cover for fish in Shasta Lake. Further inundation of trees along the shoreline within the Inundation Zone would create more snags and large woody debris important for fish cover in areas where it is not removed. Vegetation Management Areas are described with corresponding differing levels of vegetation removal within the inundation zone; from no treatment to complete vegetation removal (Table 20) (USBR 2013).

Table 20. Vegetation Removal by Action Alternative; Type and Amount (acres)

Action Alternative	Vegetation Removal (type)	Vegetation Removal (acre)
CP1	Complete Removal	150
	Overstory Removal	220
CP2	Complete Removal	236
	Overstory Removal	347
CP3, CP4, CP4A, CP5	Complete Removal	337
	Overstory Removal	495

Complete Vegetation Removal

Complete vegetation removal would clear all existing vegetation from the designated treatment area and would generally be applied to locations along and adjacent to developed recreation areas, including boat ramps, day use areas, campgrounds, marinas, and resorts. Exceptions would be made in areas with high shoreline erosion potential, or habitat for special-status species.

Timber would be harvested and removed to landings, trees would be cut to within 24 inches of ground level and brush would be cut flush to the ground. The tree stumps would be left in place to reduce shoreline erosion. Complete vegetation removal is intended to maximize shoreline access and minimize the risk to visitors from snags and water hazards.

Overstory Removal

Overstory removal involves removing all trees from the treatment area that are greater than 10 inches in diameter at breast height, or 18 feet in height, generally in houseboat mooring areas or narrow arms of the reservoir where snags pose the greatest risk to boaters. Trees would be harvested and removed to landings and the remaining understory vegetation would be left in place. As with complete vegetation removal, where possible, trees would be felled into the reservoir during removal to minimize damage to reservoir embankments. Trees would be cut to within 24 inches of the ground surface and stumps would be left in place to reduce shoreline erosion. Overstory removal is intended to minimize the risk to visitors from snags and water hazards.

No Treatment

Designated areas of the inundation zone would be left untreated with no vegetation removed. This prescription would generally be applied to stream inlets, the upper end of major drainages, the shoreline of wider arms of the reservoir, and special habitat areas. This treatment is intended to maximize the habitat benefits of inundated and residual vegetation.

Loss of Riverine Habitat

The project would result in the conversion of riverine habitat to lacustrine habitat within the lower reaches of the hundreds of tributaries that enter Shasta Lake. Varying portions of the 1,681 tributaries totaling about 2,962 miles that enter Shasta Lake would be affected (USBR 2014). These tributaries are important spawning and rearing habitat for trout and other fish species within the lake. The inundation of the lower McCloud River may affect its status as a river with State Wild and Scenic River Act protection. Fluctuations in reservoir levels could disturb fish spawning in riverine areas, particularly if the depth and rate of filling of the reservoir increases during the spring. Sedimentation and deposition patterns in the tributaries would change with the conversion of the lower reaches from riverine to lacustrine. The inundation of the lower reach of tributaries would also affect seed dispersal of riparian vegetation.

The inundation of the lower reaches of tributaries would also affect the fluvial and biological characteristics of the stream channels. This may result in potential changes in channel location, channel geometry, slope, form, turbidity, sedimentation, nutrients, erosion, mass wasting, channel aggradation or degradation, incision, cutbanks, loss of SRA cover, and increase in warm-water predatory fish habitat and access by eliminating existing barriers.

The enlargement of Shasta Dam and the implementation of the CPs would result in the following amount of impact to the riverine habitat:

CP1 – 6.5-Foot Dam Raise
CP1 would result in the conversion of about 14 acres of wetlands and 19 acres of riverine waters into lacustrine habitat.

CP2 – 12.5-Foot Dam Raise
CP2 would result in the conversion of about 19 acres of wetlands and 26 acres of riverine waters into lacustrine habitat.

CP3, CP4, CP4A and CP5 – 18.5-Foot Dam Raise
CP3, CP4, CP4A, and CP5 would result in an increase in gross pool area of about 2,570 acres. This amounts to an average increase in landward encroachment of the water surface around the reservoir at gross pool of about 50 feet. The distance would be greater along inflowing streams and creeks. About 30.14 acres of the McCloud River riverine and 8.67 acres of wetland habitat would be inundated and converted to lacustrine habitat. CP3, CP4, CP4A, and CP5 would have the greatest fluctuations in reservoir levels resulting in the greatest amount of shoreline erosion and disturbance of spawning habitat. About 28 acres of wetland and 76.5 acres of riverine habitat would be converted to lacustrine habitat in CP3, CP4, CP4A, and CP5.

CP5 also provides for some environmental restoration around Shasta Lake. Preliminary descriptions for restoration have been provided for potential projects and actions; however, details for final environmental restoration sites are not available at this time.

Special-Status Aquatic Species

Aquatic special-status species such as hardhead and rough sculpin would be affected by the conversion of riverine habitat to lacustrine in the lower reaches of the numerous tributaries entering Shasta Lake. This would also increase the amount of deep-water habitat available for predator species and eliminate fish barriers by partial or complete inundation (USBR 2014). Special-status aquatic species also may be affected by water quality impairment through temporary increases in sedimentation and turbidity associated with construction. Amphibian and reptile special-status species such as foothill yellow-legged frog and northwestern pond turtle may be adversely affected by the conversion of riverine habitat to lacustrine. The inundation of roads, culverts, and other structures may create other adverse effects by creating barriers to fish passage and restricting the movement of amphibians and other aquatic species.

Terrestrial/Wetland Vegetation and Wildlife

Inundation of Upland Habitat

The proposed project would result in the permanent loss of upland habitat within the Inundation Zone around Shasta Lake. Upland habitat types that would be affected include annual grassland, blue oak –gray pine woodland, blue oak woodland, closed-cone pine – cypress, mixed chaparral, montane hardwood – conifer, montane hardwood, montane riparian, ponderosa pine, Klamath mixed conifer and Douglas-fir. Enlarging the reservoir would also increase fragmentation of upland species habitat. Table 21 summarizes habitat type impacts in acres by the action alternatives. The quantity and quality of upland habitat that would be lost is analyzed in greater detail in the draft Habitat Evaluation Procedure (HEP) report which is attached in Appendix E of this document. A final HEP report is currently not planned to be completed by the Service for the SLWRI EIS at this time, because of schedule and budgetary constraints, and because the final mitigation areas will not likely be decided upon unless, and until, a decision is made by Congress to fund the proposed project. Additionally, more information would be required on habitat disturbance associated with construction-related activities and the relocation of campgrounds, roads, bridges, marinas, and other facilities before the final HEP report can be completed.

Shoreline Erosion and Mass Wasting

The inundation of upland habitat would result in increased shoreline erosion and mass wasting. This would increase the amount of barren lands near the shoreline. CP3, CP4, CP4A, and CP5 are expected to have the highest rate of fluctuation in reservoir levels resulting in the greatest amount of erosion of upland habitat surrounding the reservoir.

Construction-Related Disturbance

Construction-related disturbances during construction activities at Shasta Dam could temporarily disturb and/or permanently eliminate common plant communities, including annual grassland and chaparral, and sensitive oak communities including blue oak savanna, foothill pine-oak woodland, and valley oak woodland. The proposed aggregate mining (borrow sources; see figure 2) that would likely occur in the primary study area (to supply the project with materials needed for the dam raise) could also result in the temporary disturbance or permanent loss of common plant communities. Because the exact location and size of the staging areas, travel routes, and mining sites have not been determined, the possibility of temporary or permanent disturbance of common plant communities from these activities cannot be evaluated. Additionally, relocation of campgrounds, roads, bridges, marinas, and other facilities beyond the Inundation Zone would result in the permanent and/or temporary loss of common and sensitive plant communities near Shasta Lake. At this time, there is no information available on where facilities would be relocated and the size of the disturbance. Therefore, we cannot estimate at this time the amount of each habitat type that would be disturbed by the relocation of facilities.

Table 21. Habitat Type Impacts in Acres (Impoundment and Relocation Combined).

Habitat Type[1] (WHR)	SLWRI Alternatives		
	CP1 (6.5-foot rise)	CP2 (12.5-foot rise)	CP3, CP4, CP4A, CP5 (18.5-foot rise)
Annual grassland	43.47	44.49	46.31
Barren	155.41	159.26	168.45
Blue oak-gray pine	19.56	23.94	25.75
Blue oak woodland	5.91	6.24	11.40
Closed-cone pine-cypress	313.22	409.49	550.87
Douglas-fir[2]	3.03	3.08	3.38
Klamath mixed conifer	-	-	10.96
Mixed chaparral	276.26	335.49	422.97
Montane hardwood-conifer	734.26	831.22	982.82
Montane hardwood	517.46	591.37	703.90
Montane riparian	30.94	39.85	59.02
Ponderosa pine	1,237.00	1,379.77	1,594.49
Riverine	7.05	9.79	22.96
Lacustrine	1,227.27	1,725.82	2,491.99
Urban	268.11	276.24	284.08

[1] California Wildlife Habitat Relationships System
[2] Formerly classified as Sierran Mixed Conifer

Construction-related disturbances could temporarily disturb wildlife, nesting raptors, and migratory birds associated with habitat in the vicinity of the construction site and staging areas. These impacts could interfere with the movement of native or migratory wildlife, or the use of nursery sites, and could result in increased road kills and nest abandonment.

CP1 – 6.5 Foot Dam Raise

Construction of CP1 would involve raising the main concrete dam and several dikes by 6.5 feet, replacement of 7 bridges, and modification of 75 small road segments. There is no information available at this time to evaluate how much habitat would be temporarily or permanently disturbed by project-related construction activities in CP1.

All four of the marinas on Sacramento River arm of Shasta Lake would be affected to some extent, as would the single marina on the McCloud River arm, and three of the four marinas on the Pit River arm. The affects would range from slight impacts to boat ramps to substantial loss of buildings, access, and boat ramps. Four of the five boat ramps would be substantially affected.

CP1 would likely affect as many as 17 campgrounds/day-use sites to some degree; these facilities include traditional overnight campgrounds accessed by vehicles and RVs, boat-in campgrounds as well as day-use facilities. The affects range from some inundation of access roads during high water events, to the permanent loss of campground sites and infrastructure. Additionally, seven trails would be affected to some degree by CP1.

Five other facilities would be affected by CP1, including the USFS Lakeshore Fire Station, the Campbell Creek and Didallas Recreation Residence Track cabins, and the USFS Station at Turntable Bay.

CP2 – 12.5-Foot Dam Raise

Construction of CP2 would involve raising the main concrete dam and several dikes by 12.5 feet, replacement of 7 bridges, and modification of 95 small road segments. There is no information available at this time to evaluate how much habitat would be temporarily or permanently disturbed by project-related construction activities in CP2.

CP2 would result in affects to six boat ramps and seven marinas, nine of the boat ramps and seven of the marinas would be affected substantially. CP2 would affect four resorts, all substantially. Nineteen campgrounds/day-use facilities would be affected, 9 traditional, 4 day-use and 6 boat-ins, of these, substantial affects would occur to 8 of the traditional campgrounds, 3 of the day-use and 4 of the boat-in. Both USFS facilities that would be affected by CP1 would also be affected by CP2 and 7 trails and trailheads would be substantially affected. Three recreational residence tract and one commercial tour facility would be substantially affected (USBR 2013).

CP3, CP4, CP4A and CP5 – 18.5-Foot Dam Raise

Construction of CP3, CP4, CP4A, or CP5 would involve raising the main concrete dam by 18.5 feet, raising 3 minor dikes, replacement of 7 bridges, and modification of over 100 small road segments. There is no information available at this time to evaluate how much habitat would be temporarily or permanently disturbed by project-related construction activities in CP3, CP4, and CP5.

The affects from CP3, CP4, CP4A, and CP5 will be the same as CP2, but to a greater degree. All six boat ramps would be substantially affected by the increased inundation of the 18.5-foot dam raise. The affects to eight of the nine marinas that would be affected would now be substantial. One more resort would be affected, but substantial affects would be to four of them, the same as for CP2. Twelve traditional campgrounds would be affected by CP3, CP4, CP4A, and CP5; 9 of them would be substantially affected, one of those being a private campground. The affects to day-use areas and boat-in campgrounds would be similar to CP2, but would include more loss of area and facilities, and an additional day-use area would be substantially affected. The number of USFS facilities, trails and trailheads, and other residential and commercial facilities that would be affected is the same as CP2, but with greater amounts of area under inundation and more facilities potentially affected (Reclamation 2014). CP5 also provides for environmental restoration around Shasta Lake; however, the details of such environmental restoration are not available at this time.

It is not unreasonable to expect that all facilities and lost areas and infrastructure would be replaced as much as practicable. This will likely add to the overall loss of habitat, and increase the affects to existing plants and wildlife derived from the implementation of the proposed project.

Rare and Special-Status Floral Species

Shasta Snow-Wreath

Ten of 24 populations (46 percent of all known existing populations), including 4 large populations, of Shasta snow-wreath could be partly or completely lost within the Inundation Zone (Table 22) (NSR 2004, Lindstrand and Nelson 2005a,b, USBR 2013, 2014) under CP1 (6.5-foot dam raise). Eleven of 24 populations (46 percent) of Shasta snow-wreath could be affected by CP2 (12.5-foot dam raise). Collectively, 11 of the 24 known (46 percent) Shasta snow-wreath populations would be affected by a 18.5-foot dam raise (CP3, CP4, CP4A, and CP5), and one more would potentially be impacted within a relocation area, making a total of 12 populations that would be impacted, or 50 percent of the existing populations (USBR 2014). The eleven Shasta snow-wreath populations that would be impacted by the 18.5-foot dam raise encompass about 79 acres, of which about 2.6 acres would be lost completely (USBR 2014; Lindstrand *in litt.* 2014). The extent of impacts to each of the eleven populations would range from less than 1 percent to as much as 97 percent (Lindstrand *in litt.* 2014). All the currently known Shasta snow-wreath populations combined would cover an area of about 270 acres, so the inundated area would account for about 1 percent of the total known occupied area (Lindstrand *in litt.* 2014). The actual number of individual plants that would be affected is not known, but it is recognized that "thousands" of Shasta snow-wreath stems occur within the Inundation Zone (J. Nelson, Shasta-Trinity National Forest, pers. comm. 2014). Additional populations of Shasta snow-wreath may be disturbed by construction activities, the relocation of facilities, and further spreading of invasive species. A portion of at least one population occurs within the relocation area at Ellery Creek and activities to decommission the campground could affect that population (USBR 2013). Another 11 populations of Shasta snow-wreath (46 percent) are currently threatened by non-project related activities (*e.g.*, mining, development, fire, invasive species, and other human-related disturbances) due to their locations along roads, trails, and logging areas (Lindstrand and Nelson 2005a,b, Lindstrand 2007). Only one known population of Shasta snow-wreath is not currently threatened by the SLWRI or non-project related activities due to their remote location (Lindstrand 2007; USBR *in litt.* 2014). The CALFED Programmatic EIS/EIR includes Shasta snow-wreath among "evaluated species for which direct mortality as a result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy" (Table 4-5 in MSCS section of CALFED 2000b).

Cantelow's Lewisia

One population was observed within the Inundation Zone on a rock outcrop on the right bank of the Upper Sacramento River riverine reach near the Shasta Lake/Upper Sacramento River transition zone (NSR 2004). Three additional occurrences were found at the north side of Elmore Mountain along the Sacramento River arm (Lindstrand, NSR, *in. litt.* 2012). All or portions of these four populations would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities (USBR 2013).

Table 22. Summary of Impacts to Shasta Snow-Wreath Populations Adjacent to Shasta Lake Under 18.5-foot Dam Raise (CP3, CP4, CP4A, and CP5).

Population	Location	Genetic cluster	Size (Acres)	Loss (Acres)	Percent Total Loss to Population	Comments
Blue Ridge (west)	Main Body	1	1.11	0.750	67.57	Lower portion of population would be flooded.
Blue Ridge (east)	Main Body	2	0.03	0.002	6.67	Lower portion of population would be flooded.
Brock Creek	Pit River Arm	2	1.38	0.634	45.94	Nearly half of the population would be flooded.
Campbell Creek	McCloud River Arm	1	1.90	0.036	1.89	Small area at the downstream portion of the population would be flooded.
Cove Creek	Main Body	1	1.87	0.401	21.44	Lower portion of population would be flooded.
Ellery Creek	McCloud River Arm	1	28.65	0.047	0.16	The entire very small disjunct sub-population located near Ellery Creek Campground would be flooded.
Jones Valley	Main Body	1	0.33	0.015	4.55	Nearly all of both small disjunct sub-populations at the lower portion of the population would be flooded.
Keluche Creek	McCloud River Arm	2	0.15	0.146	97.33	Nearly all of the population would be flooded.
Shasta Caverns	McCloud River Arm	2	0.08	0.0372	46.5	Nearly all of the population would be flooded.
South of Cove Creek	Main Body	1	1.39	0.149	10.72	Lower portion of population would be flooded.
Stein Creek	Pit River Arm	1	42.15	0.469	1.11	Lower portion of population would be flooded.

Shasta Huckleberry

The Shasta huckleberry is currently known from 23 general locations in the upper Spring Creek, Dry Fork, (little) Squaw Creek, Shoemaker Gulch, and Little Backbone Creek drainages. Other locations have been recently found including South Fork Mountain, Bohemotash Mountain, and the vicinity of Bully Hill. All locations occur in an area historically known as the Copper Belt of Shasta County and many in the immediate vicinity of historic copper mining activities. There are 4 populations of Shasta huckleberry within the Inundation Zone that would be impacted by an 18.5-foot raise of Shasta Dam (USBR 2014). The impacts from inundation would affect about a dozen Shasta huckleberry shrubs, and potentially others would be lost due to disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities (Lindstrand *in litt.* 2014; USBR 2013).

Northern Clarkia
Two populations of northern clarkia would likely be inundated as a result of the 18.5-foot dam raise (USBR 2014), including the population near the Sugarloaf area along the Sacramento River arm (CDFG 2007a). Four additional populations near Bailey Cove along the McCloud River arm and near Allie Cove on the main body of Shasta Lake are outside of the Inundation Zone, but could be disturbed by the relocation of campgrounds, roads, bridges, and other facilities (USBR 2013). Potential habitat and other unknown populations may be lost due to inundation or disturbance as well (J. Nelson, Shasta-Trinity National Forest, pers. comm., 2014).

Shasta Clarkia
The closest known occurrence of Shasta clarkia to Shasta Lake is less than 1.55 miles southeast of the Pit River arm (CDFG 2007a). Although this occurrence would not be inundated, it and other unknown occurrences and potential habitat could be disturbed by the relocation of campgrounds, roads, bridges, and other facilities.

Silky Cryptantha
The closest known occurrence of silky cryptantha to Shasta Lake is about 4.35 miles south of Allie Cove (CDFG 2007a). However, potential habitat and other unknown populations of the species may be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities.

Special-Status Terrestrial Mollusks

Oregon shoulderband
There are 220 occurrences of Oregon shoulderband within the Inundation Zone (USBR 2014). These occurrences and potentially other unknown occurrences and habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities.

CP1 (6.5-foot dam raise) would result in impacts to 1,195.43 acres of Oregon shoulderband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP1 a total of 1,620.41 acres of Oregon shoulderband habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,679.21 acres of Oregon shoulderband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP2 a total of 2,104.19 acres of Oregon shoulderband habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2,415.14 acres of Oregon shoulderband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP3 a total of 2,840.12 acres of Oregon shoulderband habitat would be impacted (USBR 2013).

Church's (Klamath) sideband
There are 325 occurrences of Church's sideband within the Inundation Zone (USBR 2014). These occurrences and potentially other unknown occurrences and habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities.

CP1 (6.5-foot dam raise) would result in impacts to 1,195.43 acres of Church's sideband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP1 a total of 1,620.41 acres of Church's sideband habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,679.21 acres of Church's sideband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP2 a total of 2,104.19 acres of Church's sideband habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2,415.14 acres of Church's sideband habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP3 a total of 2,840.12 acres of Church's sideband habitat would be impacted (USBR 2013).

Shasta Chaparral Snail
There are 15 known occurrences of Shasta chaparral snail within the Inundation Zone along the Sacramento River, McCloud River, Squaw Creek, and Pit River arms (Lindstrand 2007). These occurrences and potentially other unknown occurrences and habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities.

CP1 (6.5-foot dam raise) would result in impacts to 1,195.43 acres of Shasta chaparral snail habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP1 a total of 1,620.41 acres of Shasta chaparral snail habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,679.21 acres of Shasta chaparral snail habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP2 a total of 2,104.19 acres of Shasta chaparral snail habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2,415.14 acres of Shasta chaparral snail habitat within the impoundment area. An additional 424.98 acres would be impacted within the relocation area. For CP3 a total of 2,840.12 acres of Shasta chaparral snail habitat would be impacted (USBR 2013).

Shasta Hesperian Snail

There are 31 known occurrences of Shasta Hesperian snail in riparian habitat within the Inundation Zone along the Sacramento River, McCloud River, Squaw Creek, and Pit River arms (Lindstrand 2007). All of these occurrences as well as other unknown occurrences and potential habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities. There are 1,681 known tributaries that enter Shasta Lake many of which contain potential habitat for Shasta Hesperian snail that would be lost.

CP1 (6.5-foot dam raise) would result in impacts to 27.71 acres of Shasta Hesperian snail habitat within the impoundment area. An additional 0.72 acre would be impacted within the relocation area. For CP1 a total of 28.43 acres of Shasta Hesperian snail habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to about 37 acres of Shasta Hesperian snail habitat within the impoundment area. An additional 0.72 acre would be impacted within the relocation area. For CP2 a total of about 37.72 acres of Shasta Hesperian snail habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 57.97 acres of Shasta Hesperian snail habitat within the impoundment area. An additional 0.72 acre would be impacted within the relocation area. For CP3 a total of 58.69 acres of Shasta Hesperian snail habitat would be impacted (USBR 2013).

Shasta Sideband

Shasta sideband snails are restricted to limestone outcrops in the vicinity of Shasta Lake along the McCloud River arm (Lindstrand 2007). There are four known occurrences of Shasta sidebands within the Inundation Zone along the McCloud River arm (Lindstrand 2007, NSR 2004). These occurrences and potentially other unknown occurrences and habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities. It is not known what percent of the total population and potential habitat would be lost.

CP1 (6.5-foot dam raise) would result in impacts to 5.43 acres of Shasta sideband snail habitat within the impoundment area. An additional 0.97 acres would be impacted within the relocation area. For CP1 a total of 6.40 acres of Shasta sideband snail limestone habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 7.64 acres of Shasta sideband snail limestone habitat within the impoundment area. An additional 0.97 acres of limestone habitat would be impacted within the relocation area. For CP2 a total of 8.61 acres of Shasta sideband snail limestone habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 11.09 acres of Shasta sideband snail limestone habitat within the impoundment area. An additional 0.97

acres of limestone habitat would be impacted within the relocation area. For CP3 a total of 12.06 acres of Shasta sideband snail limestone habitat would be impacted (USBR 2013).

Wintu Sideband

Wintu sideband snails are restricted to limestone outcrops in the vicinity of Shasta Lake along the Pit River arm (Lindstrand 2007). There are two known occurrences of Wintu sidebands within the Inundation Zone along the Pit River arm (Lindstrand 2007, NSR 2004). These occurrences and potentially other unknown occurrences and habitat would be lost due to inundation or disturbance associated with the relocation of campgrounds, roads, bridges, and other facilities. It is not known what percent of the total population and potential habitat would be lost.

CP1 (6.5-foot dam raise) would result in impacts to 1.50 acres of Wintu sideband snail habitat within the impoundment area. Currently, no additional acres are anticipated to be impacted within the relocation area. For CP1 a total of 1.50 acres of Wintu sideband snail habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 2.06 acres of Wintu sideband snail habitat within the impoundment area. Currently, no additional acres are anticipated to be impacted within the relocation area. For CP2 a total of 2.06 acres of Wintu sideband snail habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2.85 acres of Wintu sideband snail limestone habitat within the impoundment area. Currently, no additional acres are anticipated to be impacted within the relocation area. For CP3 a total of 2.85 acres of Wintu sideband snail limestone habitat would be impacted (USBR 2013).

Special-Status Amphibians and Reptiles

Foothill Yellow-Legged Frog

Foothill yellow legged-frog would be adversely affected by the inundation of riverine, riparian, and surrounding upland habitat and conversion into lacustrine habitat. During surveys conducted in support of the *Draft Tributary Fisheries Characterization Report*, foothill yellow-legged frogs were observed in nine perennial tributaries (NSR 2013). The inundation of the lower reaches of tributaries would allow additional access to foothill yellow-legged frog habitat by larger predatory fish (e.g., largemouth bass). The inundation would reduce available habitat and potentially increase fragmenting between existing habitats. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 34.75 acres of Foothill yellow-legged frog habitat within the impoundment area. An additional 0.72 acre would be impacted within the relocation area. For CP1 a total of 35.47 acres of Foothill yellow-legged frog habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 47.05 acres of foothill yellow-legged frog habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acre of impacts. CP2 would result in a total of 47.77 acres of foothill yellow-legged frog habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 80.90 acres of foothill yellow-legged frog habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acres of impacts. CP3 would result in a total of 81.62 acres of foothill yellow-legged frog habitat impacted (USBR 2013).

Shasta Salamander

Shasta salamander would be adversely affected by the inundation of limestone, mixed conifer, woodland, and chaparral habitats. The inundation would also allow predatory fish species additional access to Shasta salamander habitat, potentially increasing fragmentation of existing habitat, and creating new barriers to movement. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 994.27 acres of Shasta salamander habitat within the impoundment area. An additional 424.99 acres would be impacted within the relocation area with 0.96 acre of that being limestone habitat. For CP1 a total of 1,419.26 acres of Shasta salamander habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,679.21 acres of Shasta salamander habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 424.99 acres of impacts. CP2 would result in a total of 2,104.20 acres of Shasta salamander habitat impacted (USBR2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 38 sites within the impoundment and relocation areas; 2,415.13 acres of Shasta salamander habitat within the impoundment area would be impacted, 15.57 acres of that would be limestone habitat. Relocation area impacts would be similar to CP1, making for at least an additional 424.99 acres of impacts. CP3 would result in a total of 2,840.12 acres of Shasta salamander habitat impacted, of that 16.53 acres would be limestone habitat (USBR 2013).

Northwestern Pond Turtle

Northwestern pond turtle would be adversely affected by the inundation of riverine, riparian, wetland and surrounding upland nesting habitat and conversion into lacustrine habitat. The inundation may affect traditional nesting sites and increase the vulnerability of those sites to disturbance and predation. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone. The following impact amounts do not include upland habitat for the species.

CP1 (6.5-foot dam raise) would result in impacts to 34.75 acres of northwestern pond turtle habitat within the impoundment area. An additional 0.72 acres would be impacted within the relocation area. For CP1 a total of 35.47 acres of northwestern pond turtle aquatic habitat would be impacted, additional upland habitat would also be impacted, but those impacts are currently unavailable (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 47.05 acres of northwestern pond turtle habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acres of impacts. CP2 would result in a total of 47.77 acres of northwestern pond turtle aquatic habitat impacted, additional upland habitat would also be impacted, but those impacts are currently unavailable (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 80.90 acres of northwestern pond turtle habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acres of impacts. CP3 would result in a total of 81.62 acres of northwestern pond turtle aquatic habitat impacted, additional upland habitat would also be impacted, but those impacts are currently unavailable (USBR 2013).

Special-Status Mammals

Pacific Fisher

Pacific fisher would be adversely affected by the inundation of mixed conifer and conifer/woodland habitats. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone. Pacific fishers have been found all across the surrounding Shasta Lake area (L. Lindstrand, NSR, pers. comm. 2014).

CP1 (6.5-foot dam raise) would result in impacts to 749.34 acres of Pacific fisher habitat within the impoundment area. An additional 330.48 acres would be impacted within the relocation area. For CP1 a total of 1, 07982 acres of Pacific fisher habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1057.27 acres of Pacific fisher habitat within the impoundment area. An additional 330.48 acres would be impacted within the relocation area. For CP2 a total of 1,387.75 acres of Pacific fisher habitat would be impacted (USBR2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 1,533.31 acres of Pacific fisher habitat within the impoundment area. An additional 330.48 acres would be impacted within the relocation area. For CP3 a total of 1,863.79 acres of Pacific fisher habitat would be impacted (USBR 2013).

Ringtail

Ringtail would be adversely affected by the inundation of mixed conifer and conifer/woodland habitats. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 1,201.01 acres of ringtail habitat within the impoundment area. An additional 457.74 acres would be impacted within the relocation area. For CP1 a total of 1,658.75 acres of ringtail habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,687.70 acres of ringtail habitat within the impoundment area. An additional 457.74 acres would be impacted within the relocation area. For CP2 a total of 2,145.44 acres of ringtail habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2,431.35 acres of ringtail habitat within the impoundment area. An additional 457.74 acres would be impacted within the relocation area. For CP3 a total of 2,889.09 acres of ringtail habitat would be impacted (USBR 2013).

Greater Western Mastiff-Bat and Other Bat Species

Greater western mastiff-bat, Townsend's big-eared bat, pallid bat, and other bat species would be adversely affected by the inundation of roosting habitat within caves and abandoned mines and foraging habitat within mixed conifer and conifer/woodland habitats. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 31.43 acres of bat species habitat within the impoundment area. An additional 35.12 acres would be impacted within the relocation area. For CP1 a total of 66.55 acres of bat habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 45.15 acres of bat species habitat within the impoundment area. An additional 35.12 acres would be impacted within the relocation area. For CP2 a total of 80.27 acres of bat habitat would be impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 68.98 acres of bat species habitat within the impoundment area. An additional 35.12 acres would be impacted within the relocation area. For CP3 a total of 104.10 acres of bat habitat would be impacted (USBR 2013).

Special-Status and Migratory Birds

Northern Spotted Owl

Northern spotted owl would be adversely affected by the inundation of coniferous forest habitat. Additional habitat would be temporarily or permanently disturbed by dam, levee, and dike construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 437.89 acres of northern spotted owl habitat within the impoundment area. An additional 340.92 acres would be impacted within the relocation area. For CP1 a total of 778.81 acres of northern spotted owl habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 643.51 acres of northern spotted owl habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 340.92 acres of impacts. CP2 would result in a total of 984.43 acres of northern spotted owl habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 976.09 acres of northern spotted owl habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 340.92 acres of impacts. CP3 would result in a total of 1,317.01 acres of northern spotted owl habitat impacted (USBR 2013).

Western Purple Martin

Western purple martin would be adversely affected by the complete or increased inundation of existing, partly inundated snags that provide suitable nesting habitat particularly in the Pit River arm. Additional snag nesting habitat could be lost by greater fluctuations in water levels accelerating the rate of decay of partly inundated snags. Other suitable snags may be cleared within the Inundation Zone for access and human safety. Although the inundation of trees within the Inundation Zone would likely create additional snags, there would be a time lag of decades before the newly inundated snags would provide suitable nesting habitat for the western purple martin. In spite of the current, limited use of nesting sites in upland locations associated with large burn areas (Lindstrand, NSR, pers. comm., 2014), this loss of a substantial portion of the currently existing nest sites could result in the western purple martin abandoning the important nesting sites in the Pit River arm (Len Lindstrand, NSR, pers. comm., 2014). The western purple martin could also be disturbed by noises associated with construction or the relocation of recreational areas. Shasta Lake is the largest and one of only a few known purple martin breeding locations in interior northern California. Between 18 and 42 nesting pairs occur at Shasta Lake based on monitoring performed by Reclamation since 2007. In 2013 the purple martin population declined markedly to only 17 pairs, and in 2014 the population rose to 25 pairs (Lindstrand, NSR, pers. comm., 2014). The reason for the decrease is currently unknown, but serves to illustrate the vulnerability of the small population at Shasta Lake (USBR 2014).

Yellow-Breasted Chat

Yellow-breasted chat would be adversely affected by the inundation of riparian habitat and adjacent uplands. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 27.71 acres of yellow-breasted chat habitat within the impoundment area. An additional 0.72 acre would be impacted within the relocation area. For CP1 a total of 28.43 acres of yellow-breasted chat habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 37.26 acres of yellow-breasted chat habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acre of impacts. CP2 would result in a total of 37.98 acres of yellow-breasted chat habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 57.94 acres of yellow-breasted chat habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acre of impacts. CP3 would result in a total of 58.66 acres of yellow-breasted chat habitat impacted (USBR 2013).

Little Willow Flycatcher

Little willow flycatcher would be adversely affected by the inundation of riparian habitat and adjacent uplands. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 27.71 acres of little willow flycatcher habitat within the impoundment area. An additional 0.72 acres would be impacted within the relocation area. For CP1 a total of 28.43 acres of little willow flycatcher habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 37.26 acres of little willow flycatcher habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acres of impacts. CP2 would result in a total of 37.98 acres of little willow flycatcher habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 57.94 acres of little willow flycatcher habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 0.72 acres of impacts. CP3 would result in a total of 58.66 acres of little willow flycatcher habitat impacted (USBR 2013).

Long-Eared Owl

Long-eared owl would be adversely affected by the inundation of coniferous forest habitat. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 143.59 acres of long-eared owl habitat within the impoundment area. An additional 327.40 acres would be impacted within the relocation area. For CP1 a total of 470.99 acres of long-eared owl habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 987.70 acres of long-eared owl habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 327.40 acres of impacts. CP2 would result in a total of 1,315.10 acres of long-eared owl habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 1,428.39 acres of long-eared owl habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 327.40 acres of impacts. CP3 would result in a total of 1,755.79 acres of long-eared owl habitat impacted (USBR 2013).

Osprey

Osprey would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone. Higher lake levels would likely result in the loss of nest sites for osprey. This impact would be potentially significant in the short-term. Foraging habitat would increase for osprey. No long-term impact to foraging habitat for osprey would occur. There is no estimate available at this time for the amount of osprey habitat that would be permanently or temporarily disturbed.

American Peregrine Falcon

American peregrine falcon would be adversely affected by the inundation of mixed conifer and conifer/woodland habitats. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone. Construction and vegetation removal associated with dam construction activities, construction activities in the relocation areas, and removal of various amounts of vegetation in the impoundment areas during the nesting season could result in the incidental loss of fertile eggs or nestlings or otherwise lead to the abandonment of nests of American peregrine falcons, a State fully protected and MSCS-covered species. This impact could be potentially significant. There is no estimate available at this time for the amount of American peregrine falcon habitat that would be permanently or temporarily disturbed.

Great Blue Heron

Great blue heron would be adversely affected by the inundation of riparian and wetland habitats and the conversion into lacustrine habitat. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 1,072.33 acres of great blue heron habitat within the impoundment area. An additional 402.22 acres would be impacted within the relocation area. For CP1 a total of 1,474.55 acres of great blue heron habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,505.51 acres of great blue heron habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 402.22 acres of impacts. CP2 would result in a total of 1,907.73 acres of great blue heron habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 2,167.00 acres of great blue heron habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 402.22 acres of impacts. For CP3 a total of 2,569.22 acres of great blue heron habitat would be impacted (USBR 2013).

California Yellow Warbler

California yellow warbler would be adversely affected by the inundation of riparian habitat and adjacent uplands. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 25.92 acres of California yellow warbler habitat within the impoundment area. An additional 9.15 acres would be impacted within the relocation area. For CP1 a total of 35.07 acres of California yellow warbler habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 37.26 acres of California yellow warbler habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 9.15 acres of impacts. CP2 would result in a total of 46.41 acres of California yellow warbler habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 54.00 acres of California yellow warbler habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 9.15 acres of impacts. CP3 would result in a total of 63.15 acres of California yellow warbler habitat impacted (USBR 2013).

Bald Eagle

The bald eagle is currently protected by the Bald and Golden Eagle Protection Act and is listed under CESA as a State endangered species. Bald eagles would be affected by the loss of nesting habitat in riverine areas within the Inundation Zone. There are at least four known bald eagle nest sites that occur within the Inundation Zone. Potential foraging habitat would increase as a result of the larger Shasta Lake pool. Additional habitat would be temporarily or permanently disturbed by construction activities as well as the relocation of campgrounds, marinas, roads, bridges, and other facilities beyond the Inundation Zone.

CP1 (6.5-foot dam raise) would result in impacts to 979.05 acres of bald eagle habitat within the impoundment area. An additional 393.11 acres would be impacted within the relocation area. For CP1 a total of 1,372.16 acres of bald eagle habitat would be impacted (USBR 2013).

CP2 (12.5-foot dam raise) would result in impacts to 1,376.97 acres of bald eagle habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 393.11 acres of impacts. CP2 would result in a total of 1,770.08 acres of bald eagle habitat impacted (USBR 2013).

CP3 (18.5-foot dam raise; and including CP4, CP4A, and CP5) would result in impacts to 1,989.40 acres of bald eagle habitat within the impoundment area. Relocation area impacts would be similar to CP1, making for at least an additional 393.11 acres of impacts. CP3 would result in a total of 2,382.51 acres of bald eagle habitat impacted (USBR 2013).

Primary Study Area: Sacramento River between Keswick Dam and RBPP

Aquatic Habitat

One of two primary objectives of the SLWRI is increasing the survival of anadromous fish. In all of the proposed alternatives, benefits to anadromous fish survival are limited to modifications of the TCD and increasing the size of the cold water pool available to maintain cooler temperatures in the Sacramento River between Keswick Dam and RBPP. However, salmonid population modeling in SALMOD shows that in the majority of years the SLWRI results in no benefit, or even a slight decrease, in the survival of anadromous fish (USBR 2014). Only in a few dry and critically dry water years does the SLWRI result in significant increases relative to the No Action Alternative in the production of anadromous fish due to an enlarged cold water pool (USBR 2014).

Another effect of the SLWRI is changes in the timing, frequency, and duration of flood flows in the Sacramento River between Keswick Dam and the RBPP. Flood flows are important for mobilizing sediment and maintaining a diversity of riparian habitat to improve spawning and rearing habitat for anadromous fish. In the SLWRI, hydrological data is provided in monthly time steps through CALSIM II. However, flooding and temperature conditions operate on finer time scales from hours to weeks. Therefore, CALSIM II is unable to adequately simulate the effects of the SLWRI alternatives on flooding and temperature conditions in the Sacramento River. Below is a discussion of the effects of the SLWRI alternatives on the hydrology and aquatic habitat of the Sacramento River between Keswick Dam and RBPP.

Another potential effect of raising Shasta Dam is an increase in the loading of toxic mercury, cadmium, copper, and zinc from Keswick Reservoir to important spawning habitat in the Sacramento River downstream from Keswick Dam. The raising of Shasta Dam may result in the inundation of abandoned mines and mine tailings resulting in an increase in the loading of acid mine drainage into Shasta Lake that would be transported into Keswick Reservoir. This increased loading would reduce the ability of Keswick Reservoir to dilute acid mine drainage from the Iron Mountain Mine Superfund site resulting in increased loading of toxic metals into prime spawning habitat for anadromous fish in the Sacramento River.

The SLWRI alternatives could also potentially result in the release of toxic heavy metals from the sediments in Keswick Reservoir into the water column. Managing the reservoir and the power plant for peak hydroelectric power generation requires lowering Keswick Reservoir, which could expose the sediments to scouring action, potentially mobilizing metals in the water column and creating conditions toxic to aquatic organisms (Fujimara *et al.* 1995, Finlayson *et al.* 2000). Uncontrolled discharge of acid-mine drainage into the Sacramento River has resulted in high levels of cadmium, copper, and zinc, which has caused fish kills (CH2M-Hill 1992). These risks have been reduced by remedial actions completed at the Iron Mountain Mine Superfund Site, including removal of contaminated sediments from the Spring Creek Arm of Keswick Reservoir in 2009-2010 (EPA 2013).

Hydrology

The frequency distribution of monthly flows out of Keswick Dam for the No Action and SLWRI alternatives shows that there are no significant changes in the frequency and intensity of flood flows or drought flows among the No Action and the SLWRI alternatives. However, the CALSIM output data is for monthly flows and would likely mask any changes in the intensity and duration of flood flows that occur on a daily or weekly timestep. Flood flows are geomorphically and ecologically significant for mobilizing bed substrate and the creation of a mix of riparian successional states. Additionally, a reduction in flood flows in the mainstem Sacramento River would likely result in further downcutting of the tributaries and affects to riparian habitat (Mount 1995).

Also important is the timing of flows which is discussed below for each of the alternatives. Anadromous fish and other aquatic species evolved to adapt to predictable changes in the seasonality of flows in the Sacramento River. Historically, flows in the Sacramento River increased through the winter and spring wet season, decreasing through the summer dry season to a minimum in early fall. However, since the construction and operation of Shasta Dam, the seasonal distribution of flows has been substantially modified resulting in decreases in flood flows during the winter and spring and increases in summer flows to provide water for irrigation and M&I.

A study of breeding riparian songbirds along the Sacramento River found that the median flood date (50,000 cfs flows) was the most significant variable for predicting the nesting success of black-headed grosbeaks (Small 2007). Black-headed grosbeaks nest in mid-canopy riparian vegetation from May – July along the Sacramento River. Flood flows close to the springtime breeding season were found to increase the nest survival rate of black-headed grosbeaks by reducing the activity of mammalian predators (*e.g.*, rats and raccoons) (Small 2007). Thus additional decreases in spring flood flows with an enlarged Shasta Dam could result in a decrease in the nest survival rate of black-headed grosbeaks due to increased springtime activity of mammalian predators.

Another recent study found that to reach a goal of a sustainable population of western yellow-billed cuckoo along the Sacramento River will require that river channel management encourage channel meander dynamics and channel cut-off to maintain the natural regeneration of cottonwood and willow pioneer plant communities (Greco 2013). The natural regime of flood flow that duplicates the hydrodynamic and geomorphic processes needed for the continuing natural successional vegetative communities along the Sacramento River will be essential to maintain the western yellow-billed cuckoo population.

The timing of flood flows was also found to affect the relative distribution of native riparian vegetation and exotic plant species. A study of the seed composition of winter and spring sediment traps along the Sacramento River between Hamilton City and Colusa showed a greater proportion of native riparian vegetation (*e.g.*, willows) seeds associated with spring flood events while winter flood events resulted in a greater proportion of non-native plant species (Little 2007). Thus a further decrease in spring flood flows with the SLWRI could result in a decrease in native riparian vegetation and increase in exotic plant species. The enlargement of Shasta Dam with the SLWRI is likely to result in a further departure from the natural seasonal cycle of flows in the Sacramento River.

The change in monthly flows out of Keswick Dam in the SLWRI alternatives relative to No Action would result in a decrease in average monthly flows out of Keswick Dam 4 months of the year and an increase in monthly flows 7 months of the year. The SLWRI alternatives increase flows during the late summer months and decrease flows during the winter months.

CP1 – 6.5 Foot Dam Raise

Of the SLWRI alternatives, CP1 would have the least amount of cold water available to maintain cooler temperatures for anadromous fish in the Sacramento River between Keswick Dam and RBPP during dry and critical years. CP1, however, would have the least impact on altering the timing, frequency, and duration of ecologically important flood flows.

CP2 – 12.5-Foot Dam Raise

CP2 would provide more available cold water than CP1 to maintain cooler temperatures for anadromous fish in the Sacramento River between Keswick Dam and RBPP during dry and critical years. CP2, however, would have a greater impact on altering the timing, frequency, and duration of ecologically important flood flows.

CP3 – 18.5-Foot Dam Raise

CP3 would provide more cold water storage than CP1 and CP2 to maintain cooler temperatures for anadromous fish in the Sacramento River between Keswick Dam and RBPP during dry and critical years. CP3, however, would have the greater impact on altering the timing, frequency, and duration of ecologically important flood flows.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus

Of the SLWRI alternatives, CP4 would provide the greatest amount of cold water available to maintain cooler temperatures for anadromous fish in the Sacramento River between Keswick Dam and RBPP during dry and critical years. CP4, like CP1, would also have the least impact on altering the timing, frequency, and duration of ecologically important flood flows.

CP4A – 18.5-Foot Dam Raise, Preferred Alternative

CP4A would provide half the amount as CP4 of cold-water pool available to maintain cooler temperatures for anadromous fish in the Sacramento River between Keswick Dam and RBPP during dry and critical years. CP4A, like CP2, would also have a greater impact on altering the timing, frequency, and duration of ecologically important flood flows.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 would provide an unspecified amount of cold water for anadromous fish benefits. The effects of CP5 on the flows in the Sacramento River between Keswick Dam and RBPP are similar to CP3 described above.

Anadromous Fish

One of two primary goals of the SLWRI is to increase survival of anadromous fish in the Sacramento River between Keswick Dam and RBPP. Reclamation used SALMOD modeling to estimate annual immature smolt production for the four runs of Chinook salmon within the Sacramento River between Keswick Dam and RBPP for the No Action and SLWRI alternatives for water years 1922 – 2002.

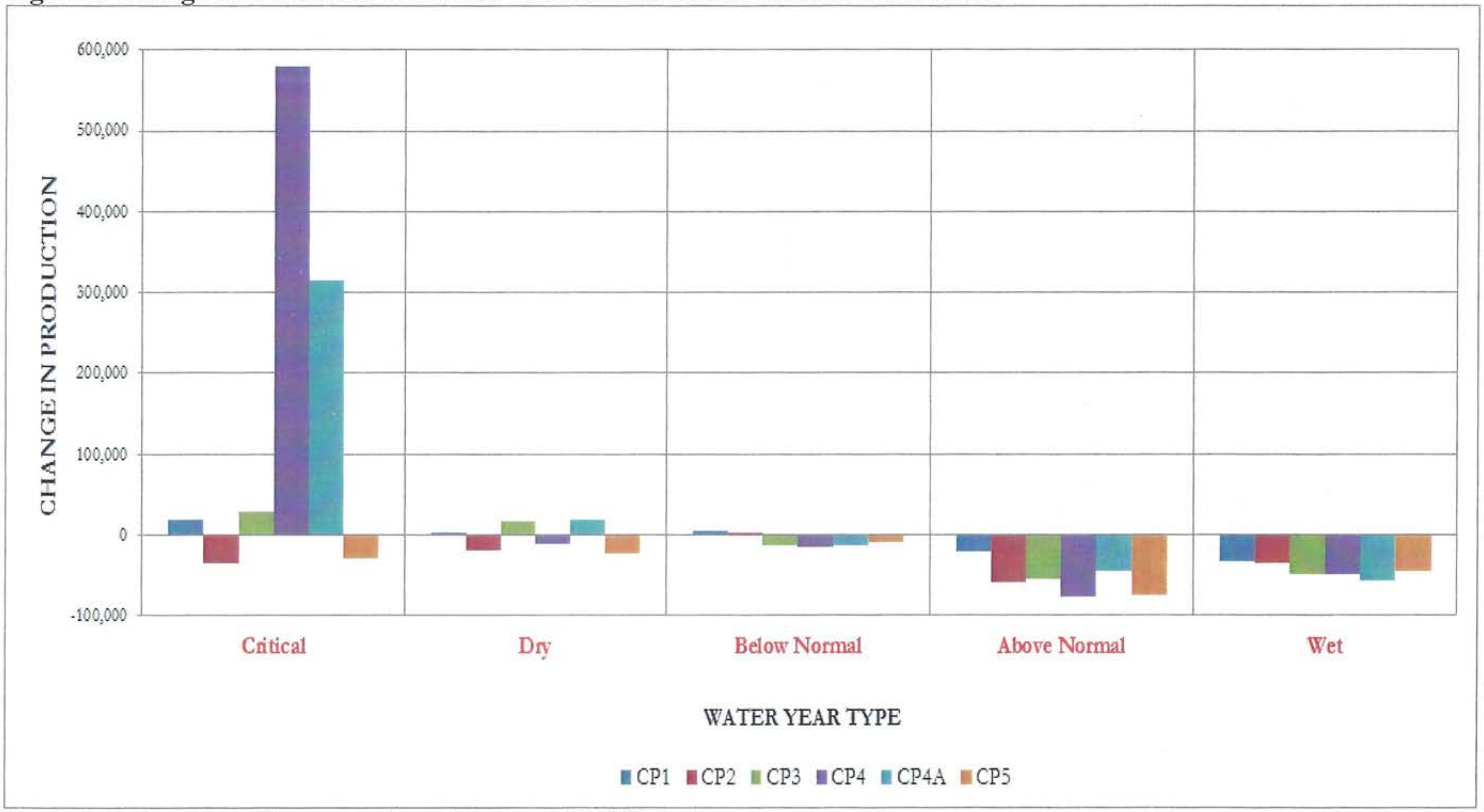
Below is a discussion of the changes in production of winter-, spring-, fall-, and late fall-run Chinook salmon immature smolts in each of the SLWRI alternatives relative to the No Action Alternative based on Reclamation's SALMOD modeling. However, it should be noted that SALMOD modeling likely underestimates the mortality of Chinook salmon eggs, fry, pre-smolts and immature smolts: (1) due to the inability of SALMOD to model resource competition among the four runs of Chinook salmon and steelhead; and (2) by limiting the simulation to areas upstream of the RBPP where mortality rates are considerably lower than further downstream. All models have inherent limitations based on the limits of the data input into the model and the assumptions made by the model. Although the following discussion uses quantitative results in the form of percentage of change of production, it must be remembered that these are simulated results from the models and should only be seen in the light of comparing the various Project Alternatives, and not viewed as predictions of actual production.

For the period of 81 years (1922 -2002) used for Reclamation's modeling (SALMOD), no significant change (a change of greater than 5 percent) in average production for any of the Chinook salmon runs (winter-run, spring-run, fall-run, and late fall-run) resulted from any of the proposed alternatives (CP1, CP2, CP3, CP4, CP4A, and CP5) compared to either the No-Action Alternative (Future Conditions 2030) or the Existing Condition (2005) (USBR 2014). Critical water years account for 13 years, dry water years account for 17, below normal account for 14, above normal account for 11, and wet water years account for 26 out of the 81 years simulated in the SALMOD modelling (USBR 2014).

Winter-run Chinook Salmon

SALMOD modeling for CP1 showed no significant change (≥5 percent) in production for winter-run Chinook salmon. Overall there was a slight decrease in production (<1 percent) for CP1 relative to the No Action. For CP2, modeling showed an even greater decrease of overall production for winter-run Chinook salmon, although the decrease was still less than 1 percent (-0.7 percent). Modeling did show a decreases in production in 4 out of 5 of water year types, but all less than significant. CP3 also showed a slight decrease in overall production, and decreases in 3 out 5 of water year types. CP4 showed a slight increase in overall production (1.7 percent), with significant increase (17.2 percent) during critical water years, which accounted for 13 out of 81 years simulated. CP4 also showed a decrease in production of winter-run Chinook salmon in 4 out of 5 of water year types. CP4A showed a slightly smaller increase in overall production (0.7 percent), with a less significant increase (9.3 percent) during critical water years. CP4A showed a decrease in production of winter-run Chinook salmon in 3 out of 5 of water year types. Finally, CP5 showed an overall less than significant decrease of -0.9 percent in production of winter-run Chinook salmon, and showed decreases in production in all water year types relative to No Action (Figure 3). The life-cycle data and the spawning locations for winter-run Chinook salmon used by Reclamation in their SALMOD modeling are not current. Current data (2003 – 2014) shows that winter-run Chinook spawn in greater proportions in Spawning Segments numbers 1 and 2, and less in Segment 3 as Reclamation's modeling used. Also, winter-run Chinook salmon in the mainstem Sacramento River spawn approximately a month later on average than the dates used by Reclamation in their modeling (CDFW 2014). A more detailed analysis of the effects of the SLWRI on winter-run Chinook salmon will be provided by NMFS in Section 7 consultation under the ESA.

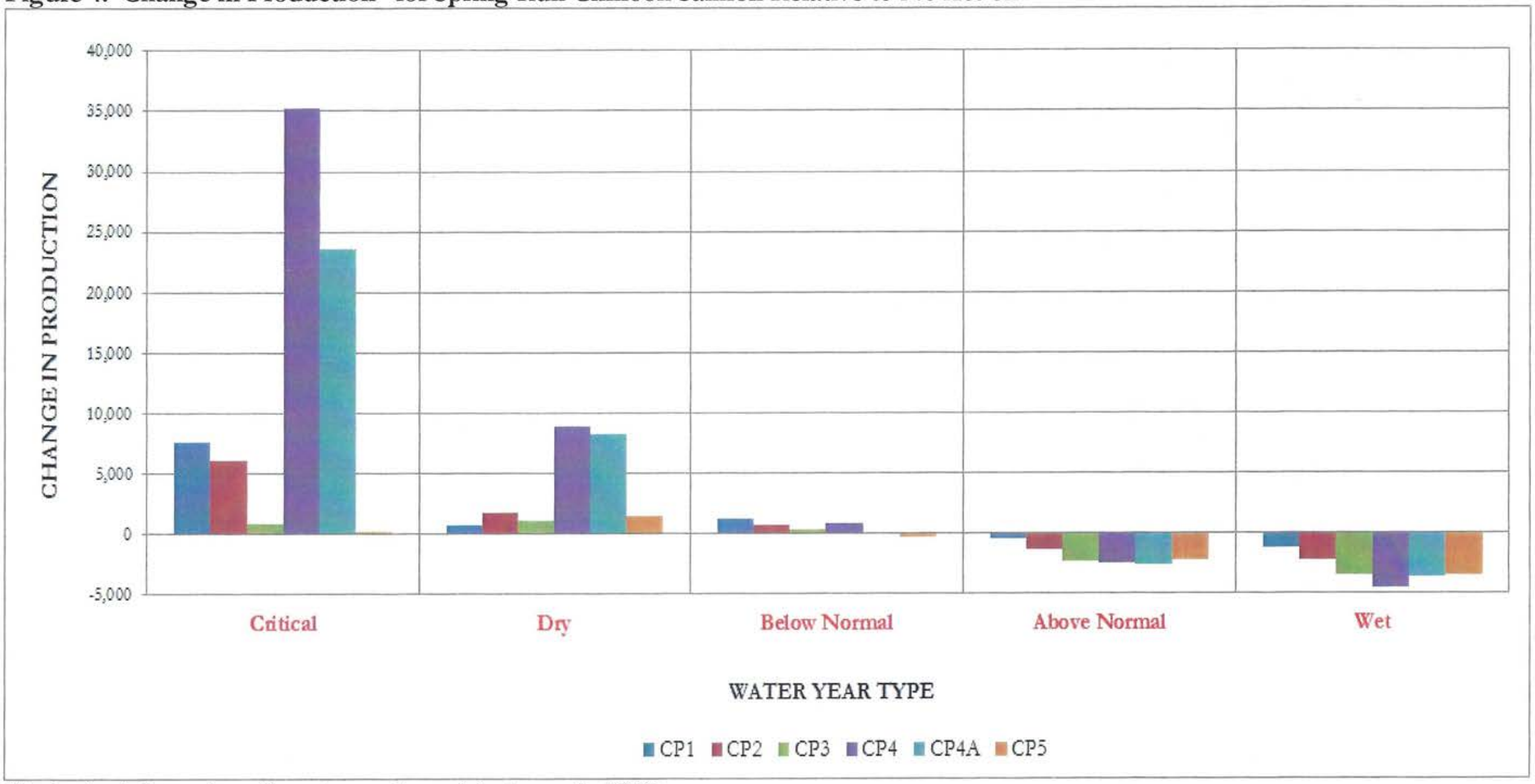
Figure 3. Change in Production* for Winter-Run Chinook Salmon Relative to No Action



*Production is the number of immature smolts surviving to pass the RBPP

Spring-run Chinook Salmon
SALMOD modeling for CP1 showed no significant change (≥5 percent) in production for spring-run Chinook salmon. Overall there was a slight increase in production (0.7 percent) for CP1 relative to the No Action, but with significant increase (9.3 percent) during critical water years, which accounted for 13 out of 81 years simulated. For CP2, modeling showed a slight increase of overall production for spring-run Chinook salmon, although the increase was still less than 1 percent (0.4 percent). Modeling did show a significant increase (7.6 percent) for CP2 during critical water years, but also a -1.2 percent decrease for wet water years which accounted for 26 out of 81 years simulated. CP3 also showed a slight decrease (-0.6 percent) in overall production, and a decrease in 37 out 81 of years simulated relative to No Action. CP4 showed an increase in overall production (3.6 percent), with a significant 43.4 per cent increase during critical water years and a 5.2 percent increase during dry water years, which accounted for 30 out of 81 years simulated. CP4 also showed a less than significant decrease in production of spring-run Chinook salmon in wet and above normal water year types which accounted for 37 of the 81 years simulated. CP4A showed a slightly smaller increase in overall production (2.4 percent), with a significant increase (29.0 percent) during critical water years. CP4A showed a decrease in production of spring-run Chinook salmon in wet and above normal water year types which accounted for 37 of the 81 years simulated. Finally, CP5 showed an overall less than significant decrease of -0.7 percent in production of spring-run Chinook salmon, and showed slight decreases in production in 3 out of 5 water year types relative to No Action (Figure 4). A more detailed analysis of the effects of the SLWRI on winter-run Chinook salmon will be provided by NMFS in Section 7 consultation under the ESA.

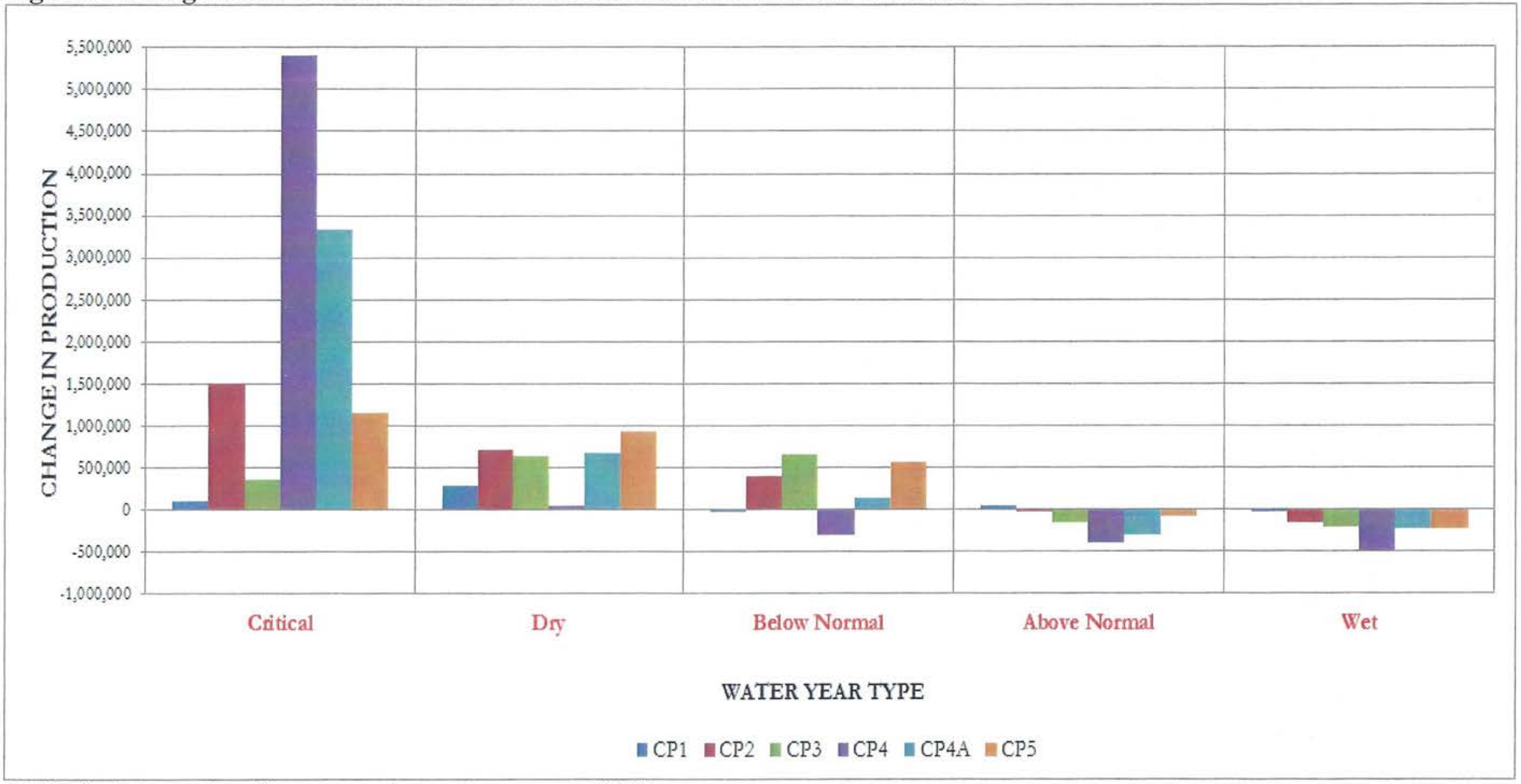
Figure 4. Change in Production* for Spring-Run Chinook Salmon Relative to No Action



*Production is the number of immature smolts surviving to pass the RBPP

Fall-run Chinook Salmon
SALMOD modeling for CP1 showed no significant change (≥5 percent) in production for fall-run Chinook salmon. Overall there was a slight increase in production (0.3 percent) for CP1 relative to the No Action. For CP2, modeling showed a slight increase of overall production for fall-run Chinook salmon, although the increase was still less than significant (1.4 percent). Modeling did show a barely significant increase (5.7 percent) for CP2 during critical water years. CP3 also showed a slight increase (0.7 percent) in overall production, and no significant change in production for any water year types simulated relative to No Action. CP4 showed an increase in overall production (2.1 percent) of fall-run Chinook salmon, with a significant 20.4 per cent increase during critical water years, which accounted for 13 out of 81 years simulated. CP4 also showed a less than significant decrease in production of fall-run Chinook salmon in below normal, wet and above normal water year types which accounted for 51 of the 81 years simulated. CP4A showed a slightly smaller increase in overall production (2.0 percent), with a significant increase (12.6 percent) during critical water years. CP4A showed a decrease in production of fall-run Chinook salmon in wet and above normal water year types which accounted for 37 of the 81 years simulated. Finally, CP5 showed an overall less than significant increase of 1.4 percent in production of fall-run Chinook salmon, and showed slight decreases in production of fall-run Chinook salmon in wet and above normal water year types relative to No Action (Figure 5).

Figure 5. Change in Production* for Fall-Run Chinook Salmon Relative to No Action



*Production is the number of immature smolts surviving to pass the RBPP

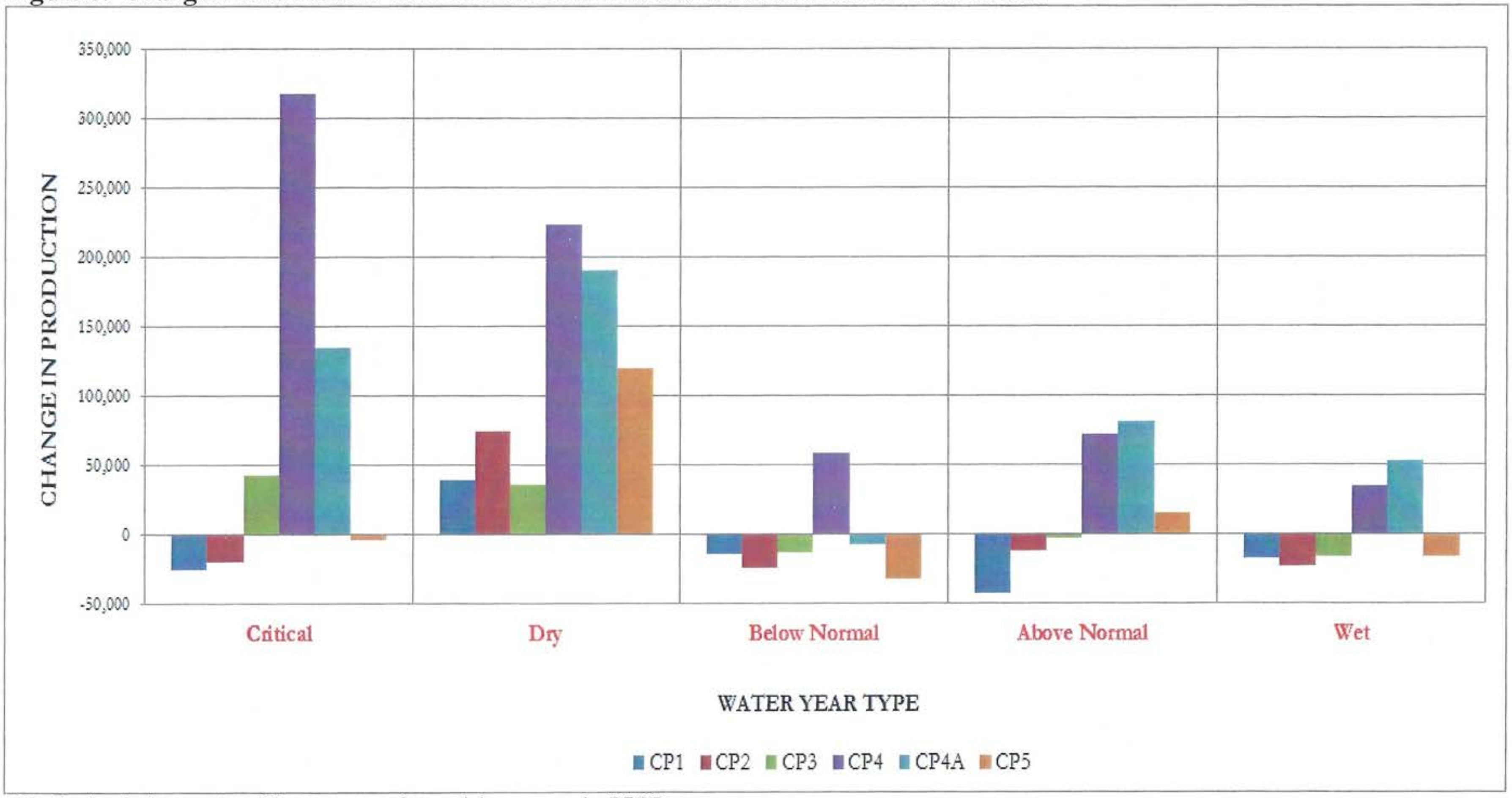
Late Fall-run Chinook Salmon

SALMOD modeling for CP1 showed no significant change (≥5 percent) in production for late fall-run Chinook salmon. Overall there was a slight decrease in production (-0.1 percent) for CP1 relative to the No Action, with slight decreases in production in 4 out of 5 water year types, accounting for 65 out of the 81 years simulated. For CP2, modeling showed no change of overall production for late fall-run Chinook salmon, although, as with CP1, slight decreases were predicted in production in 4 out of 5 water year types, accounting for 65 out of the 81 years simulated. CP3 showed a slight increase (0.1 percent) in overall production, and no significant change in production for any water year types simulated relative to No Action. CP4 showed a slight increase in overall production (1.7 percent) of late fall-run Chinook salmon, with no significant change in production for any of the water years simulated. CP4A showed a slightly smaller increase in overall production (1.2 percent), also with a no significant change in production for any of the water years simulated. Finally, CP5 showed no significant overall change in production of late fall-run Chinook salmon, or in any water year types relative to No Action (Figure 6).

Steelhead Trout

There is not enough information available at this time to adequately evaluate the effects of the SLWRI on steelhead. Reclamation has equated the impacts and effects of the SLWRI to steelhead as the same as those to late fall-run Chinook salmon based on the NMFS assumption that late fall-run Chinook salmon could be used as a surrogate (NMFS 2009; USBR 2014) (Figure 6). A more detailed analysis of the effects of the SLWRI on steelhead will be provided by Reclamation in its consultation with NMFS under Section 7 of the ESA.

Figure 6. Change in Production* for Late Fall-Run Chinook Salmon Relative to No Action



*Production is the number of immature smolts surviving to pass the RBPP

Green Sturgeon
There is not enough information available at this time to adequately evaluate the effects of the SLWRI on green sturgeon. A more detailed analysis of the effects of the SLWRI on green sturgeon will be provided by Reclamation in its consultation with NMFS under Section 7 of the ESA.

Native Resident Fish

The decrease in temperatures in the Sacramento River with the SLWRI alternatives would likely have a negative impact on native resident fish that require warmer temperatures such as hardhead, California roach, and Sacramento pikeminnow. Optimal temperatures for hardhead are 75-82°F (Knight 1985). Sacramento pikeminnow also prefer warmer water temperatures and rarely thrive below 15°C (59°F) (Moyle 1976). A report from the 1950s stated that cold flows from Shasta Dam had forced Sacramento pikeminnow miles downstream (Taft and Murphy 1950). Therefore, a further decrease in temperatures in the Sacramento River between Keswick Dam and RBPP would also likely cause Sacramento pikeminnow to move further downstream. This effect of pushing the Sacramento pikeminnow farther downstream could have a beneficial effect on rearing juvenile salmonids, limiting the predation pressure early in their lifecycle, but there is no data and it would be speculation at this point.

Special-Status Aquatic Species

The effects of the SLWRI on special-status anadromous fish in the Sacramento River between Keswick Dam and the RBPP are discussed in the "Anadromous Fish" section above. A more detailed analysis of the effects of the SLWRI on winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon will be provided by Reclamation in its consultation with NMFS under Section 7 of the ESA. The effects of the SLWRI alternatives on hardhead are discussed in the "Native Resident Fish" section above.

Terrestrial/Wetland Vegetation and Wildlife

Impacts of the SLWRI alternatives on terrestrial and wetland vegetation and wildlife along the Sacramento River between Keswick Dam and the RBPP is related to changes in the timing, frequency, and duration of flood flows. High frequency flood flows (1 – 4-year flood events) in April – June are important for maintaining and restoring cottonwood and willow riparian habitat in the lower floodplain. Lower frequency flood flows are important for maintaining and restoring oak woodland habitat in the higher floodplain. Spring flood flows are important for the distribution and germination of native riparian vegetation (Little 2007) and for increasing the nest survival rate of black-headed grosbeak (Small 2007). Based on the monthly CALSIM II data, the SLWRI alternatives could result in slight increases in the frequency of April – June 10-year flood events relative to No Action, but would have no significant effect on the frequency of higher frequency flood events.

An analysis of the effects of changes in hydrology on riparian habitat requires data on daily time steps and more complex modeling such as in the Sacramento River Ecological Flows Tool (SacEFT) (ESSA Technologies Ltd. 2006). For instance, the SacEFT evaluates the success of cottonwood seedlings initiating at a given location. Cottonwood seeds are released within a dispersal window (from April 1 to June 30). Dispersal also needs to occur at a relative elevation above base flow within which seeds will not desiccate. While accounting for capillary fringe depth (30-60 cm), rate of stage decline determines soil moisture and the likelihood of desiccation. Hence, for successful germination and initial growth, declines cannot occur at a rate faster than the taproot growth rate (average 22 mm/day, maximum 32 mm/day). The cottonwood performance measure tallies the number of initiation successes and failures across years and across the three cross-sections available on the Sacramento River (ESSA Technologies Ltd. 2006; Roberts *et al.* 2002; Roberts 2003). Thus, a daily model of the Sacramento River (such as SacEFT) is required to adequately evaluate the effects of the SLWRI on riparian habitat.

CP1 – 6.5 Foot Dam Raise

There is not enough information at this time to adequately evaluate the effects of CP1 on riparian habitat.

CP2 – 12.5-Foot Dam Raise

There is not enough information at this time to adequately evaluate the effects of CP2 on riparian habitat.

CP3 – 18.5-Foot Dam Raise

There is not enough information at this time to adequately evaluate the effects of CP3 on riparian habitat. However, the frequency and duration of high-flow events are expected to be reduced compared to existing conditions with current operations (USBR 2014). Flood flows are important for the establishment and maintenance of riparian habitat important to sensitive species. Any alteration of the successional regime of the riparian forest along the Sacramento River would likely adversely affect the habitat of sensitive species that rely on that dynamic process. Additionally, further decreases in peak flows during the spring would inhibit the regeneration of cottonwoods and willows while potentially promoting the establishment of invasive species.

CP4 – 18.5-Foot Dam Raise

There is not enough information at this time to adequately evaluate the effects of CP4 on riparian habitat. Given the assumption that 378,000 af (or 60 percent of the increased storage from an enlarged Shasta) are held within Shasta Lake for cold water storage in CP4, the impacts to terrestrial and wetland habitat along the Sacramento River between Keswick Dam and RBPP would be the same in CP4 as in CP1.

CP4A – 18.5-Foot Dam Raise, Preferred Alternative

There is not enough information at this time to adequately evaluate the effects of CP4A on riparian habitat. As recently as June 2013, the cold water pool management scenario for CP4A was eliminated for further consideration by Reclamation as being redundant with the management scenario of CP4 and providing less benefit to anadromous fish (USBR 2013). Given the assumption that 191,000 af (or 30 percent of the increased storage from an enlarged Shasta) will be held within Shasta Lake for cold water storage in CP4A, the impacts to terrestrial and wetland habitat along the Sacramento River between Keswick Dam and RBPP would be similar in CP4A as in CP2.

CP5 – 18.5-Foot Dam Raise
There is not enough information at this time to adequately evaluate the effects of CP5 on riparian habitat. The impacts to terrestrial and wetland habitat along the Sacramento River between Keswick Dam and RBPP would be the similar in CP5 as in CP3.

Special-Status Upland and Riparian Species

Changes in the timing, frequency, and duration of flood flows in the SLWRI alternatives would negatively affect the restoration and maintenance of riparian habitat important for special-status species such as the valley elderberry longhorn beetle and the western yellow-billed cuckoo. There is not enough information available at this time to adequately evaluate the effects of the SLWRI alternatives on riparian habitat for special-status species. A more detailed analysis of the effects of the SLWRI on valley elderberry longhorn beetle and other federally-listed terrestrial species will be provided by Reclamation in Section 7 consultation under the ESA

Extended Study Area: Sacramento River between RBPP and the Delta

Aquatic Species

The benefits of maintaining cooler water temperatures in the Sacramento River for anadromous fish would most likely be limited to areas upstream of RBPP. However, changes in the timing, frequency, and duration of flows would still occur in the Sacramento River downstream of the RBPP that would likely affect juvenile rearing habitat and adult attraction flows for anadromous fish. A reduction in the frequency and duration of winter and spring flood flows would reduce natural flooding events essential for the establishment of SRA cover. This would reduce suitable juvenile salmonid rearing habitat, increase predator habitat, and affect fish passage. Riparian vegetation is also an important allocthonous source of organic matter and nutrients for the Sacramento River ecosystem (Winemiller and Jepsen 1998). Also, riparian vegetation is essential for terrestrial insects that are an important part of the diet of juvenile salmonids. Studies of the diet and growth rates of fall-run Chinook salmon juveniles in the Sacramento River and Yolo Bypass revealed that dipteran insects associated with woody debris are the preferred diet for juvenile salmonids and contributed to higher growth rates than a diet composed primarily of zooplankton (Sommer *et al.* 2001b).

Also important is the timing of flows. Spring flood flows are important for native riparian vegetation establishment (Little 2007) and for decreasing mammalian predator activities that reduce the nesting survival rates of riparian songbirds (Small 2007). The enlarging of Shasta Dam with the

SLWRI is likely to result in a further departure from the natural seasonal cycle of flows in the Sacramento River. Although the SLWRI alternatives may not change the frequency distribution of flows past the RBPP and into the Delta (analyzed on a monthly time step), they do change the timing of flows past the RBPP and inflows to the Delta relative to No Action and increase the magnitude of the shifts in regime.

Below is a discussion of what affect the preferred alternative, CP4A, would have on the monthly timing of flows for each water year type past the RBPP and into the Delta.

Flows past the RBPP CP4A – 18.5-Foot Dam Raise (CP2 – 12.5-Foot) Preferred Alternative

Overall, there would be a 1 percent increase for July (163 cfs); 2 percent increase for September (179 cfs) and November (142 cfs); and a 3 percent increase for October (180 cfs) in the average flow of the Sacramento River past the RBPP for CP4A relative to No Action. Flows past RBPP would decrease 1 percent in March (-121 cfs) and May (-76 cfs); 2 percent in January (-290 cfs) and February (-271 cfs); and 3 percent in December (-348 cfs), relative to the No Action.

During wet water years, average monthly flows would decrease by 1 percent in January (-405 cfs) and February (-362 cfs), and 4 percent in December (-842 cfs). Flows during wet water years would increase during September (110 cfs) by 1 percent and by 2 percent in November (244 cfs).

During above normal water years, average monthly inflows past RBPP would decrease by 1 percent in May (-64 cfs); decrease by 3 percent in November (-261 cfs), December (-269 cfs), and January (-464 cfs); and decrease by 4 percent in February (-906 cfs), March (-623 cfs), and June (-404 cfs). Average monthly flows past the RBPP would increase in September (5 percent, 376 cfs) and October (6 percent, 452 cfs).

During below normal water years, average monthly inflows would decrease by 1 percent in January (-108 cfs) and February (-156 cfs), 2 percent in March (-220 cfs), and 4 percent in May (-355 cfs) and December (-289 cfs). Average monthly flows past the RBPP would increase by 1 percent in July (84 cfs) and September (59 cfs); 2 percent in November (168 cfs); and 4 percent in October (275 cfs) relative to the No Action.

During dry water years, average monthly flows past the RBPP would decrease by 1 percent in February (-125 cfs) and December (-103 cfs), and 3 percent in January (-223 cfs). Average monthly flows would increase by 2 percent in August (175 cfs) and November (149 cfs); by 3 percent in June (320 cfs), July (403 cfs), and September (164 cfs); and 4 percent in October (229 cfs), relative to No Action.

During critical water years flows past the RBPP would decrease by 2 percent in August (-230 cfs) and 3 percent in January (-183 cfs) relative to the No Action. Flows would increase by 1 percent in October (46 cfs); by 3 percent in February (204 cfs) and July (326 cfs); 4 percent in December

(209 cfs); 5 percent in November (282 cfs); and 6 percent in September (289 cfs), relative to the No Action (Figure 7).

Inflows from the Sacramento River into the Delta CP4A – 18.5-Foot Dam Raise (CP2 – 12.5-Foot) Preferred Alternative

There would be a 1 percent increase for September (250 cfs), October (93 cfs), and November (94 cfs) in the average inflows from the Sacramento River into the Delta for CP4A relative to No Action. During wet water years, average monthly inflows would decrease by 1 percent (-246 cfs) in December. During above normal water years, average monthly inflows would decrease by 1 - 2 percent in February (1 percent, -655 cfs), May (1 percent, -237cfs), June (2 percent, -354 cfs), and November (2 percent, -217 cfs). During above normal water years, average monthly inflows into the Delta would increase in September (1 percent, 112 cfs) and October (2 percent, 189 cfs). During below normal water years, average monthly inflows would decrease in March (1 percent, -140 cfs), and May (2 percent, -343 cfs). During dry water years, average monthly inflows into the Delta would decrease by 1 percent in January (-180 cfs), February (-117 cfs), and December (-141 cfs), but would increase by 1 percent in April (97 cfs), May (75 cfs), and July (218 cfs), 2 percent in August (316 cfs), 3 percent in October (270 cfs) and November (368 cfs), and 7 percent in September (848 cfs), relative to No Action. During critical water years inflows would increase by 1 percent in January (120 cfs), February (77 cfs), April (73 cfs), May (72 cfs), August (62 cfs), and December (76 cfs). The average monthly inflows would increase by 2 percent (263 cfs) in July, 3 percent (258 cfs) in November, and 4 percent in September (308 cfs), relative to the No Action (Figure 8).

Terrestrial/Wetland Vegetation and Wildlife

Terrestrial, riparian, and wetland vegetation and wildlife along the Sacramento River would also be affected by changes in the timing, frequency, and duration of flows in the Sacramento River. Reduced winter flows would result in a loss of riparian cover and possible encroachment of upland vegetation and invasive species into riparian habitat. Changes in flows would affect the following aspects of riparian habitat: composition, age structure, quantity, growth, vigor, soil fertility/seed bed formation and quality, and regeneration/succession of riparian vegetation (Mount 1995; Larsen *et al* 2006; Greco 2008; Greco 2012; Fremier *et al* 2014). Riparian vegetation would also be affected by increasing summer inundation. In order to evaluate the effects of the project on riparian habitat, more data is needed on flow management specifications and their effects on daily flow releases. The SacEFT (ESSA Technologies Ltd. 2006) can be used to evaluate the effects of changes in the flow regime on riparian habitat. However, there is not enough data at this time to evaluate the effects of the SLWRI alternatives on riparian and upland vegetation and wildlife along the Sacramento River. In order to evaluate the effects of the project on riparian habitat, more data is needed on flow management specifications and their effects on daily flow releases. The Service is currently waiting for an analysis of the SLWRI alternatives using the SacEFT.

Figure 7. Sacramento River Flow Downstream of RBPP for CP4A Relative to the No Action (CFS)

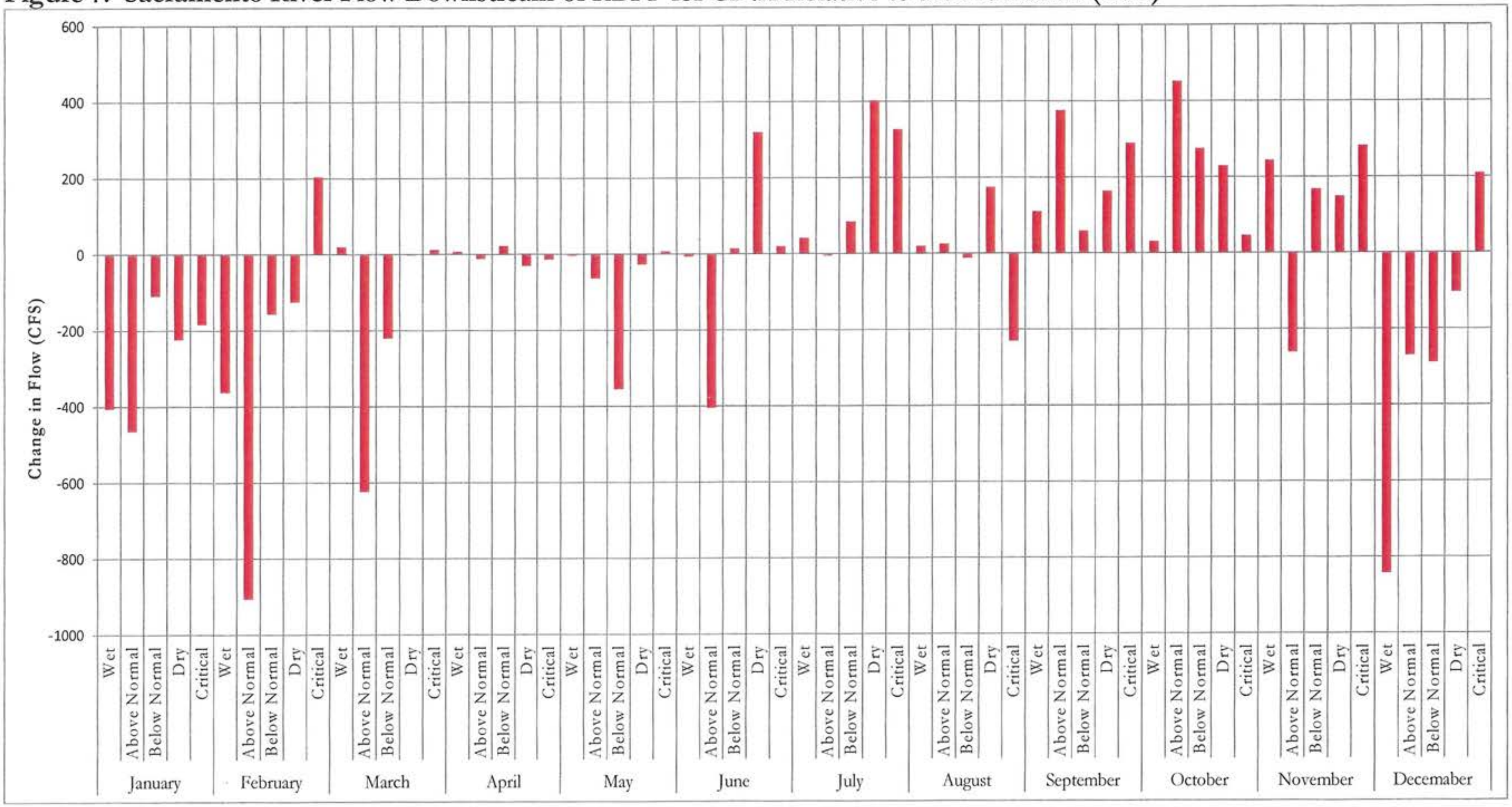
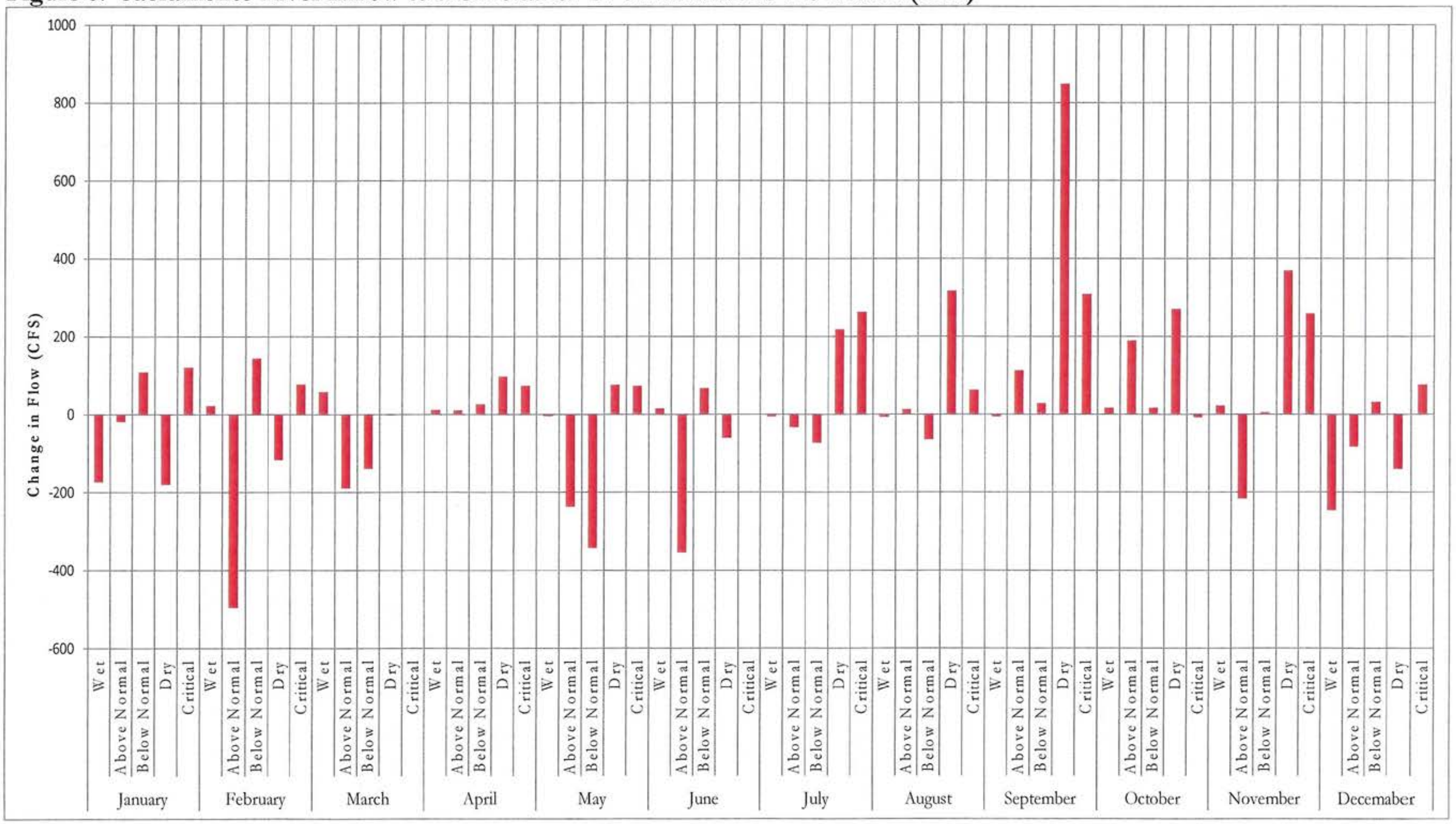


Figure 8. Sacramento River Inflow to the Delta for CP4A Relative to No Action (CFS)



Special-Status Terrestrial Species

There is not enough data at this time to evaluate the effects of the SLWRI alternatives on special-status terrestrial species along the Sacramento River. However, changes in the timing, frequency, and duration of flood flows would affect the regeneration and maintenance, and the successional dynamics of riparian vegetation important to sensitive migratory bird species such as the yellow-billed cuckoo and Swainson's hawk. The Service is currently waiting for an analysis of the SLWRI alternatives using the SacEFT. A more detailed analysis of the effects of the SLWRI on valley elderberry longhorn beetle and other federally-listed terrestrial species will be provided by Reclamation to the Service in Section 7 consultation under the ESA.

Extended Study Area: Sacramento-San Joaquin Delta and the Yolo Bypass

The enlarging of Shasta Dam in the SLWRI alternatives would affect the timing, frequency, and duration of flood flows in the Sacramento River between Keswick Dam and RBPP and further downstream. Changes in flood flows in the Sacramento River would affect hydroperiods in the Sutter and Yolo Bypasses. The Yolo Bypass in particular provides important rearing habitat for juvenile salmonids and special-status Delta fish species such as delta smelt, Sacramento splittail, and longfin smelt. The Yolo Bypass is designated as Critical Habitat for Central Valley spring-run Chinook salmon (70 FR 170). There is not enough information available at this time to evaluate the effects of the SLWRI on hydroperiods and the frequency of flooding of the Yolo and Sutter Bypasses. CALSIM modeling simulates the flooding of the Yolo and Sutter Bypasses using a monthly time step which misses the important flood events that operate on daily and weekly time scales. In order to evaluate the effects of the project on floodplain inundation, more data is needed on flow management specifications and their effects on daily flow releases.

The enlarging of Shasta Dam in the SLWRI alternatives is also likely to affect sensitive aquatic species in the Delta through changes in the timing, frequency, and duration of flows in the Sacramento River and changes in Delta exports. A decrease in Sacramento River flood flows would reduce Bay-Delta flushing flows, affect Delta water quality (*e.g.*, X2 locations, contaminant dilution), and affect Delta outflows and inflow/export ratios. All of these factors may further contribute to pelagic organism decline in the Delta.

Increased water supply reliability in the SLWRI alternatives is also likely to increase Delta exports (pumping at Jones and Banks) during dry and critical water years relative to No Action (USBR 2014). All of these factors will affect sensitive Delta species such as delta smelt, Sacramento splittail, and longfin smelt as well as juvenile salmonids. There is not enough information at this time to evaluate the effects of the SLWRI alternative on Delta outflows and the location of X2. In order to evaluate the effects of the project on Delta outflows and the location of X2, more data is needed on flow management specifications and their effects on daily flow releases.

CP1 – 6.5 Foot Dam Raise

During February in critical water years, CP1 would result in an increase in Delta exports pumping from 2,356 to 2,437 cfs at the Jones SWP facility and from 2,523 to 2,541 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones and Banks pumping facilities. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta.

CP2 – 12.5-Foot Dam Raise

During February in critical water years, CP2 would result in an increase in Delta exports pumping from 2,356 to 2,428 cfs at the Jones SWP facility and a decrease from 2,523 to 2,466 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones pumping facility. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta.

CP3 – 18.5-Foot Dam Raise

During February in critical water years, CP3 would result in an increase in Delta exports pumping from 2,356 to 2,439 cfs at the Jones SWP facility and from about 2,523 to 2,544 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones and Banks pumping facilities. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta.

CP4 – 18.5-Foot Dam Raise, Anadromous Fish Focus

Like CP1, during February in critical water years, CP4 would result in an increase in Delta exports pumping from 2,356 to 2,437 cfs at the Jones SWP facility and from 2,523 to 2,541 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones and Banks pumping facilities. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta.

CP4A – 18.5-Foot Dam Raise, Preferred Alternative

Like CP2, during February in critical water years, CP4A would result in an increase in Delta exports pumping from 2,356 to 2,428 cfs at the Jones SWP facility and a decrease from 2,523 to 2,466 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones pumping facility. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta. Overall, CP4A, the preferred alternative, would result in an increase in Delta exports of about 2 percent in dry water years and about 1 percent in critical water years through the Jones SWP facility, and an increase of about 3 percent in dry water years and 2 percent in critical water years for the Banks CVP facility (Figures 9A and 9B).

Figure 9A. Simulated Monthly Average Exports through Banks CVP Pumping Plant in Critical Water Year for CP4A Relative to No Action (USBR 2014).

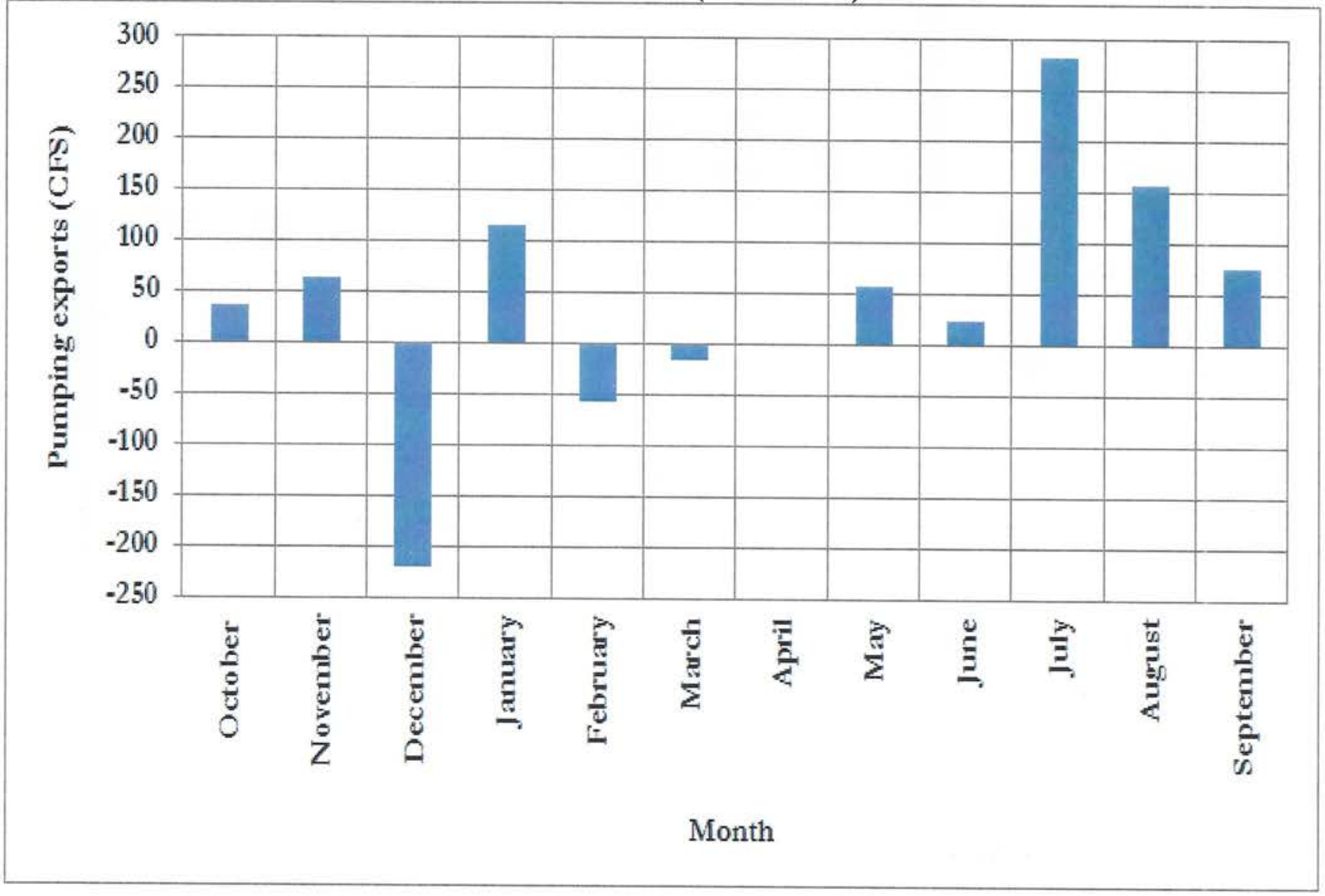
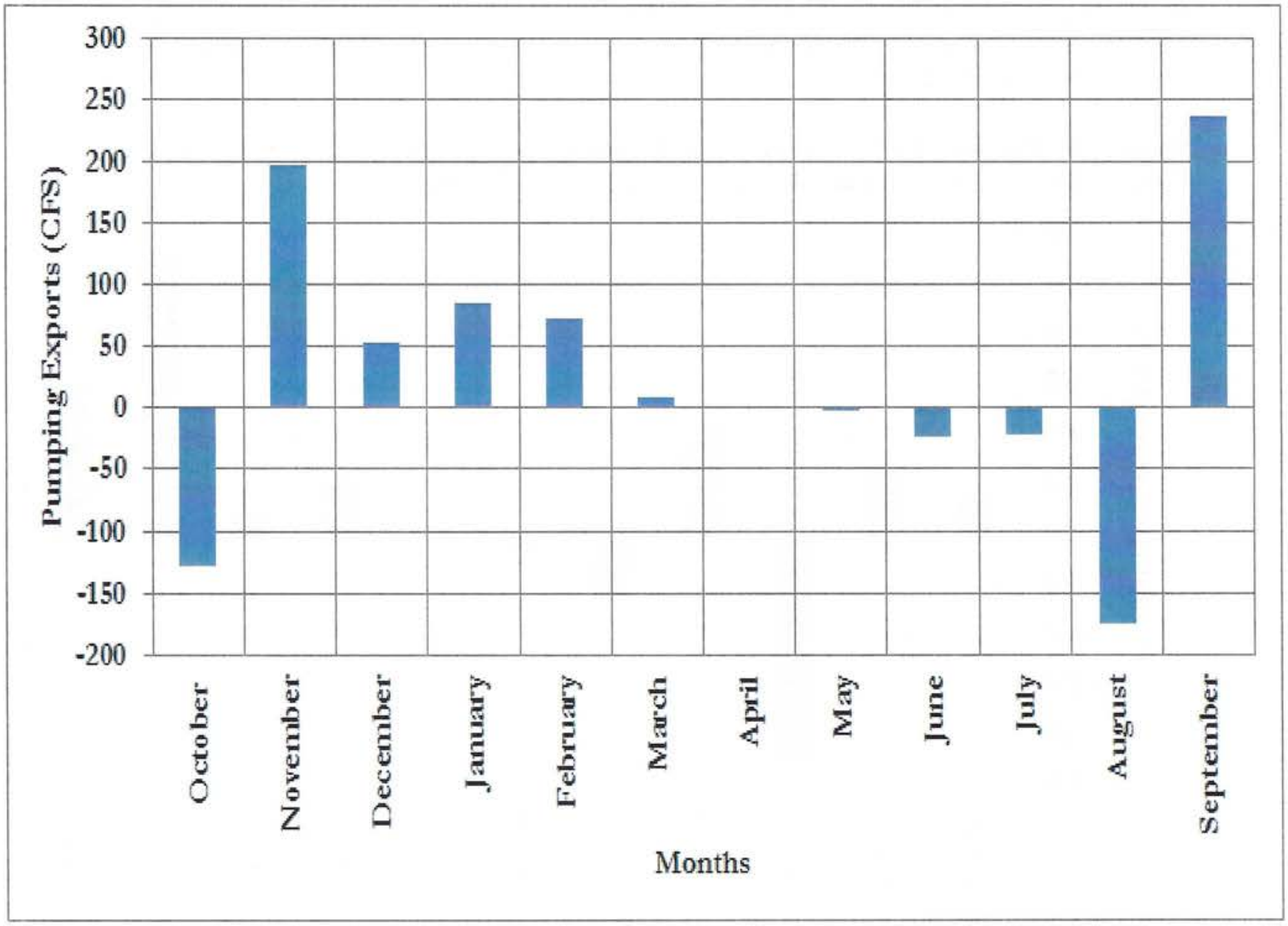


Figure 9B. Simulated Monthly Average Exports through Jones SWP Pumping Plant in Critical Water Year for CP4A Relative to No Action.



CP5 – 18.5-Foot Dam Raise, Combination Plan

During February in critical water years, CP5 would result in an increase in Delta exports pumping from 2,356 to 2,423 cfs at the Jones SWP facility and virtually unchanged from about 2,523 to 2,521 cfs at the Banks CVP facility compared to the No Action Alternative (USBR 2014). Increasing Delta exports, especially during critical water years, could result in an increase in the entrainment of fish at the Jones pumping facility. In particular, increasing Delta exports during delta smelt spawning in February could increase entrainment of this federally-listed species especially during critically dry years when the location of X2 is in the eastern Delta.

Special-Status Species

A more detailed analysis of the effects of the SLWRI on delta smelt, winter-run Chinook salmon, spring-run Chinook salmon, steelhead, green sturgeon and other federally listed species will be provided by Reclamation via section 7 consultations with the Service and NMFS under the ESA.

Extended Study Area: Downstream from other CVP and SWP Dams

Each of the SLWRI alternatives would likely result in changes in the operation of the CVP and SWP dams throughout the Central Valley (USBR 2014). These changes in the operation of CVP and SWP dams would affect wildlife within the reservoirs, as well as downstream from the dams. Rivers potentially affected include the American River, Feather River, San Joaquin River, and other rivers within the CVP-SWP area. The effects of the preferred alternative, CP4A, to Oroville and Folsom Reservoirs, and the Feather and American Rivers are discussed below.

Feather River

Based on Reclamation's modeling, during critical water years, CP4A had more water storage in Oroville Reservoir relative to the No Action alternative in every month of the year. CP4A resulted in increased storage by 2 percent for every month of the year except July, in which the storage level increased by 1 percent. The increase in water storage at Oroville Reservoir resulted in a corresponding decrease in monthly flows in the Feather River below the Thermalito Afterbay in 9 out of 12 months, with increased flows in May (29 cfs), June (26 cfs), and July (159 cfs). Operations of Oroville Dam would result in an overall slight decrease (-6 TAF) in Feather River flows relative to No Action (USBR 2014).

American River

During critical water years, CP4A had less water storage in Folsom Reservoir relative to the No Action alternative from October through May, ranging from 1 to 3 percent less end of the month storage. The greatest increase in end of the month storage would occur in July, with an increase of about 6 percent. The resulting changes in operations of Folsom Dam would result in decreases in flows in the American River near the H Street bridge relative to the No Action in 8 months out of the year, with the greatest decrease occurring in July (-20 percent) and the greatest increase in flows occurring in August (39 percent). Overall, CP4A would result in a 2 percent decrease in flows (- 18 TAF) in the American River during a critically dry year compared to the No Action (USBR 2014).

Special-Status Species

A more detailed analysis of the effects of the SLWRI on spring-run Chinook salmon, steelhead, and green sturgeon will be provided by NMFS in Section 7 consultation under the ESA.

Extended Study Area: CVP and SWP Water Service Areas

The CVP and SWP water service areas include agricultural and M&I water users throughout the Central Valley and Southern California. Increasing water reliability with the SLWRI would likely have growth-inducing effects resulting in changes in land use patterns within CVP and SWP water service areas, particularly within the San Joaquin Valley. The increased water supply reliability would likely accelerate the conversion of annual crops to permanent orchards and of remaining natural lands in the San Joaquin Valley to agricultural and urban areas. Also, increased water supply reliability would likely increase the conversion of agricultural lands to urban areas within the Central Valley and Southern California. All of these growth-inducing effects and changes in land use may adversely affect sensitive wildlife species within the Central Valley and Southern California. There is not enough information at this time to adequately analyze the effects of the SLWRI alternatives on habitat for common and special-status wildlife species in the CVP and SWP water service areas. More information on the effects of the SLWRI on federally-listed species within the CVP and SWP water service areas will be provided by Reclamation to the Service and NMFS via section 7 consultations under the ESA.

SERVICE MITIGATION POLICY

The recommendations provided herein for the protection of fish and wildlife resources are in accordance with the Service's Mitigation Policy as published in the Federal Register (46:15; January 23, 1981).

The Mitigation Policy provides Service personnel with guidance in making recommendations to protect or conserve fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service recommendations and plan early for mitigation needs. The intent of the policy is to ensure protection and conservation of the most important and valuable fish and wildlife resources, while allowing reasonable and balanced use of the Nation's natural resources.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife values involved (Table 23). The Resource Categories cover a range of habitat values from those considered to be unique and irreplaceable to those believed to be much more common and of relatively lesser value to fish and wildlife. However, the Mitigation Policy does not apply to threatened and endangered species, Service recommendations for completed Federal projects or projects permitted or licensed prior to enactment of Service authorities, or Service recommendations related to the enhancement of fish and wildlife resources.

In applying the Mitigation Policy during an impact assessment, the Service first identifies each specific habitat or cover-type that may be impacted by the project. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category analysis. Selection of evaluation species can be based on several rationale, as follows: (1) species known to be sensitive to specific land- and water-use actions; (2) species that play a key role in nutrient cycling or energy flow; (3) species that utilize a common environmental resource; or (4) species that are associated with Important Resource Problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service. (Note: Evaluation species used for Resource Category determinations may or may not be the same evaluation species used in a HEP application, if one is conducted.) Based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Table 23. Resource Categories and Mitigation Goals

Resource Category	Designated Criteria	Mitigation Goal
1	Habitat to be impacted is of high value for evaluation species and is unique or irreplaceable on a national basis or in the ecoregion section.	No loss of existing habitat value.
2	Habitat to be impacted is of high value for evaluation species and is relatively scarce or becoming scarce on a national basis or in the ecoregion section.	No net loss of in-kind habitat value.
3	Habitat to be impacted is of high to medium value for evaluation species and is relatively abundant on a national basis.	No net loss of habitat value while minimizing loss of in-kind habitat value.
4	Habitat to be impacted is of medium to low value for evaluation species.	Minimize loss of habitat value.

Mitigation planning goals range from "no loss of existing habitat value" (*i.e.*, Resource Category 1) to "minimize loss of habitat value" (*i.e.*, Resource Category 4). The planning goal of Resource Category 2 is "no net loss of in-kind habitat value"; to achieve this goal, any unavoidable losses would need to be replaced in-kind. "In-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost where such substitute resources are physically and biologically the same or closely approximate those lost. In addition to mitigation goals based on its Mitigation Policy, the Service supports a goal of no net loss of wetland acreage, while seeking a net overall gain in the quality and quantity of wetlands through restoration, development and enhancement.

Fifteen fish and/or wildlife habitats were identified in the SLWRI Project area in the vicinity of Shasta Lake which had potential for impacts from the Project. These are annual grassland, barren, blue oak woodland, blue oak – gray pine, closed-cone pine – cypress, Douglas-fir (formerly classified as Sierran mixed conifer), Klamath mixed conifer, mixed chaparral, montane hardwood - conifer, montane hardwood, montane riparian, ponderosa pine, urban, riverine, and lacustrine. Another 11 fish and/or wildlife habitats were identified along the Sacramento River (and lower reaches of tributaries) from Keswick Dam to the Delta which had potential for impacts from the Project. These are Shaded Riverine Aquatic (SRA) Cover, riverine, oak woodland, blackberry scrub, Great Valley willow scrub, Great Valley cottonwood riparian forest, Great Valley mixed riparian forest, Great Valley valley oak riparian forest, freshwater seep, seasonal wetland, and estuarine. The resource categories, evaluation species, and acres for the cover-types impacts by the SLWRI are summarized below for habitats in the vicinity of Shasta Lake (Table 24), for relocation areas (Table 25), and along the Sacramento River from Keswick Dam to the Sacramento – San Joaquin Delta (Table 26).

Shasta Lake Vicinity

Annual Grassland

The evaluation species selected for the annual grassland cover-type that would be impacted in the vicinity of Shasta Lake are golden eagle and greater western-mastiff bat. The golden eagle was selected because of the Service's responsibility for their protection and management under the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act and the species' status as a State Fully Protected species. The greater western-mastiff bat was selected because of its association with annual grassland habitat and its status as a CALFED MSCS species. Several bat roosting caves would be inundated by the SLWRI. Annual grassland areas potentially impacted by the SLWRI vary in their relative values to the evaluation species, depending on the degree of human disturbances, plant species composition, and the juxtaposition to other foraging and nesting areas. Therefore, the Service designates the annual grassland cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Barren

The evaluation species selected for the barren habitat-type that would be impacted in the vicinity of Shasta Lake are killdeer and pallid bat. The killdeer was selected to represent birds that nest on open, barren habitat, typically covered in small rocks and pebbles. The pallid bat was selected because the species is known to use rock outcroppings and fissures in cliff faces to roost. For both species barren cover-type is an important part of their life history. The killdeer was selected because of the Service's responsibility for their protection and management under the Migratory Bird Treaty Act, and the pallid bat because of its Species of Concern status. Therefore, the Service designates the barren cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Blue Oak Woodland and Blue Oak – Gray Pine

The evaluation species selected for the blue oak woodland and the blue oak – gray pine cover-types that would be impacted in the vicinity of Shasta Lake are acorn woodpecker and western gray squirrel. Acorn woodpeckers utilize oak woodlands for nearly all their life requisites; 50-60 percent of the acorn woodpecker's annual diet consists of acorns. Acorn woodpeckers can also represent impacts to other canopy-dwelling species. The western gray squirrel was selected because of its important role in promoting the generation of blue oaks by burying acorns. Because blue oak is a slow growing, long lived species and is not regenerating in many parts of its range (Schoenherr 1992), and acorns are an important food for many wildlife species, the Service has designated these habitats as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Closed-Cone Pine - Cypress

The evaluation species selected for the closed-cone pine - cypress cover-type that would be impacted in the vicinity of Shasta Lake are great horned owl and band-tailed pigeon. The great horned owl was selected to represent raptors that nest in this cover-type. The band-tailed pigeon was selected because of its status as a Game Bird Below Desired Condition; the species is known to forage in this cover-type and utilize it for cover. These species were selected because of the Service's responsibility for their protection and management under the Migratory Bird Treaty Act. Therefore, the Service designates the closed-cone pine - cypress cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Douglas-Fir

The evaluation species selected for the Douglas-fir cover-type that would be impacted in the vicinity of Shasta Lake are Shasta salamander, flammulated owl, and Pacific fisher. Shasta salamander was selected because the species is endemic to the vicinity of Shasta Lake. Flammulated owl was selected because of its association with Douglas-fir habitat and its identification by CalPIF as a focal bird species for conservation (CalPIF 2002b). The flammulated owl's preference for ponderosa pine and/or Douglas-fir has been linked to prey availability as there are four times as many lepidopteran (moth and butterfly) species associated with Douglas-fir and ponderosa pine than other common western conifers (McCallum 1994, CalPIF 2002b). Pacific fisher was selected because of its association with Douglas-fir habitat and its status as a Federal candidate species. Therefore, the Service designates the Douglas-fir cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Klamath Mixed Conifer

The evaluation species Klamath mixed conifer cover-type are the same as Douglas-fir cover-type, they include the Shasta salamander, flammulated owl, and Pacific fisher. This habitat type was added to the EIS in June 2014. Because of the similarity of Klamath mixed conifer habitat to Douglas-fir, and that the evaluation species are the same, the Service designates the Klamath mixed conifer cover-type within the project area as Resources Category 3. Our associated mitigation planning goal for this area is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Mixed Chaparral

The evaluation species selected for the mixed chaparral cover-type that would be impacted in the vicinity of Shasta Lake are wrentit, Shasta chaparral snail, and ringtail. The wrentit was selected because it is strongly associated with shrubland habitats including mixed chaparral and because it is on the United States Watch List of Birds of Conservation Concern (Yellow List: declining or rare species; American Bird Conservancy and Audubon 2007). The species has also been identified by

Table 24. Resource Categories, Evaluation Species, and Acres of Impacts by Action Alternatives in the Vicinity of Shasta Lake Affected by the SLWRI Project.

COVER-TYPE	EVALUATION SPECIES	RESOURCE CATEGORY	CP1 (acres)	CP2 (acres)	CP3, CP4, CP4A, CP5 (acres)
Annual grassland	Golden eagle Greater western-mastiff bat	3	1.40	2.42	4.61
Barren	Killdeer Pallid bat	3	7.55	11.40	17.81
Blue oak woodland	Acorn woodpecker Western gray squirrel	2	1.32	1.65	4.18
Blue oak – gray pine	Acorn woodpecker Western gray squirrel	2	10.40	14.78	46.98
Closed-cone pine – cypress	Great horned owl Band-tailed pigeon	3	247.07	343.34	484.72
Douglas-fir[1]	Flammulated owl Pacific fisher Shasta salamander	3	0.01	0.06	0.36
Klamath mixed conifer[2]	Flammulated owl Pacific fisher Shasta salamander	3	-	-	10.96
Mixed chaparral	Wrentit Shasta chaparral snail Ringtail	3	142.15	201.38	242.36
Montane hardwood – conifer	Olive-sided flycatcher Shasta sideband snail Pacific fisher Shasta snow-wreath	3	232.07	329.03	649.76
Montane hardwood	Acorn woodpecker Western gray squirrel Shasta chaparral snail	3	189.29	263.20	451.91
Montane riparian	Shasta hesperian snail Yellow-breasted chat Foothill yellow-legged frog Shasta snow-wreath	2	25.92	34.83	57.94
Ponderosa pine	Shasta salamander Pacific fisher Shasta snow-wreath Flammulated owl	3	345.23	488.00	767.30
Urban	Northern mocking bird Striped skunk	4	17.81	25.94	33.14
Riverine	Hardhead Rough sculpin Northwestern pond turtle	2	7.05	9.79	22.96
Lacustrine	Bald eagle Rainbow trout	2	1,227.27	1,725.82	2,491.99

[1] Was formerly classified as Sierran Mixed Conifer

[2] Habitat type added in June 2014

Table 25. Amount of Habitat Impacted in the Relocation Areas (Acres) (USBR 2014)

CWHR	Maximum	Minimum
Annual grassland	42.07	6.59
Barren	147.86	32.76
Blue oak woodland	4.59	0.0
Blue oak – gray pine	9.16	2.36
Closed-cone pine-cypress	66.15	9.11
Douglas-fir	3.02	0.0
Mixed chaparral	134.11	22.77
Montane hardwood-conifer	502.19	86.66
Montane hardwood	328.17	62.63
Montane riparian	5.02	0.72
Ponderosa pine	891.77	240.74
Urban	250.30	233.76
Lacustrine	0.001	0.001

CalPIF as a focal bird species for the conservation of chaparral habitat (CalPIF 2004). Shasta chaparral snail was selected because it is endemic to shrub and woodland habitats in the vicinity of Shasta Lake and because the species has been petitioned for Federal listing under ESA. Ringtail was selected because of its association with mixed chaparral habitat, its status as a California Fully Protected species, and a CALFED MSCS species. Therefore, the Service designates the mixed chaparral cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Montane Hardwood – Conifer

The evaluation species selected for the montane hardwood - conifer cover-type that would be impacted in the vicinity of Shasta Lake are olive-sided flycatcher, Shasta sideband snail, Pacific fisher, and Shasta snow-wreath. The olive-sided flycatcher was selected to represent Neotropical migratory birds that breed in this cover-type near Shasta Lake. The species was also selected because of its status as a Bird of Conservation Concern and a California Species of Special Concern. Shasta sideband snail was selected because it is endemic to limestone outcrops in the vicinity of Shasta Lake and its status as a USFS Survey and Manage species. Pacific fisher was selected because of its association with montane hardwood – conifer habitat and its status as a Federal candidate species. The Shasta snow-wreath was selected because the species is endemic to montane riparian and forest habitats near Shasta Lake. Therefore, the Service designates the montane hardwood - conifer cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Table 26. Resource Categories, Evaluation Species, and Acres of Impacts by Action Alternatives of the Sacramento River (and Lower Reaches of Tributaries) from Keswick Dam Downstream to the Delta Impacted by the SLWRI Project.

COVER-TYPE	EVALUATION SPECIES	RESOURCE CATEGORY	CP1 (acres)*	CP2 (acres)*	CP3, CP4, CP4A, CP5 (acres)*
Shaded Riverine Aquatic Cover	Fall-run Chinook salmon	1	-	-	-
Riverine	Fall-run Chinook salmon Hardhead Northwestern pond turtle	2	-	-	-
Oak woodland	Yellow warbler Acorn woodpecker	2	-	-	-
Blackberry scrub	Yellow warbler	2	-	-	-
Great Valley willow scrub	Yellow-breasted chat	2	-	-	-
Great Valley cottonwood riparian forest	Yellow-billed cuckoo Black-headed grosbeak	2	-	-	-
Great Valley mixed riparian forest	Yellow-billed cuckoo Black-headed grosbeak	2	-	-	-
Great Valley valley oak riparian forest	Yellow warbler Song sparrow	2	-	-	-
Freshwater seep	Yellow-breasted chat Common yellowthroat	2	-	-	-
Seasonal wetland	Tricolored blackbird Yellow-breasted chat	2	-	-	-
Estuarine	Longfin smelt Sacramento splittail	2	-	-	-

*Currently not available

Montane Hardwood

The evaluation species selected for the montane hardwood cover-type that would be impacted in the vicinity of Shasta Lake are acorn woodpecker, western gray squirrel, and Shasta chaparral snail. Acorn woodpeckers utilize oaks for nearly all their life requisites; 50-60 percent of the acorn woodpecker's annual diet consists of acorns. Acorn woodpeckers can also represent impacts to other canopy-dwelling species. The western gray squirrel was selected because of its important role in promoting the generation of oaks by burying acorns. Shasta chaparral snail was selected because it is endemic to shrub and woodland habitats in the vicinity of Shasta Lake and because the species has been petitioned for Federal listing under the ESA. Therefore, the Service designates the montane hardwood cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Montane Riparian

The evaluation species selected for the montane riparian cover-type that would be impacted in the vicinity of Shasta Lake are Shasta hesperian snail, yellow-breasted chat, foothill yellow-legged frog, and Shasta snow-wreath. The Shasta hesperian snail was selected because its range is highly restricted to riparian habitat in the vicinity of Shasta Lake, its status as a USFS Survey and Manage species, and the species has been petitioned for Federal listing under the ESA. The yellow-breasted chat was selected because it depends on riparian habitat for breeding, is a CalPIF focal species, and the Service is responsible for its protection and management under the Migratory Bird Treaty Act. Foothill yellow-legged frog was selected because of its dependence on riparian habitat. The Shasta snow-wreath was selected because it is endemic to montane riparian and forest habitats near Shasta Lake. Because of the scarcity of this habitat type and its high value to many sensitive wildlife species, the Service designates the montane riparian cover-type within the Project area as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Ponderosa Pine

The evaluation species selected for the ponderosa pine cover-type that would be impacted in the vicinity of Shasta Lake are Shasta salamander, Shasta snow-wreath, Pacific fisher, and flammulated owl. Shasta salamander was selected because the species is endemic to the vicinity of Shasta Lake. The Shasta snow-wreath was selected because it is endemic to forest habitats near Shasta Lake. Pacific fisher was selected because of its association with this forest type near Shasta Lake, and its status as a Federal candidate species. Flammulated owl was selected because of its association with Sierran mixed conifer habitat and its identification by CalPIF as a focal bird species for conservation (CalPIF 2002b). The flammulated owl's preference for ponderosa pine and/or Douglas-fir has been linked to prey availability as there are four times as many lepidopteran (moth and butterfly) species associated with Douglas-fir and ponderosa pine than other common western conifers (McCallum 1994, CalPIF 2002b). Therefore, the Service designates the ponderosa pine cover-type within the Project area as Resource Category 3. Our associated mitigation planning goal for these areas is "no net loss of habitat value while minimizing loss of in-kind habitat value."

Urban

The evaluation species selected for urban cover-type that would be impacted in the vicinity of Shasta Lake are the northern mocking bird and the striped skunk. The northern mocking bird was selected because it is a common year-round resident of urban habitats, and the Service's responsibility for their protection and management under the Migratory Bird Treaty Act. The striped skunk was selected because of its adaptation to urban habitats and in many cases its numbers are higher in urban habitats than in natural habitats. Therefore, the Service designates the urban cover-type within the project area as Resource Category 4. Our associated mitigation planning goal for these areas is "minimize the loss of habitat value."

Riverine

The evaluation species selected for riverine cover-type that would be impacted in the vicinity of Shasta Lake are hardhead, rough sculpin, and northwestern pond turtle. Hardhead was selected because of its reliance on riverine habitat to escape predatory nonnative centrarchids in Shasta Lake. Rough sculpin was selected because the fish species is largely restricted to spring-fed tributaries of the Pit River near the Project area, the potential adverse impacts of the conversion of riverine habitat into lacustrine, and because of its status as a California threatened and Fully Protected species. Northwestern pond turtle was selected due to its dependence on stream and wetland habitat throughout the SLWRI Inundation Zone and vicinity. Because of the high value of this habitat to many sensitive wildlife species, the Service designates the riverine cover-type within the Project area as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Lacustrine

The evaluation species selected for lacustrine cover-type that would be impacted within Shasta Lake are bald eagle and rainbow trout. The bald eagle was selected because Shasta Lake has the highest concentration of breeding bald eagles in California, the Service is responsible for the protection of the bald eagle under the Bald and Golden Eagle Protection Act, and because of its status as California Endangered and a Bird of Conservation Concern. Rainbow trout was selected because it is the principal game species in Shasta Lake and its tributaries. Because of the high value of this habitat to many sensitive wildlife and game species, the Service designates the lacustrine cover-type within the Project area as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Sacramento River and the Sacramento-San Joaquin Delta

Shaded River Aquatic (SRA) Cover

SRA cover is defined as the nearshore aquatic area occurring at the interface between a river (or stream) and adjacent woody riparian habitat. The principal attributes of this valuable cover-type include: (a) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and (b) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents (USFWS 1992). Due to the scarcity and high value of SRA cover to an array of fish and wildlife species, the Service classified all areas of SRA cover existing along the following major riverine channels of the Sacramento River system within the Sacramento Valley, California, as Resource Category 1 (USFWS 1992): (1) the Sacramento River, from Keswick Dam (River Mile 302) downstream to Rio Vista (River Mile 13); (2) the Sacramento River's four primary distributary channels---Steamboat, Miner, Sutter, and Georgiana sloughs---which branch off the main river downstream of the city of Sacramento, roughly between the towns of Clarksburg and Walnut Grove; (3) the Feather River, from Oroville Dam downstream to the confluence with the Sacramento River; (4) the Yuba River, from Engelbright Dam downstream to the confluence with the Feather River; and (5) the American River, from Nimbus Dam downstream to the confluence with the Sacramento River (USFWS 1992).

The evaluation species selected for SRA cover that would be impacted is fall-run Chinook salmon. Overhanging vegetation in SRA cover moderates water temperatures, which is an important factor for all life stages of salmonid fishes. The vegetation provides food and habitat for both terrestrial and aquatic invertebrates, which in turn serve as food for numerous bird species and several fish species including Chinook salmon and steelhead trout (Hydrozoology 1976, Sekulich and Bjornn 1977, Rondorf *et al.* 1990, Sommer *et al.* 2001b, Winemiller and Jepsen 1998, Cannon 2007). Based on the high value, uniqueness, and irreplaceability of SRA cover for the evaluation species, the Service has determined SRA cover which would be affected by the project should be placed in Resource Category 1, with an associated mitigation planning goal of "no loss of existing habitat value."

Riverine

The evaluation species selected for riverine cover-type that would be impacted in the Sacramento River between Keswick Dam and the Delta are fall-run Chinook salmon, hardhead, and northwestern pond turtle. Fall-run Chinook salmon was selected because of its commercial importance, and it is a target species that the SLWRI is expected to benefit by enlarging the cold water pool at Shasta Dam to maintain colder temperatures in the Sacramento River upstream of the RBPP. Hardhead was selected because of its potential for adverse effects of the SLWRI on it and other warmer water native fish species by maintaining colder temperatures in the Sacramento River upstream of the RBPP. Most streams in which hardhead occur have summer temperatures in excess of 20°C (68°F), and optimal temperatures for hardhead appear to be 24-28°C (75.2-82.4°F) (Moyle 2002). Northwestern pond turtle was selected to represent off channel riverine habitat. Because of the high value of this habitat to many sensitive and commercially important aquatic species, the Service designates the riverine cover-type within the Project area from Keswick Dam downstream to the Delta as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Oak Woodland

The evaluation species selected for oak woodland cover-type that would be impacted along the Sacramento River are acorn woodpecker and yellow warbler. Acorn woodpeckers utilize oak woodlands for nearly all their life requisites; 50-60 percent of the acorn woodpecker's annual diet consists of acorns. Acorn woodpeckers can also represent impacts to other canopy-dwelling species. Yellow warbler abundance is positively associated with the abundance of valley oak in the Sacramento Valley (RHJV 2004). Thus, the Service has selected acorn woodpecker and yellow warbler because of their dependence on oak woodland. Because of the valley oak and blue oak component of the oak woodland cover-type and their significance to yellow warbler, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Blackberry Scrub

The evaluation species selected for blackberry scrub cover-type that would be impacted along the Sacramento River is yellow warbler. Yellow warbler abundance is positively associated with the occurrence of blackberry in riparian habitat of the Sacramento Valley (RHJV 2004). Thus, the

Service has selected yellow warbler because of its dependence on blackberry scrub. Because of the importance of blackberry scrub for yellow warbler and other riparian obligate species, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Great Valley Willow Scrub
The evaluation species selected for Great Valley willow scrub cover-type that would be impacted along the Sacramento River is yellow-breasted chat. Yellow-breasted chat abundance is positively associated with sandbar willow, a component species of Great Valley willow scrub (RHJV 2004). Because of the importance of Great Valley willow scrub for yellow-breasted chat and other riparian obligates, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Great Valley Cottonwood Riparian Forest and Great Valley Mixed Riparian Forest
The evaluation species selected for Great Valley cottonwood riparian forest and Great Valley mixed riparian forest cover-types that would be impacted along the Sacramento River are black-headed grosbeak and yellow-billed cuckoo. Black-headed grosbeak was selected because the species' abundance and occurrence is positively associated with Fremont cottonwood presence and tree species richness, respectively, which are important components of Great Valley cottonwood riparian forest and Great Valley mixed riparian forest cover-types (RHJV 2004). Black-headed grosbeak was identified by RHJV as a focal bird species for the conservation of riparian habitat (RHJV 2004). Yellow-billed cuckoo was selected because of its dependence on cottonwood-willow riparian habitat and its status as a California endangered species, a Federal candidate species, and a CALFED MSCS species. In California, there are only about 30 breeding pairs of yellow-billed cuckoo with 23 – 25 pairs occurring in the Sacramento River between Red Bluff and Colusa (Laymon and Halterman 1989, Halterman 1991). Yellow-billed cuckoos require large patches of cottonwood-willow riparian habitat with high canopy cover and foliage volume, and moderately large and tall trees. Additionally, the Service has responsibility for the protection and management of both bird species under the Migratory Bird Treaty Act. Because of the significance of the habitat to yellow-billed cuckoo and other riparian bird species, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Great Valley Valley Oak Riparian Forest
The evaluation species selected for Great Valley valley oak riparian forest cover-type that would be impacted along the Sacramento River are yellow warbler and song sparrow. Yellow warbler and song sparrow abundance are positively associated with the presence of valley oak in the Sacramento Valley (RHJV 2004). Both species are identified by RHJV as focal bird species for the conservation of riparian habitat (RHJV 2004). Additionally, the Service has responsibility for the protection and management of both bird species under the Migratory Bird Treaty Act. Thus, because of the significance of Great Valley valley oak riparian forest to riparian obligate species, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Freshwater Seep
The evaluation species selected for freshwater seep cover-type that would be impacted along the Sacramento River are yellow-breasted chat and common yellowthroat. The presence of sedges has a positive influence on the abundance of both bird species (RHJV 2004). Additionally, the Service has responsibility for the protection and management of both bird species under the Migratory Bird Treaty Act. Thus, because of the scarcity of freshwater seep habitat and its significance to yellow-breasted chat and common yellowthroat, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Seasonal Wetland
The evaluation species selected for seasonal wetland cover-type that would be impacted along the Sacramento River are tricolored blackbird and yellow-breasted chat. Additionally, the Service has responsibility for the protection and management of both bird species under the Migratory Bird Treaty Act. Thus, because of the scarcity of seasonal wetland habitat and its significance to tricolored blackbird and yellow-breasted chat, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

Estuarine
The evaluation species selected for estuarine habitat that would be impacted in the Delta are white sturgeon and Sacramento splittail. Both fish species are highly dependent on the Delta estuarine habitat for their survival. Because of the dependence of white sturgeon, Sacramento splittail, and other estuarine species on the Delta, the Service has designated these areas as Resource Category 2. Our associated mitigation planning goal for these areas is "no net loss of in-kind habitat value."

RESULTS AND DISCUSSION

Preferred Alternative CP4A

On June 23, 2014, the Service and the other Cooperating Agencies for the SLWRI were provided with the administrative draft of the final EIS for the SLWRI. Because of the accelerated schedule and the truncated time allowed for analysis by Reclamation, the Service has not been able to provide the same level of detailed analysis for CP4A that we were able to do for the previous action alternatives. As recently as June 2013, the scenario for CP4A was eliminated by Reclamation as being redundant with CP4 and providing less benefit to anadromous fish (USBR 2013).

Hydrological and Ecological Modeling

The following models were used by Reclamation for analyzing the potential effects of the proposed project:

CALSIM II

On June 30, 2004, Reclamation's Central Valley Operations Office issued the Long-Term CVP and SWP Operations Criteria and Plan (OCAP) BA to update the proposed CVP operation in view of changes in regulations, increases in system demand, and anticipated new programs/projects coming on-line in the future for ESA compliance. The NMFS and the Service issued their corresponding Biological Opinions (BO) in October 2004 and February 2005 (revision), respectively. The 2004 OCAP and OCAP BA were supported by a set of CALSIM II studies that were released by Reclamation on February 2, 2004, with revisions released on June 30, 2004 (USBR 2004c). Reclamation re-initiated ESA Section 7 consultation for OCAP with NMFS and the Service in June and July 2006, respectively. In 2007, the 2005 and 2006 BOs were found to be unlawful and inadequate, and were remanded to the Service and NMFS to be revised (USBR 2014). In December 2008, the Service issued its revised BO, and in 2009 NMFS issued the Final Biological and Conference Opinion on the Long-Term Operations of the CVP and SWP. Reclamation revised their modeling studies using the 2008 OCAP Study 3 and Study 5a as applied as the CALSIM II modeling bases in the SLWRI analysis of the CVP and SWP operating policy and planning standards. The 2008 OCAP Study 3 and Study 5a represent 2005 and 2030 levels of development for CVP/SWP system, respectively. Modifications were made on these two OCAP studies to represent each SLWRI modeling scenario. The SLWRI uses an updated version of CALSIM II that incorporated the requirements in the Service's 2008 U.S. and the 2009 NMFS OCAP biological opinions and other recent changes in CVP and SWP facilities and operations, such as implementation of the San Joaquin River Restoration Program. Two CALSIM II studies have been developed: the first study represents the existing conditions (2005 level of development), and the second study represents the future conditions (2030 level of development).

CALSIM II simulates monthly flows throughout the CVP-SWP system based on climatic conditions during the October 1921– September 2003 simulation period. The main limitation of CALSIM II is the time-step. Mean monthly flows do not define daily variations that could occur in the rivers due to dynamic flow, climatic conditions, or management. Therefore, CALSIM II masks any differences among the SLWRI alternatives that occur on a daily or weekly time scale such as changes in the duration and intensity of flood flows. In CALSIM II hydrological model simulations, CP4 is assumed to be the same as CP1, and CP4A is assumed the same as CP2, except for the higher water levels in CP4 and CP4A (USBR 2014).

Sacramento River Water Quality Model (SRWQM)

The Sacramento River Water Quality Model (SRWQM) utilizes the CALSIM monthly flows disaggregated into daily flows based loosely on historical patterns from 6-hour meteorological inputs developed for water years 1922 - 2002. The SRWQM outputs daily water temperatures. The disaggregation process, however, results in a very crude representation of flow and temperature conditions on a daily time scale (USBR 2003; R. Yaworsky, USBR, pers. comm., 2014). Reservoirs modeled by the SRWQM include Trinity, Lewiston, Whiskeytown, Shasta, and Keswick. River reaches modeled include the Sacramento River from Keswick Dam to Knights Landing and Clear Creek from Whiskeytown Dam to the confluence with the Sacramento River.

SALMOD

SALMOD simulates the effects of flow and temperature on salmon production and mortality for each of the four runs of Chinook salmon in 14 reaches of the Sacramento River between Keswick Dam and RBPP for water years 1922 - 2002. SALMOD utilizes SRWQM daily flow and temperature output aggregated into weekly timesteps for the 81-year simulation period. SALMOD presupposes egg and fish mortality are directly related to spatially and temporally variable microhabitat and macrohabitat limitations, which themselves are related to the timing and volume of streamflow and other meteorological variables. SALMOD is a spatially explicit model in which habitat quality and carrying capacity are characterized by the hydraulic and thermal properties of individual mesohabitats, which serve as spatial computation units in the model. The model tracks a population of spatially distinct cohorts that originate as eggs and grow from one life stage to another as a function of water temperature in a computational unit. Individual cohorts either remain in the computational unit in which they emerged or move, in whole or in part, to nearby units. Model processes include spawning (with redd superimposition), incubation losses (from either redd scouring or dewatering), growth (including egg maturation), mortality due to water temperature and other causes, and movement (habitat- and seasonally induced).

SALMOD differentiates between "base" mortality and "project-related" mortality. "Base", or background, rates of mortality cover all causes of death not otherwise modeled by SALMOD. For example, "normal" or "background level" predation falls into this category, as would mortality due to chronically low dissolved oxygen, egg survival, unscreened diversions, and the like. The fractional rates used came from the calibrated Trinity River model and are identical to those used previously on the Sacramento River (Bartholow 2003). The weekly base mortality rates were eggs, 0.035; fry, 0.025; pre-smolts, 0.025; and immature smolts, 0.025. The adult rate was 0.002 based on judgment. "Project-related" mortality is simulated for each life stage of Chinook salmon in SALMOD based on unsuitable water temperatures (temp mortality), flushing flows or redd dewatering (incubation), superimposition, and forced movement due to flows and/or fish density (habitat mortality). Note that the No Action Alternative can have "project-related" mortality (*i.e.*, temp, incubation, superimposition, and habitat) as defined above. SALMOD also simulates mortality related to entrainment of salmonids in unscreened water diversions (seasonal mortality). The different types of mortality simulated by SALMOD for each life stage are further defined below:

- <u>Pre-spawn base mortality</u>: number of eggs lost due to mortality of adult females before spawning due to factors that would occur regardless of the Project (*e.g.*, predation); pre-spawn base mortality is assigned a weekly mortality rate of 0.002.

- Pre-spawn project mortality: number of eggs lost *in vivo* (while eggs are still inside the female) due to Project-related temperature mortality prior to spawning.
- Incubation mortality: number of eggs lost due to flushing flows or redd dewatering resulting from Project-related actions (*i.e.*, above background levels).
- Superimposition: number of eggs lost due to spawning on top of a currently incubating redds resulting from Project-related activities.
- Eggs-base mortality: number of eggs lost due to factors that would occur regardless of the Project; in SALMOD the weekly eggs-base mortality rate is assigned a value of 0.035.
- Eggs-temp mortality: number of eggs lost due to unsuitable water temperatures in which the exposure kills the egg after spawning.
- Fry-base mortality: number of fry lost due to factors that would occur regardless of the Project (*e.g.*, predation); in SALMOD the weekly fry-base mortality rate is assigned a value of 0.025.
- Fry-temp mortality: number of fry lost due to unsuitable water temperatures.
- Fry-habitat mortality: number of fry lost due to Project-related mortality resulting from forced movement due to habitat constraints; this mortality is triggered by flow and fish density within the habitat.
- Pre-smolt-base mortality: number of pre-smolts lost due to factors that would occur regardless of the Project (*e.g.*, predation); in SALMOD the weekly pre-smolt-base mortality rate is assigned a value of 0.025.
- Pre-smolt-temp mortality: number of pre-smolts lost due to unsuitable water temperatures.
- Pre-smolt-habitat mortality: number of pre-smolts lost due to Project-related mortality resulting from forced movement due to habitat constraints; this mortality is triggered by flow and fish density within the habitat.
- Pre-smolt seasonal mortality: extra outmigration mortality due to factors such as water diversions.
- Immature smolt-base mortality: number of immature smolts lost due to factors that would occur regardless of the Project (*e.g.*, predation); in SALMOD the weekly immature smolt-base mortality rate is assigned a value of 0.025.
- Immature smolt-temp mortality: number of immature smolts lost due to unsuitable water temperatures.
- Immature smolt-habitat mortality: number of immature smolts lost due to Project-related mortality resulting from forced movement due to habitat constraints; this mortality is triggered by flow and fish density within the habitat.
- Immature smolt-seasonal mortality: extra outmigration mortality due to factors such as water diversions.

"Production" is defined by SALMOD as the number of immature smolts that survive to out-migrate past the RBPP. In the case of fall-run Chinook salmon, tributary entrants (the number of young fall-run Chinook salmon entering the Project Reach from the tributaries) are included in the SALMOD simulation and final production values. However, because SALMOD is not able to simulate more than one Chinook salmon run at a time, the simulations of winter-, spring-, and late fall-run Chinook salmon do not include tributary entrants. Therefore, SALMOD is not able to simulate the effects of resource competition and predation among the different size classes of the four runs of Chinook salmon (and the tributary entrants) and steelhead as they simultaneously inhabit the Sacramento River between Keswick Dam and RBPP. Competition and predation among the four runs of Chinook salmon and steelhead are thought to be an important source of mortality for salmonids in the Sacramento River (Koch *in litt.* 2006; B. Oppenheim, NMFS, pers. comm., 2014).

SALMOD assumes a constant number of returning adult spawners; therefore, the cumulative effects of the SLWRI alternatives on the population of the four runs of Chinook salmon cannot be tracked through time. To analyze the effects of the SLWRI alternatives on current low population levels of Chinook salmon, the number of adult spawners returning every year in SALMOD was based on the 1999 – 2006 population averages (CDFG 2007b). To analyze the effects of the SLWRI alternatives on predicted higher Chinook salmon populations in the future (after implementation of restoration plans), the number of adult spawners returning every year in SALMOD was based on the AFRP population goals.

SALMOD simulations of Chinook salmon survival are limited to the reach of the Sacramento River between Keswick Dam and RBPP. Therefore, SALMOD is not able to simulate juvenile mortality in the Sacramento River downstream from RBPP. Snorkeling surveys of juvenile Chinook salmon (Cannon 2007) suggest that the lack of suitable juvenile rearing habitat in the middle Sacramento River (*i.e.*, river miles 180 – 230; a few miles downstream from Ord Ferry up to Elder Creek) is likely the most limiting factor for Chinook salmon survival in the Sacramento River; only 1 percent of this reach of the middle Sacramento River is suitable rearing habitat for juvenile Chinook salmon (Cannon 2007). Thus the benefits of an increase in immature smolt production from an enlarged cold water pool in the SLWRI alternatives as shown in SALMOD may be overshadowed by high mortality of juvenile Chinook salmon downstream from the RBPP. SALMOD is also not able to simulate the effects of cover (*i.e.* SRA cover and large woody debris) on juvenile Chinook salmon survival. Thus, SALMOD is not able to analyze the benefits of riparian habitat restoration along the Sacramento River.

The increased number of juvenile Chinook salmon attributed to each of the alternatives, as generated by SALMOD are not to be interpreted as exact predicted increases or decreases in population, nor even as estimates of survival of successful out-migrants through the Delta or returning adults. Rather, those numbers should be used simply as comparisons between the different alternatives using the constraints of the SALMOD modeling. The actual effects to the juvenile Chinook salmon numbers from the different alternatives will likely vary significantly from the numbers given as the results of the SALMOD modeling (USBR 2013).

SALMOD neglects juvenile rearing in nonnatal tributaries; Maslin *et al.* (1996, 1997, 1998, 1999) found juvenile Chinook salmon rearing in the lower reaches of all 30 of the intermittent nonnatal tributaries of the Sacramento River surveyed. The warmer temperatures and pulses of organic matter in the tributaries resulted in faster growth rates of juvenile Chinook salmon. Juvenile winter-run Chinook salmon in particular were found in disproportionate numbers over 1.85 miles (3 km) upstream in nonnatal tributaries. Faster growing fish smolt earlier, and may enter the Delta earlier in the year, before low water and pumping degrade rearing habitat. Optimal rearing conditions in the tributaries exist from about December through March (Maslin *et al.* 1999).

The primary objectives of the SLWRI are increasing Water Supply Reliability and Anadromous Fish Survival with Ecosystem Restoration as a secondary objective. Six alternatives were developed to address the objectives of the SLWRI by raising Shasta Dam 6.5 feet (CP1), 12.5 feet (CP2), or 18.5 feet (CP3, CP4, CP4A, and CP5) and modifying the TCD to maintain cooler temperatures for anadromous fish spawning and rearing habitat in the Sacramento River between Keswick Dam and the RBPP. CP4 included dedicating 378,000 af of the increased storage for cold water reserves. All six of the SLWRI alternatives provided benefits for increased Water Supply Reliability, but only one alternative (CP4) achieved measurable benefits to Anadromous Fish Survival. However, even in CP4, the benefits of an enlarged cold water pool for Anadromous Fish Survival would be limited to a few dry and critically dry water years representing 5 – 15 percent of the 1922 – 2002 water years simulation period.

For the period of 81 years (1922 -2002) used for Reclamation's modeling (SALMOD), no significant change (a change of greater than 5 percent) in average production for any of the Chinook salmon runs (winter-run, spring-run, fall-run, and late fall-run) resulted from any of the proposed alternatives (CP1, CP2, CP3, CP4, CP4A, and CP5) compared to either the No-Action Alternative (Future Condition 2030) or the Existing Condition (2005) (USBR 2013).

For *Impact Aqua-12: Changes in Flow and Water Temperature in the Upper Sacramento River Resulting from Project Operation – Chinook Salmon* (USBR 2014) the following conclusions are given for each of the Alternatives and for each of the different Chinook salmon runs (percent change in average production in parenthesis):

CP1:

Winter-run Chinook Salmon

Production

CP1 would have a less-than-significant (less than 5 percent) average decrease in winter-run Chinook salmon production relative to the Existing Condition (-0.3) *and the No-Action Alternative* (-0.2). (USBR 2013).

Spring-Run Chinook Salmon

Production

Spring-run Chinook salmon production for the 81-year period does not change significantly between CP1 and the No-Action Alternative (0.7) *and the Existing Condition* (0.6). (USBR 2013).

Fall-Run Chinook Salmon

Production

The overall average fall-run Chinook salmon production for the 81-year period was similar for CP1 relative to the No-Action Alternative (0.3) *and the Existing Condition* (1.1). (USBR 2013).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon production for the 80-year period was similar for CP1 relative to the No-Action Alternative (-0.1).

Overall average late fall-run Chinook salmon production for the 80-year period was similar for CP1 relative to Existing Conditions (0.5). (USBR 2013).

CP2:

Winter-Run Chinook Salmon

Production

The overall average winter-run production for the 81-year period was similar for CP2 relative to the No-Action Alternative (-0.7) *and the Existing Condition* (-0.1). (USBR 2013).

Spring-Run Chinook Salmon

Production

The overall 81-year average production for spring-run Chinook salmon under CP2 is insignificantly higher relative to the No-Action Alternative (0.4) *and insignificantly lower than the Existing Condition* (1.3) (USBR 2013).

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production for the simulation period was slightly higher for CP2 than for either the No-Action Alternative (2.1) *or Existing Condition* (1.2) (USBR 2013).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon production for the 80-year period was similar (less than 5 percent change) for CP2 relative to the No-Action Alternative (0) *and the Existing Condition* (0.8) (USBR 2013).

CP3:

Winter-Run Chinook Salmon

Production

Overall average winter-run production for the 82-year period would be similar (less than 5 percent change) for CP3 relative to the No-Action Alternative (-0.4) *and the Existing Condition* (0.2) (USBR 2013).

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon production for the 81-year period remained relatively similar (less than 5 percent change) to the No-Action Alternative (-0.6) *and Existing Condition* (0.7) (USBR 2013).

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production for the 81-year period was similar between CP3 and the No-Action Alternative (0.7) *and the Existing Condition* (1.6) (USBR 2013).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon production for the 80-year period was similar to CP3 and the No-Action Alternative (0.1) *and the Existing Condition* (0.5) (USBR 2013).

CP4:

Winter-Run Chinook Salmon

Production

Overall average winter-run production for the 81-year period would be greater under CP4 conditions relative to the No-Action Alternative (1.7) *and Existing Condition* (2.3) (USBR 2013).

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon production increased for the 82- year period under CP4 compared to the No-Action Alternative (3.6) *and the Existing Condition* (4.3) (USBR 2013).

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production under CP4 increased for the 81-year period compared with the No-Action Alternative (2.1) *and Existing Condition* (3.0) (USBR 2013).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon production for the 80-year period under CP4 conditions was slightly greater than the No-Action Alternative (1.7) *and the Existing Condition* (2.1) (USBR 2013).

CP4A:

Winter-Run Chinook Salmon

Production

Overall average winter-run production for the 81-year period would be greater relative to the No-Action Alternative (0.7) *and the Existing Condition* (1.5). Winter-run Chinook salmon would have an overall insignificant increase in production, but a significant increase in production during critical water years (USBR 2014).

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon production increased for the 82-year period under CP4A compared to the No-Action Alternative (2.4) *and slightly lower than Existing Condition* (3.4). Spring-run Chinook salmon would have significantly reduced flow- and water temperature-related mortality under CP4A, but an insignificant increase in overall production (USBR 2014).

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon production under CP4A increased for the 81-year period compared with the No-Action Alternative (2.0) *and Existing Condition* (2.2). Fall-run Chinook salmon would have significantly reduced project-related mortality, but an insignificant increase in overall production under CP4A (USBR 2014).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon production for the 80-year period under CP4A conditions was slightly greater than the No-Action Alternative (1.2) *and the Existing Condition* (1.5). Late fall-run Chinook salmon and steelhead (using late fall-run Chinook salmon as a surrogate for steelhead) would have an insignificant change in project-related mortality and production under CP4A (USBR 2014).

CP5:

Winter-Run Chinook Salmon

Production

The overall average winter-run production for the [81]*-year period was similar for CP5 relative to the No-Action Alternative* (-0.9) *and the Existing Condition* (-0.4) (USBR 2013).

Spring-Run Chinook Salmon

Production

Overall average spring-run Chinook salmon simulated production for CP5 is slightly higher relative to the No-Action Alternative (-0.7) *and slightly lower than Existing Condition* (0.4) (USBR 2013).

Fall-Run Chinook Salmon

Production

Overall average fall-run Chinook salmon simulated production for the simulation period was slightly higher for CP5 than for either the No-Action Alternative (1.4) *or Existing Condition* (2.2) (USBR 2013).

Late Fall-Run Chinook Salmon

Production

Overall average late fall-run Chinook salmon simulated production for the 80-year period was similar to CP5 and the No-Action Alternative (0.2) *and the Existing Condition* (0.7) (USBR 2013).

SALMOD modeling of the No Action alternative reveals that thermal mortality to winter-, fall-, and late fall-run Chinook salmon (exceeding a mortality rate of 2 percent) in the Sacramento River between Keswick Dam and the RBPP is limited to a few dry and critically dry water years. Winter-run Chinook currently only exist in the Sacramento River downstream of Keswick Dam and spawn in late spring and summer when ambient air temperatures are at their peak. This means that cold water released from Shasta Dam during the period that winter-run are spawning and their eggs are incubating is critical for their persistence as a population. This is most important during critical water years when the cold water storage is limited and winter-run are most at risk. Conversely, for late fall-run Chinook that spawn from December through March, additional cold water storage would have no effect on survival of eggs since cold water for spawning and egg incubation is not limited at that time of the year. Also, the life-cycle data and the spawning locations for winter-run Chinook salmon used by Reclamation in their SALMOD modeling are not current. Current data (2003 – 2014) shows that winter-run Chinook spawn in greater proportions in Spawning Segments numbers 1 and 2, and less in Segment 3 as Reclamation's modeling used. Also, winter-run Chinook salmon in the mainstem Sacramento River spawn approximately a month later on average than the dates used by Reclamation in their modeling (CDFW 2014). SALMOD modeling also shows that in the vast majority of years, the predominate sources of mortality to anadromous fish in the Sacramento River in No Action are superimposition, habitat constraints, the flushing or dewatering of redds, and entrainment in unscreened water diversions. Initially, the SLWRI alternatives included other measures to address the objectives of Anadromous Fish Survival and Ecosystem Restoration. These measures included riparian and floodplain restoration, increasing minimum flows, screening water diversions, improving fish passage, and removal of invasive species. However, all of these restoration measures were removed from further consideration except for proposed restoration along the upper Sacramento River in CP4, CP4A, and CP5 (CP5 includes restoration around Shasta Lake) (USBR 2006a, 2007, 2011a, b, 2013, 2014). The inclusion of these restoration measures would likely result in a decrease in mortality of anadromous fish in the Sacramento River due to superimposition, habitat constraints, and the flushing or dewatering of redds. This would result in benefits to anadromous fish during all years instead of being limited to a few dry and critically dry water years. The restoration of floodplain and riparian habitat and removal of invasive species would have the added benefit of providing important nesting habitat for raptors and migratory birds including the western yellow-billed cuckoo and, should be included in all the alternatives.

The SALMOD modeling results for the SLWRI show the greatest benefit of the enlarged cold water pool in CP4 (less so for CP4A) is the reduction in thermal mortality of spring-run Chinook salmon eggs. However, the Service believes that the SALMOD modeling likely overestimates the benefits of the enlarged cold water pool to spring-run Chinook salmon. In a February 3, 2006, letter to Reclamation regarding SALMOD, CDFG (CDFW) stated:

> *There is doubt that a distinct spring-run Chinook salmon population still spawns in the main-stem upper Sacramento River, because spawn timing and areas overlap with fall-run Chinook spawning. However, main-stem and tributary rearing habitat for juvenile spring-run Chinook should still be considered for known tributary populations including Clear Creek, Battle Creek, Beegum Creek, Antelope Creek, Mill Creek, Deer Creek and Butte Creek (*Koch *in litt.* 2006*).*

In January 2007, a CDFG (CDFW) fish biologist reiterated that:

> *We* [CDFW] *consider the spring-run in the mainstem to be hybridized with the much more numerous fall-run and the Department* [CDFW] *thinks NO unique spring-run population currently exists in the mainstem. We* [CDFW] *consider there to be no unique population of Sacramento River mainstem spring-run. Rather each year a variable number of straying spring-run find their way to the upper Sacramento River near Redding and spawn with the fall-run* (Killam *in litt.* 2007).

Additionally, the Service has pointed out to Reclamation that SALMOD modeling currently overestimates the number of spring-run spawners returning to the mainstem Sacramento River (M. Brown, Red Bluff FWO, pers. comm., 2014), this is likely a result of the hybridization, overlapping of runs, and the influence of hatchery fish, although the extent to which these factors contribute to the overestimation is currently unquantifiable (J. Smith, Red Bluff FWO, *pers. comm.*, 2015).

The spawning data for winter-run Chinook salmon used by Reclamation in their SALMOD modeling appears to be outdated and not representive of current information (D. Killam,CDFW, *in litt.*, 2015). The spawning temporal distribution for winter-run Chinook salmon displayed in Table 5-8 of the SALMOD section of the EIS (USBR 2014) indicates that the peak of spawning would occur earlier by over one month, and is likely due to not using the most current information. Contemporary data from ongoing winter-run carcass surveys indicate that the peak (50 percent) of spawning occurs about July 1 (D. Killam,CDFW, *in litt.*, 2015) compared to about May 27 as indicated on Table 5-8 of the EIS (USBR 2014).

Additionally, the winter-run spawning spatial distribution used by Reclamation in their SALMOD modeling was developed using data only from the 2001 through 2005 spawning ground surveys (USBR 2014). The most recent data available from 2003 to 2014 indicate there has been a shift towards more spawning in upstream areas, most likely due to improved fish passage at the Anderson-Cottonwood Irrigation District Dam (Jim Smith, Red Bluff FWO, pers. comm. 2015). Current data shows that 87.1 percent of winter-run spawning occurs in Spawning Segments 1 and 2 which extend from Keswick Dam to the Highway 44 Bridge (about 5.6 miles downstream). Reclamation's SALMOD data shows only 62.4 percent of winter-run spawning occurred in those same two Spawning Segments (USBR 2014). It is unclear how the use of the most current data would have changed the results of the modeling done in support of the proposed project without having the modeling rerun with the most current data available.

Another source of error in the SALMOD modeling for the SLWRI is the inability to simulate resource competition among the four runs of Chinook salmon and steelhead in the mainstem Sacramento River and the lower reaches of the tributaries. Bartholow (2003) states about the development of the SALMOD model, ". . . I assumed that the four races do not use, and compete for, the same microhabitat at the same time." CDFW responded in their February 3, 2006, letter to Reclamation regarding the SALMOD modeling:

> *We* [CDFW] *believe this assumption is an over-simplification because it implies that juveniles of each Chinook race sequentially use rearing habitat in the upper river and have no overlap in residence period. Chinook juveniles of all sizes and multiple races rear in the upper river year-round and should be addressed in the model* (Koch *in litt.* 2006).

Bruce Oppenheim, NMFS fish biologist, agreed that resource competition and predation among the four runs of Chinook salmon and steelhead (including resident *O. mykiss*), in particular, was an important source of mortality of Chinook salmon fry and pre-smolts in the Sacramento River (B. Oppenheim, NMFS, pers. comm., 2014). Therefore, the Service believes that the SALMOD modeling in the SLWRI underestimates the mortality of Chinook salmon fry, pre-smolts, and immature smolts (of spring-run and late fall-run especially) due to predation, resource competition, and habitat constraints. SALMOD also likely underestimates mortality of spring-run eggs due to superimposition by the more numerous fall-run.

The conclusions in this report concerning the effects of the SLWRI on Chinook salmon in the upper Sacramento River are heavily contingent on the modeling results provided by Reclamation. Any changes to the assumptions and improvements to the modeling may yield different results and lead to a different conclusion.

Spawning gravel augmentation for only 10 years

Three of the five action alternatives (CP4, CP4A, and CP5) include augmenting spawning gravel as a part of the alternative description. The augmentation would be for a period of 10 years, after which time the program would be re-evaluated and a decision would be made whether or not to continue the augmentation program. The reason for the need for augmented spawning gravel is that Shasta Dam inhibits the natural replenishment of spawning gravel.

Restoration of Abandoned Gravel Mines along the Sacramento River

The restoration of abandoned gravel mines along the Sacramento River would benefit anadromous fish survival by replacing deep water habitat for predatory fish species (*e.g.*, Sacramento pikeminnow) with spawning habitat for salmonids (Grant 1992). The gravel pits are also a net sink for spawning gravels and large woody debris; filling in the gravel pits would improve the recruitment of spawning gravels and large woody debris further downstream.

Increase Minimum Anadromous Fish Flows

The 1993 biological opinion for the operation of the CVP and SWP (NMFS 1993) required minimum flows of 3,250 cfs from October 1 through March 31 to protect rearing juvenile winter-run Chinook salmon (i.e., assist in downstream migration and help prevent stranding). The 2001 AFRP Final Restoration Plan (USFWS 2001) recommends minimum Sacramento River flows at Keswick Dam for October 1 to April 30 based on October 1 carryover storage in Shasta Lake and critically dry runoff conditions (driest decile runoff of 2.5 million af) to produce a target April 30

Shasta Lake storage of 3.0-3.2 million af for temperature control. Therefore, the recommendations in the AFRP Final Restoration Plan (USFWS 2001) are based on maintaining sufficient carryover storage in Shasta Lake for temperature control for winter-run Chinook salmon.

The winter-run Chinook salmon spawning period runs from late April – October with peak spawning in May – June (Table 19; CDFG 1998, Moyle 2002, Vogel and Marine 1991). Therefore, the October 1 to April 30 time period for increasing minimum flows, as discussed above, would not include the winter-run Chinook salmon spawning period. The recommendations and reasonable and prudent measures in the 1993 biological opinion (NMFS 1993) and the AFRP Final Restoration Plan (USFWS 2001) were based on a limited cold water pool available in Shasta Lake. However, with improvements to the TCD and an enlarged cold water pool in Shasta Lake, increases in minimum flows could also be provided in May – September to improve spawning habitat for endangered winter-run Chinook salmon while still maintaining enough cold water storage for temperature control. If increasing minimum flows were combined with higher Shasta Dam raises (e.g., 18 feet), then both flow and temperature requirements could be met for winter-run Chinook salmon.

Staff at the Service's Red Bluff Fish and Wildlife Office (FWO) observed that when flows from Keswick Dam drop below 4,000 cfs side channels upstream of the Clear Creek confluence (*e.g.*, Girvan Road area) begin to dewater as do other areas upstream near Bonnyview Bridge and near Turtle Bay (USFWS 2006; T. Kisanuki, USBR, pers. comm., 2014; M. Gard, Sacramento FWO, pers. comm., 2011). They also observed that a few fall-run Chinook salmon redds were totally dewatered in the Girvan Road area side channels of lower Clear Creek when flows out of Keswick dropped below 4,000 cfs (T. Kisanuki, USBR, pers. comm., 2014).

The Service agrees with Reclamation that increasing seasonal minimum flows to 5,000 cfs instead of 4,200 cfs would provide more optimal spawning conditions. The Service also believes that increasing seasonal minimum flows should be combined with Shasta Dam raises of greater than 6.5 feet to evaluate the capability of providing optimal flows and colder temperatures for spawning in the Sacramento River between Keswick Dam and RBPP.

Construct Instream Fish Habitat Downstream from Keswick Dam

Nearly all of the spawning of the endangered winter-run Chinook salmon occurs in the Sacramento River between Keswick Dam and RBPP. Due to the canyon-like nature and frequency of high flows immediately downstream from Keswick Dam, instream construction of fish habitat further downstream would likely be more successful then such efforts within the reach immediately downstream of Keswick Dam.

Rehabilitate Inactive Instream Gravel Mines along Stillwater and Cottonwood Creeks

Gravel mining on Cottonwood Creek for construction aggregate began in 1901 (CH2M-Hill 2002). Large-scale gravel mining on Cottonwood Creek began in 1960 when Caltrans excavated several hundred thousand cubic yards of gravel for the construction of Interstate 5 (Resource Management International, Inc. 1987). Three active gravel and sand mines continue to operate in Cottonwood Creek (CH2M-Hill 2007).

One of the high priority goals for Cottonwood Creek in the AFRP Final Restoration Plan (USFWS 2001) is to "establish limits on instream gravel mining operations by working with state and local agencies to protect spawning gravel and enhance recruitment of spawning gravel to the Sacramento River in the valley sections of Cottonwood Creek." Gravel mining in Cottonwood Creek and other tributaries significantly reduces the gravel supply to the Sacramento River and contributes to high turbidity and high sediment yields which adversely affect water quality as far away as the Delta (California Department of Water Resources [DWR] 1992). South Fork Cottonwood Creek and Cottonwood Creek are said to be the second and third most turbid streams, respectively, of the 11 westside tributaries north of Thomes Creek (DWR 1992).

Salmonids that emerge as fry in the mainstem Sacramento River utilize the lower reaches of tributaries such as Cottonwood and Stillwater creeks for rearing. Investigations of nonnatal rearing of juvenile Chinook salmon in intermittent tributaries to the Sacramento River found that all tributaries with a near-mouth gradient of less than 1 percent supported non-natal Chinook salmon rearing (Maslin *et al.* 1997). During surveys in February and March, 1997, 291 fall-run, 23 spring-run, and 3 winter-run juvenile Chinook salmon were observed rearing in nonnatal habitat in Stillwater Creek 0.8 km (0.5 mile) upstream of the confluence with the Sacramento River (Maslin *et al.* 1997). Juvenile Chinook salmon were found as far as 11.5 – 22.1 km (7.15 – 13.75 miles) upstream in nonnatal tributaries in Thomes Creek, Rock Creek, Mud Creek, and Pine Creek (Maslin *et al.* 1996). Of the juvenile Chinook salmon runs, winter-run were found the farthest upstream in nonnatal tributaries; over 80 percent of winter-run were over 3 km (1.85 miles) upstream compared to 50 percent of spring-run and 25 percent of fall-run (Maslin *et al.* 1999). The total population of juvenile Chinook salmon rearing in nonnatal tributaries in 1998 was estimated to be between 100,000 and 1,000,000 (Maslin *et al.* 1998); a later study found that the higher end of this range is more likely (Maslin *et al.* 1999).

Juvenile Chinook salmon rearing in the nonnatal tributaries grew faster and were heavier for their length than those rearing in the mainstem (Maslin *et al.* 1996, 1997, 1998, 1999). Faster growing fish smolt earlier, and may enter the Delta earlier in the year, before low water and pumping degrade rearing habitat. Optimal rearing conditions in the tributaries exist from about December through March. Maslin *et al.* (1996) stated that juvenile Chinook salmon entering the tributaries early in the year, such as winter-run and spring-run, probably derive the most benefit from tributary rearing. The authors further stated that "actions may be necessary to protect intermittent stream habitat, and ensure adequate flows and habitat conditions for rearing." Therefore, the restoration of the lower reaches of Cottonwood and Stillwater creeks would improve rearing habitat for salmonids that emerged within the primary Sacramento River study area (Maslin *et al.* 1996, 1997, 1998, and 1999). Maslin *et al.* (1999) stated that significant restoration of juvenile rearing habitat could be achieved with site-specific projects in tributaries to the Sacramento River including Stillwater Creek. The authors stated that Churn Creek has tremendous potential for both spawning and rearing habitat;

the major problem for Churn Creek is dewatering by agricultural extraction (Maslin *et al.* 1997). Thus, the Service disagrees with Reclamation's assumption that the rehabilitation of inactive gravel mines along Stillwater and Cottonwood creeks "would not contribute directly to increasing anadromous fish survival within the primary Sacramento River study area."

Another high priority AFRP goal is the establishment, restoration, and maintenance of riparian habitat on Cottonwood Creek (USFWS 2001). The restoration of tributaries is also important for replenishing the recruitment of spawning gravels and large woody debris in the Sacramento River. The initial construction of Shasta Dam blocked the recruitment of spawning gravel and large woody debris from the upper Sacramento, McCloud, and Pit rivers. Therefore, gravel and large woody debris recruitment in the Sacramento River between Keswick Dam and RBDD comes from the tributaries such as Stillwater and Cottonwood creeks. Restoring native riparian habitat at inactive gravel pits on Stillwater and Cottonwood creeks would help replenish spawning gravels downstream in the primary Sacramento River study area.

Construct Instream Fish Habitat on Tributaries to the Sacramento River

The Service disagrees with the assumption that constructing instream fish habitat on tributaries to the Sacramento River "would not contribute directly to increasing anadromous fish survival within the primary Sacramento River study area." The lower reaches of the tributaries to the Sacramento River provide important nonnatal rearing habitat for juvenile anadromous fish that emerge as fry within the primary Sacramento River study area (Maslin *et al.* 1996, 1997, 1998, 1999). As stated above, the juvenile salmon rearing in nonnatal tributary streams grew faster and were heavier for their length than those rearing in the mainstem, and enter the Delta earlier. Therefore, the construction of instream fish habitat on tributaries to the Sacramento River would likely increase the survival rate of juveniles entering the Delta, and thus would increase the number and physical condition of salmon migrating to the ocean in every water year type.

Modify Storage and Release Operations at Shasta Dam

The modification of water storage specifically for increased anadromous fish survival, and the concept of adaptive release operations at Shasta Dam for improved water flows only appears in one of the SLWRI alternatives (CP4) as currently defined in the DEIS (USBR 2013). The Service agrees with Reclamation that permitting "pulse flows" during the flood season would improve aquatic habitat conditions. Allowing flood flows during the spring seed dispersal period would also aid in the regeneration of cottonwoods and willows. Cottonwoods and willows provide important SRA cover for salmonids as well as nesting habitat for many migratory birds.

Transfer Existing Shasta Lake Storage from Water Supply to Cold Water Releases

Reclamation should evaluate among the SLWRI alternatives the capability of improving flow and temperature conditions for anadromous fish in the Sacramento River between Keswick Dam and RBPP and water supply reliability without raising Shasta Dam. This potentially could be accomplished through water conservation and operational changes at Shasta Dam combined with the modifications to the TCD and conjunctive use of other existing and planned water storage facilities in the Central Valley.

Screen Diversions on Old Cow and Cow Creeks

The Service disagrees with the statement that screening diversions on Old Cow and Cow creeks would not contribute directly to increasing anadromous fish survival within the primary Sacramento River study area. The lower reaches of nonnatal tributaries, such as Cow and Old Cow creeks, are important rearing habitat for juvenile salmonids that emerge as fry in the primary Sacramento River study area (Maslin *et al.* 1996, 1997, 1998, 1999). Screening diversions on the lower reaches of nonnatal tributaries would increase the survival rate of juvenile salmonids in all types of water years.

Remove or Screen Diversions on Battle Creek

The Service also believes that removing or screening diversions on Battle Creek would contribute directly to increasing anadromous fish survival within the primary Sacramento River study area. The lower reaches of nonnatal tributaries, such as Battle Creek, are important rearing habitat for juvenile salmonids that emerged as fry in the primary Sacramento River study area. Removing or screening diversions on the lower reaches of nonnatal tributaries would increase the survival rate of juvenile salmonids and the potential number of adults returning to spawn during all types of water years in the Sacramento River primary study area.

Reduce Acid Mine Drainage Entering Shasta Lake

A U.S. Geological Survey study of metal transport in the Sacramento River (Alpers *et al.* 2000) revealed that acid mine drainage entering Shasta Lake and Keswick Reservoir resulted in elevated concentrations of cadmium, copper, and zinc concentrations in caddis fly larvae at several sites downstream of Keswick Dam. Cadmium showed the highest level of bioaccumulation in whole-body and cytosol analyses with concentrations 5 to 36 times higher than reference caddis fly samples from Cottonwood Creek. In fact, cadmium bioaccumulation persisted in caddis fly larvae samples collected as far as 73 miles (118 kilometers) downstream from Keswick Dam (Alpers *et al.* 2000). Copper and zinc concentrations in caddis flies at Sacramento River sites were 1.4 to 3.0 times greater than concentrations of those at Cottonwood Creek sites. Caddis flies are the preferred diet of juvenile salmonids (Sommer *et al.* 2001b); thus juvenile salmonids in the Sacramento River are particularly at risk of bioaccumulation of toxic levels of cadmium and other trace metals from acid mine drainage entering Shasta Lake and Keswick Reservoir.

State records document more than 20 fish-kill events in the Sacramento River since 1963 related to the uncontrolled discharge of acid mine drainage downstream from Iron Mountain Mine (USEPA 2006). Acid mine drainage from Iron Mountain Mine killed 100,000 or more fish on separate occasions in 1955, 1963, and 1964 (Nordstrom 1977, CH2M-Hill 1992, USEPA 2006). Remediation and pollution control activities at the Iron Mountain Mine Superfund site now neutralize almost all the acid mine drainage and control 95 percent of the copper, cadmium, and zinc that used to flow into nearby streams and then into the Sacramento River (USEPA 2013).

Another toxicity issue associated with mining in the Shasta Lake area is mercury (Nordstrom *et al.* 1977). Mercury (quicksilver) was used extensively in the gold mining and recovery operations, especially at hydraulic placer mines in the Klamath Mountains but also at mills associated with hardrock mines in both of these areas (Bradley 1918, Alpers *et al.* 2000). Mercury concentrations in water and biota, particularly fish, are major environmental and health concerns in the lower reaches of the Sacramento River and in the Bay-Delta; however, the sources and chemical forms of mercury transported in the Sacramento River remain largely undetermined (Alpers *et al.* 2000).

During a site visit at Shasta Lake, acid mine drainage with a pH of 2 was observed near the Bully Hill Mine within the Inundation Zone of the SLWRI (P. Uncapher, NSR, pers. comm. 2014). The raising of Shasta Dam could further exacerbate loading of metals into Shasta Lake by inundating or elevating the water table near other abandoned mines and mine tailings. The inundation could increase the rate of loading of copper, cadmium, zinc, and mercury into the water column and aquatic organisms. These toxic elements could then bioaccumulate within sensitive raptor species such as the bald eagle and osprey that prey on fish in Shasta Lake. Shasta Lake has the highest concentration of breeding bald eagles in California and should be protected from the adverse effects of acid mine drainage.

It is very important that changes in operation of Shasta and Keswick Reservoirs and the Spring Creek Debris Dam associated with the SLWRI alternatives are coordinated with the U.S. EPA to ensure consistency with the Iron Mountain Mine remedy and institutional controls involving reservoir operations. Without such coordination cadmium, copper, and zinc could be mobilized and transported downstream through Keswick Dam and into the only known spawning habitat for the endangered winter-run Chinook salmon (Moyle 2002).

Restore Riparian and Floodplain Habitat along the Sacramento River

The Service agrees with Reclamation that the restoration of riparian and floodplain habitat along the Sacramento River would have a high likelihood of success in achieving the secondary objective of Ecosystem Restoration as well as the primary objective of Anadromous Fish Survival. In fact, snorkeling surveys of juvenile Chinook salmon in the middle Sacramento River (RM 180 – 230 [a few miles downstream from Ord Ferry upstream to Elder Creek]) suggest that the lack of suitable juvenile rearing habitat may be the most limiting factor for anadromous fish survival; less than 1 percent of the middle Sacramento River is suitable rearing habitat for juvenile Chinook salmon (Cannon 2007).

Riparian vegetation is an important allocthonous (organic matter which enters a lake or river from the atmosphere or drainage basin) source of nutrients and large woody debris into the aquatic ecosystems (Winemiller and Jepsen 1998). Large woody debris increases the production of caddis flies and other invertebrates (Sedell *et al.* 1988, Gurnell *et al.* 1995, Junk *et al.* 1989) which are an important part of the diet of juvenile Chinook salmon (Rondorf *et al.* 1990, Sommer *et al.* 2001b). In fact, accelerated growth rates of juvenile Chinook salmon that reared in the Yolo Bypass floodplain compared to the Sacramento River were attributed to the greater densities of invertebrate prey associated with woody debris (Sommer *et al.* 2001b). Therefore, the dominance of zooplankton in the diets of Sacramento River salmon likely reflects a relatively low availability of other more energetically valuable prey items such as invertebrates associated with woody debris (Sommer *et al.* 2001b). Restoration of riparian and floodplain habitat should be combined with efforts to eradicate invasive species such as giant reed (*Arundo donax*).

The SLWRI EIS (USBR 2014) includes in CP4, CP4A, and CP5 potential riparian, floodplain, and side channel restoration along the Sacramento River between Keswick Dam and RBPP. However, riparian and floodplain restoration along the Sacramento River is already included as a mitigation measure in all of the SLWRI alternatives (Mitigation Measure Bot-7 Develop and Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities; USBR 2013). Reclamation should clarify what riparian, floodplain, and side channel restoration measures are being considered as mitigation in all of the SLWRI alternatives and what is separately being considered as an environmental enhancement measure in CP4, CP4A, and CP5.

Under CP4, CP4A, and CP5 restoration of riparian, floodplain and/or side channel habitat is proposed and included in the alternative description to a limited extent. In addition, all of the sites included and described are already included in the Upper Sacramento River Anadromous Fish Habitat Restoration Program (USBR 2015) as restoration sites and projects under the CVPIA. Currently, no final location or plans have been provided, only preliminary sites have been suggested, and there is insufficient information provided for any of these proposed restoration sites for the Service to analyze the effects of these potential projects.

Promote Great Valley Cottonwood Regeneration on the Sacramento River

The Service disagrees with Reclamation's statement that "there would be major complexities associated with continuing Federal participation in an ongoing broad-scope program in the Sacramento Valley." The promotion of Great Valley cottonwood regeneration on the Sacramento River is a primary restoration goal of SRCAF and AFRP and is currently being considered under Reclamation's North-of-the-Delta Offstream Storage Investigation (NODOS). "Ongoing broad-scope" programs are an important part of the monitoring and adaptive management strategy currently used by the Service and Federal partners in ecosystem restoration.

The Service also disagrees with Reclamation's statement that the promotion of Great Valley cottonwood regeneration on the Sacramento River "would not directly contribute to accomplishing the primary or other secondary planning objectives." As stated above, the lack of suitable juvenile rearing habitat in the middle Sacramento River may be the most limiting factor to anadromous fish survival. Promoting cottonwood regeneration and reconnecting the floodplain would increase SRA cover and backwater habitat for juvenile salmonid rearing. Also, promoting cottonwood regeneration would provide a source of recruitment for large woody debris in the Sacramento River that provides important rearing habitat for juvenile salmonids. The recruitment of large woody debris into the Sacramento River from the upper Sacramento, McCloud, and Pit rivers was cutoff with the initial construction of Shasta Dam. As stated previously, woody debris from riparian vegetation also increases the abundance of caddis flies and other invertebrates that are a significant part of the diet of juvenile Chinook salmon (Rondorf *et al.* 1990, Sommer *et al.* 2001b). Riparian vegetation is also an important allocthonous source of nutrients into the aquatic ecosystem (Winemiller and Jepsen 1998).

Additionally, promoting cottonwood regeneration would also contribute to achieving the secondary planning objective of Ecosystem Restoration as well as restoring breeding habitat for sensitive migratory birds such as black-headed grosbeak, blue grosbeak, Swainson's hawk, yellow-breasted chat, and yellow-billed cuckoo.

Promoting cottonwood regeneration does not necessarily require active restoration and engineering techniques. Cottonwood regeneration may be accomplished through "natural" rather than "active" restoration by allowing spring flood flows followed by a slow reduction in river stage (SRCAF 2003). Cottonwood regeneration would respond to pulse flows in April and May if they are followed by a slow reduction in river stage in early summer that allows seedlings to tap into the water table (Roberts *et al.* 2002, Roberts 2003); this could be accomplished during wet years when water supply is not limiting.

Reclamation has an obligation under CVPIA Section 3406 (b)(1)A to maintain and restore riparian habitat along the Sacramento River. The regeneration of Great Valley cottonwoods was initially inhibited when the construction of Shasta Dam changed the hydrology of the Sacramento River and reduced spring flood flows important in seed dispersal. The enlarging of Shasta Dam would likely further exacerbate cottonwood regeneration by further reducing spring flood flows.

Preserve Riparian Corridor along Cow Creek

The Service also believes that preserving the riparian corridor along Cow Creek would directly contribute to accomplishing the primary and secondary planning objectives. One of the high priority goals for Cow Creek identified in the Final AFRP Restoration Plan (USFWS 2001) is the fencing of select riparian corridors within the watershed to exclude livestock. As stated above, the lower reaches of nonnatal tributaries, such as Cow Creek, are important rearing habitat for juvenile salmonids that emerged as fry in the primary Sacramento River study area. Preserving the riparian corridor along the lower reaches of Cow Creek would increase SRA cover for juvenile salmonids; this would increase the physical condition and survival rate of juvenile salmonids and thus the number of adults returning to the Sacramento River primary study area to spawn in all types of water years. Preserving the riparian corridor on the lower reaches of Cow Creek would also directly contribute to the secondary planning objective of Ecosystem Restoration by preserving the riparian corridor along the Sacramento River and its confluence with Cow Creek. Preserving the riparian corridor along the lower reach of Cow Creek would provide a seed bank for the regeneration of riparian vegetation at the confluence with the Sacramento River and further downstream. The initial construction of Shasta Dam reduced the spring flood flows important in the regeneration of cottonwoods and willows along the Sacramento River. An enlarged Shasta Dam would likely further reduce spring flood flows and the ability of cottonwoods and willows to regenerate along the Sacramento River.

A riparian corridor along Cow Creek would also provide a source of recruitment of large woody debris into the Sacramento River. Large woody debris provides important rearing habitat for juvenile salmonids. The recruitment of large woody debris from the upper Sacramento, McCloud, and Pit rivers was cut off by the initial construction of Shasta Dam. As stated previously, riparian vegetation is an important source of large woody debris which provides, cover, nutrients, and invertebrate prey for juvenile Chinook salmon (Winemiller and Jepsen 1998, Sedell *et al.* 1988, Gurnell *et al.* 1995, Junk *et al.* 1989, Rondorf *et al.* 1990, Sommer *et al.* 2001b).

The primary objective of Anadromous Fish Survival in the SLWRI would be addressed by restoring the riparian corridor along the lower reaches of larger tributaries and smaller intermittent tributaries to the Sacramento River which provide important rearing habitat for juvenile salmonids. Larger tributaries such as Battle Creek that are fed by cold water springs and/or drain snow melt from higher elevations provide constant colder temperature refugia for rearing of juvenile winter-run Chinook salmon that emerged as fry in the primary Sacramento River study area (M. Brown, Red Bluff FWO, pers. comm., 2007). Smaller intermittent tributaries also provide important rearing habitat, especially for juvenile winter- and spring-run Chinook salmon; the warmer temperatures and pulses of organic matter inputs result in higher growth rates of juvenile Chinook salmon that rear in intermittent tributaries compared to the mainstem Sacramento River (Maslin *et al.* 1996, 1997, 1998, 1999). Therefore, preserving the riparian corridor along larger tributaries and smaller intermittent tributaries of the Sacramento River would achieve the primary objective of increasing Anadromous Fish Survival by improving rearing habitat for juvenile Chinook salmon (and steelhead) that emerged as fry in the primary Sacramento River area.

Remove and Control Non-native Vegetation in Cow Creek and Cottonwood Creek

The Service believes that the removal and control of non-native vegetation in Cow Creek and Cottonwood Creek would directly contribute to accomplishing the primary and secondary planning objectives. Non-native vegetation disperses downstream from Cow and Cottonwood creeks into the primary Sacramento River study area. Therefore, any efforts to control invasive species within the primary Sacramento River study area must also control invasive species upstream and in the lower reaches of the tributaries to the primary study area. The removal of invasive species along the lower reaches of tributaries to the Sacramento River is necessary for achieving the secondary objective of Ecosystem Restoration within the primary Sacramento River study area.

Recently, a $42,000 grant from the California Department of Food and Agriculture funded the eradication of invasive *Arundo* along a 16-mile stretch of Stillwater Creek (Darling 2007). *Arundo* is a noxious weed that dramatically alters the ecological and successional processes in riparian systems and ultimately moves most riparian habitats towards pure stands of this alien grass (Bell 1997). *Arundo* displaces native vegetation until the riparian area can no longer support a diverse population of native wildlife species. *Arundo*'s destruction of overhanging canopy vegetation allows for greater solar exposure of surface water, resulting in increased water temperatures which may increase to a point where they become lethal for steelhead and salmon. Avian and terrestrial species also lose nesting and foraging habitat. *Arundo* also alters stream flow and geomorphology. It grows readily on gravel bars and in the streambed, changing flow regimes and directing erosive flows to opposite banks. The flows undercut and destabilize stream banks, causing tree loss, property damage, and siltation. The silt impairs fish spawning grounds, leading to further stress on threatened aquatic species (Bell 1997, Dale *et al.* 2002, Iverson 1993, Leidy 1998). Therefore, the Service believes that the removal and control of noxious weeds such as *Arundo* on the mainstem Sacramento River and in the tributaries addresses the primary and secondary goals of Anadromous Fish Survival and Ecosystem Restoration, and thus should be a priority in the SLWRI.

Roadway relocation

As a result of implementation of the SLWRI and the enlargement of Shasta Lake, a number of roadways would be inundated and subsequently need to be relocated. Some estimates and preliminary descriptions of possible relocations have been described, but nothing in detail. The Service is unable to analyze the effects of the relocations for the action described above because the habitat type and amount of impacts for the exact locations where the roadways would be relocated to have not been provided.

Recreation Facilities

As a result of implementation of the SLWRI and the enlargement of Shasta Lake, a number of recreational facilities would be inundated and subsequently need to be relocated. Some estimates and preliminary descriptions of possible relocations have been described, but nothing in detail. The Service is unable to analyze the effects of the relocations for the action described above because the habitat type and amount of impacts for the exact locations where the facilities would be relocated to have not been provided.

Non-recreational structures

As a result of implementation of the SLWRI and the enlargement of Shasta Lake, a number of non-recreational facilities would be inundated and subsequently need to be relocated. Some estimates and preliminary descriptions of possible relocations have been described, but nothing in detail. The Service is unable to analyze the effects of the relocations for the action described above because the habitat type and amount of impacts for the exact locations where the facilities would be relocated to have not been provided.

Utilities minor infrastructure

As a result of implementation of the SLWRI and the enlargement of Shasta Lake, a number of utility facilities and infrastructures would be inundated and subsequently need to be relocated. Some estimates and preliminary descriptions of possible relocations have been described, but nothing in detail. The Service is unable to analyze the effects of the relocations for the action described above because the habitat type and amount of impacts for the exact locations where the facilities would be relocated to have not been provided.

Rare Species in the Vicinity of Shasta Lake

The Service believes that the SLWRI would result in adverse effects to rare and special-status species within the vicinity of Shasta Lake. The raising of Shasta Lake would inundate portions of the limited habitats of the following seven rare, but not federally-listed, species each of which is endemic to the vicinity of Shasta Lake: Shasta snow-wreath, Shasta salamander, Shasta sideband snail, Wintu sideband snail, Shasta chaparral snail, Shasta hesperian snail, and an undescribed variety of red huckleberry unofficially known as "Shasta huckleberry" (Lindstrand and Nelson 2005a,b; NSR 2004; Lindstrand 2007; DeWoody and Hipkins 2007; J. Nelson, Shasta-Trinity National Forest, pers. comm., 2014; USBR 2014). Additional habitat would be disturbed by construction-related activities and the relocation of campgrounds, roads, bridges, and other facilities above the Inundation Zone. The raising of Shasta Dam and implementation of the SLWRI would result in the loss, degradation, and fragmentation of habitat and as a result, may require further evaluation by the Service of the factors threatening these seven species pursuant to section 4 of the ESA.

The rare terrestrial mollusks Shasta sideband and Wintu sideband are restricted to limited limestone outcrops in the vicinity of Shasta Lake (Lindstrand 2007); therefore, a significant portion of their habitat would be lost due to inundation or disturbance by the SLWRI. The ranges of the Shasta sideband (29 locations) and Wintu sideband (2 locations) are restricted to limestone outcrops along the McCloud and Pit River arms, respectively, in the vicinity of Shasta Lake (Lindstrand 2007; USBR 2013).

Shasta snow-wreath would especially be threatened by the raising of Shasta Dam—10 (6.5 foot raise) to 11 (18.5 foot raise) of 24 known sites of the plant species (42 to 46 percent) would be partly or completely lost within the Inundation Zone with one more impacted by relocation actions (Lindstrand and Nelson 2005a,b; NSR 2004; Lindstrand 2007; USBR 2014 *in litt.*). Another 11 occurrences of Shasta snow-wreath (46 percent) are threatened by non-project related activities due to their locations near roads, trails, and logging areas (Lindstrand 2007). Thus, only one occurrence of the Shasta snow-wreath (4 percent) is not currently threatened by the SLWRI or non-project related activities (Lindstrand 2007; USBR *in litt.* 2014).

A genetic study of the Shasta snow-wreath was conducted in 2009 and 2010. The genetic study was to (1) determine whether all Shasta snow-wreath populations are genetically identical, (2) determine whether there are several homogeneous population clusters, or (3) whether some other pattern is present. Twenty-one of 23 known Shasta snow-wreath sites were included in the study (since initiation of the study an additional Shasta snow-wreath site has been found, bringing the total to 24). The genetic study determined that the species is characterized by low genetic diversity and high levels of genetic differentiation (National Forest Genetics Laboratory 2010, DeWoody et al. 2012). No strong patterns were found between the Shasta snow-wreath populations. Although high levels of genetic differentiation and no strong population patterns are present, the genetic study found three general population clusters (USBR 2013). It is likely that the current distribution of genetic populations is an artifact of the original inundation of Shasta Lake.

The CALFED Programmatic EIS/EIR includes Shasta snow-wreath among a list of "evaluated species for which direct mortality as a result of implementing CALFED actions is prohibited as a condition of the Multi-Species Conservation Strategy" (Table 4-5 in MSCS section of CALFED 2000b).

Shasta salamander, Shasta chaparral snail, and Shasta hesperian snail are also endemic to the vicinity of Shasta Lake and would thus lose a significant portion of their habitat within the Inundation Zone. Additional habitat would be permanently or temporarily lost due to the relocation of campgrounds, marinas, roads, bridges, and other facilities to areas beyond the Inundation Zone.

Shasta huckleberry is currently known from 21 general locations in the upper Spring Creek, Dry Fork, (little) Squaw Creek, Shoemaker Gulch, and Little Backbone Creek drainages. Other general locations include South Fork Mountain, Bohemotash Mountain, and the vicinity of Bully Hill. The plant appears to have adapted to the low pH soils with unique mineral compositions often associated with abandoned mine sites in the Western Shasta Mining District (J. Nelson, Shasta-Trinity National Forest, pers. comm. 2014). All locations occur in an area historically known as the Copper Belt of Shasta County and many in the immediate vicinity of historic copper mining activities. Shasta huckleberry occurs at four locations in the SLWRI project area: (little) Squaw Creek, Shoemaker Gulch, Little Backbone Creek, and Horse Creek near Bully Hill. Nine Shasta huckleberry shrubs would be lost within the Inundation Zone in the lower Little Backbone Creek drainage (DeWoody and Hipkins 2007;; USFS 2010b, *in litt.*). Another population of Shasta huckleberry is currently threatened by non-project related ground disturbing activities associated with soil remediation on private land near the Bully Hill abandoned mine site (L. Lindstrand, NSR, pers. comm., 2014).

A genetic study was conducted in 2009 and 2010 to describe the genetics of Shasta huckleberry. The goal of the study was to determine if the Shasta huckleberry was different genetically from coastal and Sierra Nevada *Vaccinium* populations and, if so, to determine if it warrants recognition as a new taxon. The genetic study determined that the species is genetically distinct from the other *Vaccinium* populations (National Forest Genetics Laboratory 2010, DeWoody et al. 2012). Based on the results of the genetic study combined with distinct morphologic and ecologic characteristics, the Shasta huckleberry appears to be an uncommon and geographically restricted species and warrants recognition as a new taxon. It is not known at this time what percent of the total number of Shasta huckleberry plants would be lost due to the SLWRI and non-project related activities.

The western purple martin, although not confined to Shasta County, would lose essential nesting habitat along the Pit River arm. Although new snags would be created by the inundation of trees within the Inundation Zone, there would likely be a time lag of a number of years before the newly inundated snags would provide suitable nesting habitat for the western purple martin (Len Lindstrand, NSR, pers. comm. 2014). This would result in the loss of essential nesting habitat along the Pit River arm and, potentially the extirpation of this population of western purple martin (Len Lindstrand, NSR, pers. comm. 2014). In 2007 there were 18 known nesting pairs of western purple martin in the Pit River arm that may be affected by the SLWRI (Lindstrand 2007). Between the years of 2007 and 2012 the population has ranged from a low of 18 to a high of 42 nesting pairs (survey year 2011), the survey results were for 2012 with a population of 27 nesting pair (USBR 2013), in 2013 there were 17 nesting pair and in 2014 at least 25 pair (Len Lindstrand, NSR, pers. comm. 2014). Shasta Lake represents 14 – 51 percent of the total interior northern California population of western purple martins (Williams 1998).

The Service believes that the implementation of the SLWRI and the enlargement of Shasta Lake would likely result in the loss of habitat for special-status bat species. Habitats such as limestone outcroppings, abandoned mines, mixed conifer, and conifer/woodlands would be inundated surrounding Shasta Lake, many of these habitats are important to bat species.

Other special-status species that would be affected by habitat loss within the Inundation Zone include Cantelow's Lewisia, bald eagle, northern spotted owl, and the Pacific fisher.

Sacramento River and the Delta

The raising of Shasta Dam in the SLWRI would likely affect riparian and aquatic habitat along the Sacramento River from Keswick Dam all the way to the Delta. The CALSIM modeling which is based on monthly timesteps likely underestimates the effects of the SLWRI alternatives on flooding events which operate on daily and weekly timesteps. Changes in the timing, intensity, and frequency of flood flows in the Sacramento River would inhibit the fluvial processes essential for sediment transport and the establishment and maintenance of a diverse mixed-aged riparian habitat. Flooding is essential for the establishment of mixed-age riparian habitat that is important to special-status migratory birds along the Sacramento River including the rare yellow-billed cuckoo. A decrease in spring flood flows would decrease the establishment of native riparian vegetation while increasing the establishment of exotic species (Little 2007).

Native riparian vegetation is also important for providing SRA cover and the recruitment of large woody debris essential for juvenile salmonid rearing habitat in the Sacramento River. In fact, snorkeling studies in the Sacramento River show that the lack of suitable juvenile rearing habitat in the middle Sacramento River (*i.e.*, RM 180 – 230 [a few miles downstream from Ord Ferry up to the Elder Creek]) is likely the most limiting factor for Chinook salmon survival in the Sacramento River; only 1 percent of this reach of the middle Sacramento River is suitable rearing habitat for juvenile Chinook salmon (Cannon 2007).

Additionally, a decrease in spring flood flows with the SLWRI would result in a decrease in nesting survival of riparian songbirds such as the black-headed grosbeak due to an increase in the activity of mammalian predators during the songbird's breeding season (Small 2007). A decrease in flood flows would also reduce the flooding of the Yolo Bypass which is important rearing habitat for juvenile salmonids, Sacramento splittail, and longfin smelt (Sommer *et al.* 2001a,b). Decreasing flood flows would also affect Delta aquatic species such as delta smelt, Sacramento splittail, and juvenile salmonids by decreasing flushing flows, and changing the location of the freshwater-saltwater mixing zone (X2). The SLWRI alternatives also resulted in an increase in Delta exports during critically dry water years which could increase the entrainment of delta smelt and other fish species at the Jones and Banks pumping facilities.

Guidelines for Definition of the No Action Alternative

The Service believes the following activities are expected to take place, or should occur, with or without Shasta Lake expansion: (1) compliance with the Service's 2008 and NMFS's 2009 OCAP Biological Opinions (USFWS 2008, NMFS 2009), (2) continued implementation of water use efficiency and conservation (*e.g.*, increased irrigation efficiency in the Anderson Cottonwood Irrigation District [ACID]), (3) Joint Point of Diversion exchanges between the CVP/SWP, (4) supply augmentation via land retirement (*e.g.*, the San Luis Drainage Feature Re-Evaluation [USBR 2006c]), (5) water transfers, and (6) Banks Pumping Plant expansion. These ongoing and anticipated projects should be included in modeling for all SLWRI alternatives, including the No Action. To date within SLWRI planning documents reviewed by the Service, it is not clear how or if these activities were considered in modeling efforts.

In addition, the Service believes that without the SLWRI the Federal Government would take additional actions to help increase anadromous fish survival in the upper Sacramento River as required by the CVPIA, the SWRCB Order 90-5, the 1993 biological opinion for winter-run Chinook salmon (NMFS 1993), and Senate Bill 1086.

The AFRP Restoration Plan (USFWS 2001) was developed to comply with Section 3406(b)(1) of the CVPIA. The AFRP Restoration Plan (USFWS 2001) identifies several high priority actions for increasing anadromous fish survival in the upper Sacramento River including the following: (1) implementing a river flow regulation plan that balances carryover storage needs with instream flow; (2) maintaining water temperatures at or below 56°F from Keswick Dam to Bend Bridge; (3) creating a meander belt from Keswick Dam to Colusa to recruit gravel and large woody debris, to moderate temperatures and to enhance nutrient input; (4) restoring and replenishing spawning gravel, where appropriate, in the Sacramento River; (5) evaluating opportunities to incorporate flows to restore riparian vegetation from Keswick Dam to Verona that are consistent with the overall river regulation plan; and (6) identifying opportunities for restoring riparian forests in channelized section of the upper mainstem Sacramento River that are appropriate with flood control and other water management constraints.

Passed by the State Legislature in 1986, Senate Bill 1086 called for a management plan for the Sacramento River and its tributaries that would protect, restore, and enhance both fisheries and riparian habitat. The law established an Advisory Council, composed of representatives of state and federal agencies, county supervisors, and representatives of landowner, water contractor, commercial and sport fisheries, and general wildlife and conservation interests. In compliance with Senate Bill 1086, the SRCAF developed a handbook (SRCAF 2003) which identifies guidelines for the restoration of the various reaches of the Sacramento River. For the Keswick Dam – RBPP reach, SRCAF recognizes the following restoration priorities: (1) protect physical processes where still intact; (2) allow riparian forest to reach maturity; (3) restore physical and successional processes; and (4) conduct reforestation activities. Therefore, in the likely future condition without the SLWRI, some restoration of the Sacramento River is to be expected in line with the goals and mandates of CVPIA, AFRP, and SRCAF.

In addition to the above, the July 2014 Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (Chinook salmon and Steelhead Recovery Plan) (NMFS 2014), should be considered as an important component in future efforts in anadromous fish conservation both in the Sacramento River watershed and the whole of the California Central Valley drainage system, including the Delta.

RECOMMENDATIONS

Based on the information provided to date by Reclamation in the Plan Formulation Report (USBR 2006a, 2007), the Administrative Draft Environmental Impact Study (Preliminary Draft EIS; USBR 2011), the Draft EIS (USBR 2013), and the Administrative Draft Final EIS (USBR 2014), the Service has developed the following preliminary recommendations. Additional information is needed before the Service can thoroughly evaluate the effects of the SLWRI on fish and wildlife resources. These information needs are outlined below. Lastly, additional CALFED recommended conservation measures for species- and cover-types are identified in Appendix C of this report (CALFED Multi-Species Conservation Strategy species and habitat types).

The Service recommends that Reclamation:

Reevaluate the Guidelines for Definition of the No Action Alternative.

The following activities are expected to take place, or should occur, with or without Shasta Lake expansion and should be included in the benefits/impacts analysis of the No Action and Action Alternatives:

- Compliance with the Service's 2008 and NMFS's 2009 OCAP Biological Opinions
- Continued implementation of water use efficiency and conservation (e.g., increased irrigation efficiency in the ACID)
- Joint Point of Diversion exchanges between the CVP/SWP

- Supply augmentation via land retirement
- Water transfers
- Banks Pumping Plant expansion

Some of the high priority restoration actions identified by CVPIA and State Senate Bill 1086 for riparian restoration and increasing anadromous fish survival in the Sacramento River and tributaries (e.g., AFRP Restoration Plan (USFWS 2001) and SRCAF [SRCAF 2003]).

Evaluate increasing anadromous fish survival without enlarging Shasta Dam.

The capability of increasing the survival of anadromous fish and water supply reliability without raising Shasta Dam should be evaluated. This could be accomplished through an additional alternative including the following:

- Modifying the existing TCD to improve temperature control.
- Improving spawning habitat by gravel augmentation in addition to required mitigation levels.
- Improving juvenile salmonid rearing habitat through large woody debris and riparian restoration (i.e. SRA cover) in the Keswick – RBPP reach, in the lower reaches of the nonnatal tributaries, and in the Sacramento River downstream from RBPP in addition to mitigation levels required by other programs (*i.e.*, CALFED and CVPIA).
- Operational changes to Shasta Dam to increase cold water storage and/or increase minimum flows.
- Considering conjunctive use of other existing and planned water storage facilities in the Central Valley.

Modify action alternatives (in addition to mitigation identified and/or required by other programs [*i.e.*, CALFED and CVPIA]).

In the SLWRI alternatives as currently defined, the only measures remaining that address the primary objective of Anadromous Fish Survival are increasing the size of the cold water pool, modification of the TCD, spawning gravel augmentation (for a period of 10 years), and potential riparian and floodplain restoration (that likely would be included as mitigation for altered flow regimes anyway). In only one alternative (CP4), does increasing the size of the cold water pool provide any substantial benefits to anadromous fish survival. However, even in CP4, benefits to winter-, fall, and late fall-run Chinook salmon are limited to a few dry and critically dry water years representing only a limited percent of the October 1922 – September 2003 simulation period. The secondary objective Ecosystem Restoration has been dismissed from the alternatives except for unspecified "restoration around Shasta Lake" and proposed "riparian and floodplain restoration along the Sacramento River." Recommendations for modifying the remaining action alternatives are listed below and include restoration goals from the SRCAF Handbook (SRCAF 2003), AFRP Final Restoration Plan (USFWS 2001), Chinook Salmon and Steelhead Recovery Plan (NMFS 2014), and the RHJV Bird Conservation Plan (RHJV 2004). Many of these recommendations were originally included in the SLWRI "Alternatives Considered but Removed from Further Analysis" (*e.g.*, AFS-1, AFS-2, AFS-3). In addition, the Service recommends that Reclamation reconsider the resource management measures and alternatives that were removed from further analysis:

Restore the riparian corridor along mainstem Sacramento River and the lower reaches of nonnatal tributaries (see SRCAF 2003, RHJV 2004, and USFWS 2001) using the following actions:

- Restore and protect a diversity of riparian successional states focusing on maintaining wide corridors with adjacent upland habitat along mainstem Sacramento River and lower reaches of nonnatal tributaries.
- Prioritize restoration sites according to their proximity to existing high-quality sites (e.g., La Barranca site).
- Restore juvenile salmonid rearing habitat along middle Sacramento River (between RBPP and Colusa).
- Facilitate natural restoration of cottonwood and willow riparian habitat by allowing 3-5-year flood events during spring seed dispersal followed by a slow decline in river stage to insure successful germination. Pulse flows should avoid artificially raising the stage (river elevation) 2-3 feet during the bank swallow nesting season (April – July).
- Actively restore valley oak woodland and elderberry savanna riparian habitat focusing on establishing a wide continuous flood plain/riparian corridor.
- Control and eradicate non-native plant species (e.g., *Arundo donax*). Such control is best planned and implemented on a watershed scale.
- Restore meanders and oxbows.
- Restore riparian areas along the lower reaches of smaller intermittent nonnatal tributaries (e.g., Churn Creek) that provide important rearing habitat for juvenile salmonids that emerged as fry in the Sacramento River between Keswick Dam and RBPP. Intermittent tributaries are important rearing habitat for juvenile salmonids because the warmer temperatures and pulses of organic matter inputs accelerate the growth rate of juvenile salmonids (Maslin et al. 1996, 1997, 1998, 1999).
- Protect physical processes where the natural hydrology is still intact through conservation easements or landowner participation (e.g., RM 270-272 near Bend; Red Bluff – Chico Landing Reach; and RM 144-176 of the Chico Landing – Colusa Reach; conservation easement and riparian restoration next to the La Barranca site along the Sacramento River).
- Protect, enhance or re-create natural riparian processes, particularly hydrology and associated high water events, to promote the natural cycle of channel movement, sediment deposition, and scouring that create a diverse mosaic of riparian vegetation types.
- To the extent possible, manage flow to align with the near natural hydrograph (i.e., mimic natural flood events) sufficient to support scouring, deposition, and point bar formation. However, pulse flows should be time managed to avoid detrimental impacts on bank swallow nesting colonies.
- Prioritize restoration sites according to surrounding land use. For example, suitable adjacent land uses include wilderness areas, unimproved parks/open space (provided substantial invasive species issues do not exist), grazed oak woodlands, and timber production forests.

To minimize the effects of predators and cowbird parasitism on breeding birds, restoration sites should not be near intensive urban/suburban development, rural homes/ranchettes, manicured parks and golf courses, dairies, intensive feedlots, and active livestock grazing (RHJV 2004).

- Ensure that the patch size, configuration, and connectivity of restored riparian habitats adequately support the desired populations of riparian dependent species.
- Restore and manage riparian forests to promote structural diversity and volume of the understory.
- Using increased storage, increase minimum flows in the upper Sacramento River from the current 3,250 cfs to 4,000 cfs Oct 1 - Apr. 30, if end-of-September storage is 2.4 million af or greater (per the AFRP Final Restoration Plan).
- Monitor and adaptively manage to guide restoration efforts. Conduct intensive, long-term monitoring (including bird monitoring) at selected sites. In order to analyze trends, long-term monitoring should continue for at least 10 years.
- Augment gravel in the mainstem Sacramento River and lower reaches of tributaries (e.g., Cottonwood Creek) to compensate for the continuing impact of Shasta Dam on the recruitment of gravel in the mainstem Sacramento River.
- Collaborate with the AFRP to screen diversions and improve fish passage in mainstem Sacramento River and the lower reach of nonnatal tributaries. For example, screen the diversion at California Lake along the mainstem Sacramento River downstream from the confluence with Cottonwood Creek, improve fish passage at Millville on Clover Creek in the Cow Creek watershed to open up 13 miles of spawning habitat for fall-run Chinook salmon and potentially spring-run Chinook salmon and steelhead, and install a fish ladder at the Bassett diversion on Old Cow Creek.
- Collaborate with the Corps to identify and remove riprap along reaches of nonnatal tributaries and the mainstem of the Sacramento River supporting salmonid spawning and/or rearing habitat (USFWS 2004b).
- Restore habitat at inactive gravel mines and cease instream gravel mining (e.g., Cottonwood Creek). Fill in the deep borrow pit in the Sacramento River at Turtle Bay created during the initial construction of Shasta Dam; this site continues to deplete spawning gravels downstream of Keswick Dam and hampers current gravel augmentation efforts.
- Increase water use efficiency to a specified level (e.g., irrigation efficiency in the ACID).
- Ensure that Delta inflows for the Sacramento River and Yolo Bypass align with targets established in appropriate ongoing planning efforts and as provided in existing biological opinions.

Develop a mitigation and monitoring plan which addresses the following:

- Leave trees/shrubs in the Shasta Lake Inundation Zone for fish/wildlife habitat use (USFWS 2007a) and for western purple martin nesting habitat.

- Transplant Shasta snow-wreath populations within the Inundation Zone to suitable protected habitat outside of the Inundation Zone and monitor. Include plants from each of the three genetic population clusters. Analyze the ability of Shasta snow-wreath to propagate upslope beyond the Inundation Zone. Remove invasive species (e.g., Himalayan blackberry) that hinder the ability of Shasta snow-wreath to colonize new areas.
- Protect other Shasta snow-wreath populations from disturbance in perpetuity through conservation easements or other means (e.g., McCloud River arm between the bridge and the upstream reservoir).
- Develop, implement, and establish long-term funding for a Shasta snow-wreath Conservation and Management plan in coordination with the Service and USFS.
- Protect Cantelow's lewisia populations from disturbance in perpetuity through conservation easements.
- Protect Shasta sideband and Wintu sideband snail limestone outcrop habitats along the McCloud River and Pit River arms, respectively.
- Protect Shasta chaparral snail and Shasta hesperian snail habitat from disturbance in perpetuity through conservation easements or other means.
- Protect Shasta salamander habitat from disturbance in perpetuity through conservation easements or other means.
- Collaborate with PG&E to manage flows in Shasta Lake tributaries for tributary stream habitat and flow enhancement (USFWS 2007a).
- Remediate and restore mining sites and forest areas around and near Shasta Lake (e.g., treat soils to reduce acidity, plant vegetation, clean up creeks, and eliminate acid mine drainage, etc.) (USFWS 2007a); however, remediation activities should not disturb Shasta huckleberry shrubs which are adapted to the low pH soils.
- Restore Sacramento River riparian corridor habitat (e.g., riparian, wetland, and other habitats, possibly at Sacramento River Conservation Area, and other sites). (USFWS 2007a).
- Emphasize listed species recovery with project mitigation (consistent with CALFED ERP goals) (USFWS 2007a).
- Implement a coarse sediment addition project that would sustain gravel and sand loads in the Sacramento River by adding sand and spawning-sized gravel on a regular basis and at a much larger scale to better mimic natural sediment loads and therefore provide the sediment from which the river would naturally create and maintain spawning riffles (USFWS 2007a).
- Protect suitable limestone, mixed conifer, and conifer/woodland habitat for special-status bat species near Shasta Lake (i.e., western red bat, spotted bat, Townsend' big-eared bat, pallid bat, greater western mastiff-bat, small-footed myotis, long-eared myotis, fringed myotis, long-legged myotis, and Yuma myotis). The following actions should be used to locate suitable habitat for these bat species in the Inundation Zone:
    1. Use acoustic technology to identify bat species within the Inundation Zone that would be affected by the SLWRI.
    2. Collaborate with the California Bat Conservation Fund.

3. Create and/or enhance bat habitat by constructing bat boxes and modifying entrances to abandoned mine shafts in the lake area (e.g., install bat gates to allow bat passage but block human access) (USFWS 2007a).
4. Restrict the use of pesticides in bat foraging areas where possible.

- Select oak woodland mitigation sites for protection based on the following criteria (CalPIF 2002a):
    1. Sites with intact oak regeneration and decay processes.
    2. With current indicators of avian population health (i.e., a diverse species matrix, positive species trends, etc.).
    3. Diverse age structure of oak trees, particularly large old oak trees.
    4. Adjacent to intact chaparral, grassland, pine, and/or riparian habitats.
    5. Priority should be given to sites in which there are existing or highly likely conservation threats and opportunities for protection.
    6. Proximity to existing high quality sites.
    7. Protect a diverse mosaic of oak woodland habitat as recommended in the "Conservation Measures and Habitat Protection for Focal Bird Species" section below.
    8. Protect large tracts of land to include a natural diversity of oak species or intraspecific oak varieties with different seeding phenologies to help avoid synchronous or wide geographic-scale crop failures. Maintain snags and dead tree limbs, or soft-wooded live trees such as pines or sycamores. Do not allow intensive grazing that limits the recruitment of new oaks.

- Select coniferous forest mitigation sites for protection based on the following criteria:
    1. Presence of limestone outcrops supporting special-status species such as Shasta salamander, Shasta sideband, Wintu sideband snail, and Shasta snow-wreath.
    2. Includes habitat supporting special-status species such as Pacific fisher, northern spotted owl, northern goshawk, American peregrine falcon, flammulated owl, long-eared owl, black swift, Vaux's swift, Lewis's woodpecker, red-breasted sapsucker, olive-sided flycatcher, western purple martin, special-status bat species (listed above), and ringtail.
    3. Includes existing old-growth/late-successional coniferous forest habitats.
    4. Presence and preservation of habitat with current indicators of avian population health (i.e. diverse species matrix).
    5. Ensure that patch size, configuration, and connectivity of coniferous habitats adequately support the desired populations of coniferous forest associated species.
    6. Select sites near existing high quality sites.
    7. Select sites with intact adjacent habitats.
    8. Select sites with suitable surrounding land use (e.g., conservation lands, land trust properties, national forests, etc.). Surrounding land uses may influence the population sizes of brown-headed cowbirds and predators such as domestic cats, jays, skunks, raccoons, ravens, and crows.

9. High tree species diversity.
10. Presence and preservation of large trees and large snags.
11. Presence of diverse shrub understory and forest floor complexity (e.g., downed logs, root wads and a deep litter layer). Protect dry slopes brushy understory beneath oak and coniferous trees, open conifer forests interspersed with shrubs or forest edges, or shrubby stands of trees.
12. Presence of a diverse mosaic of coniferous forest habitat as recommended in the "Conservation Measures and Habitat Protection for Focal Bird Species".
13. Presence of moist coniferous forest edge with an herbaceous understory that remains green throughout the dry season. Mechanical destruction of the herbaceous layer and intensive cattle grazing should be avoided during April through August.
14. Presence of mature and old-growth dense coniferous forests, mixed forests, open woodland, or second growth habitats with an abundance of standing live, dead, or dying trees, snags, and stumps and a tall, closed canopy with large diameter trees. Retain logging residue and downed wood. Reduce habitat fragmentation.

- Select mixed chaparral mitigation sites for protection based on the following criteria (RHJV 2004):
    1. With current indicators of avian population health (i.e., a diverse species matrix, positive species trends, etc.
    2. Proximity to existing high quality chaparral habitat sites that exhibit indicators of avian population health.
    3. Suitable surrounding land use (e.g., conservation lands, land trust properties, national forests, etc.). Surrounding land uses may influence the population sizes of brown-headed cowbirds and predators such as domestic cats, jays, skunks, raccoons, ravens, and crows.
    4. Patch size, configuration, and connectivity of restored scrub habitats should adequately support the desired populations of scrub-dependent species.
    5. Manage sites to facilitate natural fire regimes in areas that still have potential to function within historic range of variability.
    6. Presence of a diverse mosaic of mixed chaparral habitat as recommended in the "Conservation Measures and Habitat Protection for Focal Bird Species" section below.
    7. Select large areas with minimal human development that contain a mixture of shrub cover including areas with mature, dense shrub habitats, and open areas of low grasses and open habitat with minimal human development.
    8.
- Select montane riparian mitigation sites for protection based on the following criteria (RHJV 2004):
    1. Presence of habitat supporting special-status species such as Shasta snow-wreath, western purple martin, foothill yellow-legged frog, tailed frog, northwestern pond turtle, osprey, bald eagle, willow flycatcher, bank swallow, yellow warbler, yellow-breasted chat, Shasta hesperian snail, pebblesnails and other aquatic mollusks.

2. Degraded habitats that could be protected and would lend themselves to the "Suggested Modifications to CP4" section above that describes recommendations for restoring riparian habitat, maintaining wide corridors, and preserving areas with natural hydrologic processes intact.
3. Select small riparian corridors (less than 200 meters in length and 20 -50 meters in width) along forest edges with cottonwood-willow associations, vegetation diversity, vertical complexity, and blackberry or wild grape for cover. Target old growth riparian forest, with large, shady oaks and cottonwoods, as well as in relatively open areas in early successional riparian zones and along levees.
4. Prioritize the selection of riparian deciduous shrub vegetation, particularly willow thickets that could be restored and protected.
5. Protect marsh habitats with a riparian habitat corridor. Restrict livestock grazing and pesticide use. Minimize habitat disturbance from mid-April – September.
6. Presence of dense early successional riparian thickets of willows with vine tangles of native blackberry, California wild rose, and pipevine and dense brush associated with streams, swampy ground and the borders of small ponds. Some taller trees (i.e., cottonwoods and alders) are required for song perches. Minimize logging.

- Identify mitigation sites and strategies early in the planning process for final analysis and incorporation into the HEP application.
- Consider lands that have been indicated as important wildlife corridors for population movement and conductivity by the California Essential Habitat Connectivity Project (Spencer et al 2010).
- Implement the following priority action for water management:
    1. Meet the ERP milestones for recovery of Chinook salmon and steelhead (CALFED Phase I condition of Biological Opinions and NCCP Determination).
    2. Meet the ERP milestones to benefit covered fish species.
    3. Meet obligations for water supply under the Environmental Water Account (EWA).
    4. Create secure storage for EWA assets.
    5. Meet CVPIA AFRP flow standards.
    6. Meet Delta water quality requirements.
    7. Provide for refuge water supplies for Level 2 and Level 4 water.
    8. Provide for seasonal flow enhancements which could include flow releases that simulate natural seasonal flows and increased flows at various times of year to provide more suitable fish habitat and water temperatures. (See ERP proposed actions in Table D-1 of the Service's Programmatic Biological Opinion for CALFED).

- Implement the National Bald Eagle Management Guidelines (USFWS 2007b).

Reclamation must develop a bald and golden eagle management plan in cooperation with the Service. This plan should minimize adverse effects to the bald eagle by incorporating the avoidance and minimization measures identified in the National Bald Eagle Management Guidelines (USFWS 2007b). Construction activities should be timed and spaced to minimize effects during the following critical bald eagle nesting periods: nest building (most sensitive phase) in January – mid-April; egg laying/incubation in February – May; hatching/rearing young in March – July. The conservation measures identified in the CALFED EIS (CALFED 2000a,b) should be followed and consult with CDFW for impacts to the State Endangered bald eagle

Fully Consider Previous Recommendations.

- Incorporate the recommendations in Appendix B (pp. 23 – 25) of this report that the Service provided in the February 17, 2007, Planning Aid Memorandum for the SLWRI (USFWS 2007a) and the appropriate conservation measures for species identified in the CALFED Programmatic Final EIR/EIS (CALFED 2000a,b) which are summarized in Appendix C of this report.
- Establish a Secondary Study Area as defined to include the Sacramento River and its tributaries from RBPP to the Delta and the area of potential operational effects, including CVP and SWP facilities that could experience reservoir water surface elevation fluctuations and stream flow changes downstream from their facilities due to an enlarged Shasta Dam (e.g., Oroville Dam and the lower Feather River, Folsom Dam and the lower American River).

Provide the Following Additional Data.

More information is required related to the following before the Service can thoroughly evaluate the effects of the SLWRI on fish and wildlife resources. Data needed include:

- Details on habitat disturbance associated with each of the SLWRI alternatives on impacts and effects to riparian habitats downstream of RBPP to the Delta.
- The ecological restorations described in CP4, CP4A, and CP5, for both the immediate Shasta Lake zone and the upper Sacramento River, need to be more completely described and the proposed action defined. The Service is unable to analyze the effects of a number of possible locations and restoration actions that may, or may not occur in association with certain alternatives.
- Additional information is needed regarding the SALMOD modeling data used by Reclamation including:
    1. Conduct a sensitivity analysis of the variables utilized in the model.
    2. Analysis of alternatives considered, but removed from further analysis (e.g., AFS-1, AFS-2, and AFS-3) with the recently revised version of SALMOD.
    3. Analysis of AFS-1, AFS-2, and AFS-3 with higher dam raises (i.e., 18 feet).
    4. Analysis of effects of riparian restoration along the mainstem Sacramento River, the lower reaches of nonnatal tributaries, and further downstream (i.e., RBPP to Colusa) on survival rates of juvenile salmonids.

5. Update and revise the life–cycle and spawning location data used in SALMOD modeling for winter-run Chinook salmon to reflect the most current information (i.e., the timing and location of recent spawning sites).

- Additional information is needed regarding the CALSIM II, or other hydrological modeling, data used by Reclamation including:
  1. Analysis of the assumptions and limitations of CALSIM II.
  2. Analysis of monthly flow data disaggregated into daily flows and how closely it simulates actual flood events on daily and weekly time steps.
  3. Yolo and Sutter Bypasses daily flows, including the effects of reduced flood flows on hydroperiods within the bypasses.
  4. Delta analysis of the effects of the SLWRI alternatives on X2 location and inflow/export ratios as it relates to sensitive Delta aquatic species.
  5. Sensitivity runs with and without NODOS (Sites Reservoir).
  6. Evaluation of other proposed CALFED water storage projects.
  7. Changes in the operation of other CVP/SWP dams and effects on temperature and flows downstream (e.g., Oroville Dam, Folsom Dam, etc.).
  8. Analysis of the capability of improving temperature and flow conditions for anadromous fish in the Sacramento River without raising Shasta Dam.
     a. Modifications to the TCD
     b. Operational changes at Shasta Dam
     c. Riparian restoration associated with AFRP and SRCAF

- Evaluation of the effects of changes in the timing, frequency, and duration of flood flows in the Sacramento River with the SLWRI on the following species/habitats using the SacEFT (ESSA Technologies Ltd. 2006).
  1. Fremont cottonwood regeneration.
  2. Green sturgeon
  3. Chinook salmon
  4. Steelhead
  5. Bank swallow
  6. Western yellow-billed cuckoo

- Evaluation of the capabilities and benefits of riparian restoration opportunities along the Sacramento River and tributaries on fish and wildlife resources using the SacEFT (ESSA Technologies Ltd. 2006).
- Evaluation of how Shasta Dam enlargement would impact efforts to provide Chinook salmon access to traditional spawning areas upstream of Shasta Dam.
- Evaluation of the effects of the SLWRI on fluvial processes in the Sacramento River using the daily Physical River Process model of the Sacramento River that Reclamation-Denver is currently developing.

- HEP data:
  Based on the preliminary data collected for each of the SLWRI alternatives identify potential mitigation sites appropriate to meet the associated cover-type mitigation goals under the Fish and Wildlife Coordination Act.
- Provide information for potentially affected USFS Survey and Manage Species (e.g., Shasta snow-wreath, Shasta chaparral snail, Shasta hesperian snail, Shasta salamander, Pacific fisher) (USFS 2001) including:
  1. Current distribution and population of species.
  2. What percent of the population and habitat would be lost or disturbed?
  3. Analysis of the extent of habitat fragmentation as a result of the proposed actions and the impacts to species.
- Location and number of abandoned mines and analysis of the effects of inundation.
- Analyze the effects of climate change in relation to the proposed actions.
- Analyze growth-inducing effects from increased water supply reliability within the CVP-SWP water service areas.
  1. Conversion of natural lands into agriculture or urban use.
  2. Conversion of agricultural lands into urban use.
  3. Changes in crop cultivation based on increased water supply reliability (e.g., conversion of row crops to orchards).
- Explain how the implementation of SLWRI would impact the Bay-Delta Conservation Plan/California Water Fix.

Conclusion

The primary objectives of the SLWRI as stated in the EIS (USBR 2014) are increasing water supply reliability and increasing anadromous fish survival, with a secondary objective of ecosystem restoration. Of the 6 alternatives evaluated by the SLWRI, all alternatives provide benefits to water supply reliability. Only one alternative (CP4) appears to provide substantial benefits to anadromous fish survival, although these benefits are limited to a few dry and critically dry water years representing less than 10 percent of the simulation period.

The initial alternatives included multiple restoration opportunities to address both anadromous fish survival and ecosystem restoration (*e.g.*, riparian habitat restoration, spawning gravel augmentation, restoration of abandoned gravel mines, removal of barriers to fish passage, screening water diversions to prevent entrainment, and removal of invasive species). However, all of the restoration opportunities were removed by Reclamation from further consideration, except for limited spawning gravel augmentation and proposed floodplain/side channel restoration included in CP4, CP4A, and CP5. CP5 also includes proposed environmental restoration around Shasta Lake. The Service believes that environmental restoration measures as described for CP5 should be included as a mitigation measure for the inundation and disturbance of habitat around Shasta Lake regardless of the alternative that is ultimately selected.

The SLWRI would inundate the limited habitat of seven rare species (*e.g.*, Shasta snow-wreath, Shasta salamander, Shasta sideband snail, Wintu sideband snail, Shasta chaparral snail, Shasta hesperian snail, and western purple martin), six of which are endemic to the vicinity of Shasta Lake. Additional habitat would be disturbed by the relocation of campgrounds, roads, bridges, and facilities beyond the Inundation Zone. Thus, the raising of Shasta Dam and implementation of the SLWRI would result in the loss, degradation, and fragmentation of habitat and as a result, may require further evaluation by the Service of the factors threatening these seven species pursuant to section 4 of the ESA. Additionally, the reduction in winter flows with the raising of Shasta Dam would result in adverse effects to riparian habitat along the Sacramento River and to sensitive aquatic species in the Delta.

In the SLWRI PFR, Reclamation allocates 61.2 percent ($505 million) of the total construction cost of CP4 to "Fish and Wildlife Enhancement" (Table 6-6 in USBR 2007), and it is assumed by the Service that a similar percentage would be allocated for the preferred alternative, CP4A. However, based on: 1) the insignificant benefits afforded to anadromous fish by CP4A (less than significant increase in overall production and less than significant decrease in overall mortality); 2) the adverse effects of the project to seven rare species in the vicinity of Shasta Lake; 3) the impacts of reduced winter flows to riparian habitat regeneration along the Sacramento River downstream of the RBPP, and 4) impacts to estuarine habitat in the Delta, the Service believes that the benefits to "Fish and Wildlife Enhancement" do not equate to 61.2 percent of the cost of the SLWRI. The money that would be required to fund "Fish and Wildlife Enhancement" in the SLWRI should not be diverted from other more cost effective environmental restoration projects identified as high priority goals for anadromous fish survival and riparian restoration by such programs as AFRP, SRCAF, RHJV, and CALFED.

Based on the Service's evaluation of the information available, as contained in this report, as well as evaluations contained in the EIS and associated documents provided by Reclamation, the Service has determined that the proposed project would not provide substantial benefits to fish and wildlife resources within the Shasta Lake pool or the adjacent upland habitats. The Service has also determined that the proposed project would not provide any substantial benefit to anadromous fish downstream of the RBPP and would only provide minimal benefit to anadromous fish (winter- and spring-run Chinook salmon) upstream of the RBPP. It is the Service's opinion that the proposed action, by further restricting high water flows, would result in additional losses of salmonid rearing and riparian habitat, and would adversely affect the recruitment and natural succession of riparian forest along the Sacramento River and bypasses. Upon consideration of the information provided to date, the level of potential impacts to fish and wildlife resources, and the lack of specificity on potential mitigation and compensation measures, the Service is unable to support the adoption of any of the proposed action alternatives.

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