4 Action Area and Environmental Baseline

4.1 Introduction

This chapter describes the action area of the proposed action (PA) as well as the environmental baseline in the action area, including an overview of environmental conditions and a description of the effects of these conditions on the species included in this biological assessment. Detailed species accounts for each species considered in this BA are provided in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

4.2 Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action (50 CFR §402.02). For purposes of this consultation, the action area includes the entire legal Delta, Suisun Marsh, and Suisun Bay; and extends upstream within the channels of the Sacramento and American Rivers below Keswick and Nimbus Dams, respectively Figure 4-1. For purposes of the Southern Resident distinct population segment (DPS) of killer whale only, the action area includes nearshore coastal areas in California, Oregon, and Washington (Figure 4-2).

The action area was derived considering several factors to account for all effects of the PA. First, to determine the action area for listed fish and their designated critical habitat, the CALSIM II model was used to screen for the extent of potential direct and indirect effects within the Sacramento and San Joaquin Rivers and their tributaries. Where CALSIM II results did not differ between the PA and No Action conditions, no effect was assumed within the Sacramento and San Joaquin Rivers and their tributaries because it indicates that the PA would not have an effect on operations, and therefore would not affect species in those areas. Where CALSIM II results did not differ between the PA and No Action conditions, it was assumed that the PA did not cause an effect, and that the action area did not need to include those areas. This is discussed further in the introduction to Section 5.4.2, *Upstream Hydrologic Changes*, which describes the tributaries that are part of the SWP/CVP with no difference between PA and No Action are the Trinity River, Clear Creek, the San Joaquin River, and the Stanislaus River; these areas therefore were excluded from the action area. Additionally, the Feather River system is excluded from the action area due to the existing formal consultation on water operations in that system, as detailed in Section 4.4 *Feather River Operations Consultation*. The entire legal Delta and Suisun Marsh are included in the action area for fish species because the PA may affect any waterway in the Delta or Suisun Marsh. Detailed modeling results are provided as Appendix 5.A, *CALSIM Methods and Results*. For listed species of wildlife, the entire legal Delta was assumed to account for all of the potential construction effects, including the siting of offsetting measures including habitat restoration. For the Southern Resident killer whale, all nearshore coastal waters within their range in California, Oregon, and Washington are included in the action area because this distribution is consistent with the description provided by NMFS (2009: 158-160).

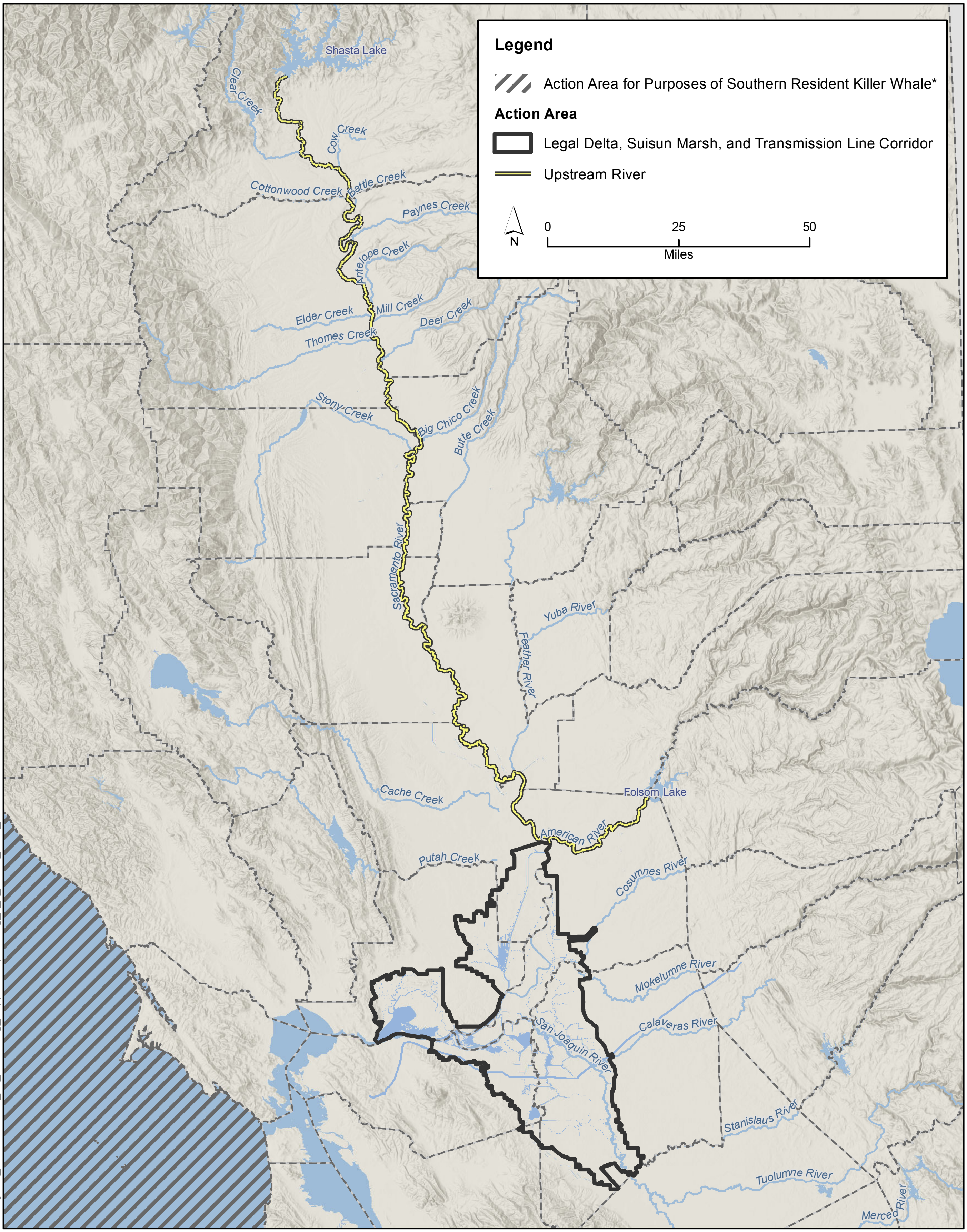

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Figure 4-1
California WaterFix Action Area

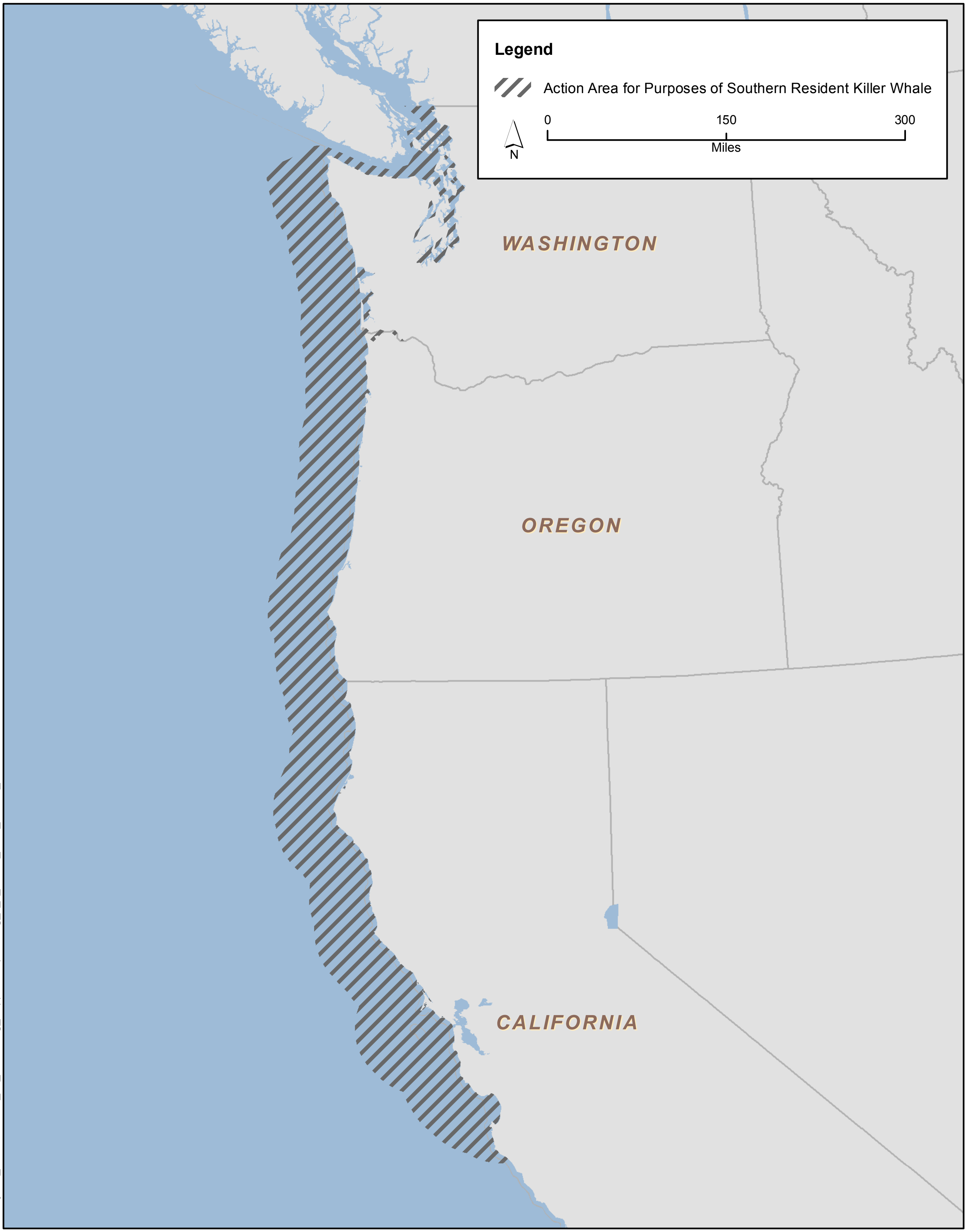

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Figure 4-2
California Water Fix Action Area for Purposes of Southern Resident Killer Whale

4.3 Environmental Context

This section includes a general description of environmental conditions in the action area to provide relevant background information for the environmental baseline. The environmental baseline for each species is presented below in Section 4.5, *Status of the Species/Environmental Baseline Summary*.

4.3.1 Historical Conditions

Much of the broad scale geology of the Central Valley, Delta, and Suisun Marsh was formed before the Pleistocene epoch (more than 2 million years ago), while finer details wrought by younger geologic formations, including the recent uplift and movement of the Coast Range and the deposition of broad alluvial fans along both sides of the Central Valley, formed during the Pleistocene epoch from 2 million to 15,000 years ago (Louderback 1951; Olmsted and Davis 1961; Lydon 1968, Shlemon 1971; Atwater et al. 1979; Marchandt and Allwardt 1981; Helley and Harwood 1985; Band 1998; Unruh and Hector 1999; Graymer et al. 2002; Weissmann et al. 2005; Unruh and Hitchcock 2009). Approximately 21,000 years ago, the last glacial maximum ended and the eustatic (worldwide) sea level began to rise from the lowstand (lowest sea level bathymetric position or depth during a geologic time) of -394 feet (-120 meters) in a series of large meltwater pulses interspersed by periods of constant rising elevation. The rise continued until the Laurentide ice sheet had completely melted 6,500 years ago and the rate of sea level rise slowed dramatically (Edwards 2006; Peltier and Fairbanks 2006). During this change from glacial to interglacial period, runoff brought enormous quantities of sediment from the Sierra Nevada and Coast Range that formed alluvial fans and altered stream channels in the Central Valley (Olmsted and Davis 1961; Shlemon 1971; Marchandt and Allwardt 1981; Helley and Harwood 1985; Weissmann et al. 2005).

The modern Delta formed sometime between 10,000 and 6,000 years ago, when the rising sea level inundated a broad valley that occupied the Delta region. Despite its name, the Sacramento–San Joaquin River Delta is not simply the merging of two river deltas, but is instead an elongated and complex network of deltas and flood basins with flow sources that include Cache Creek, Putah Creek, Sacramento River, Mokelumne River, San Joaquin River, and Marsh Creek. Based on current unimpaired flow estimates, the Sacramento River is the largest source of flows and has contributed an average of 73% of historical inflows into the Delta. The eastside tributaries, including the Mokelumne River, contribute about 6%, and the San Joaquin River contributes 21% (California Department of Water Resources 2007).

Currently, during high-flow events (when water from the Sacramento River spills into the bypasses), approximately 80% of Sacramento River flow enters the Yolo Bypass, a flood control bypass west of the city of Sacramento, via the Fremont Weir (Roos 2006). Flows begin to enter Fremont Weir when Sacramento River flows at Freeport exceed 56,000 cubic feet per second (cfs). The flood stage flows can have many sources, including direct flows from tributaries such as the Feather and American Rivers, as well as flows transiting a system of passive and active weirs (James and Singer 2008; Singer et al. 2008; Singer and Aalto 2009). The Yolo Bypass also serves as a conduit for Cache Creek and Putah Creek, as their waters enter the Sacramento River via Cache Slough at the southern end of the Yolo Bypass. The San Joaquin River discharges into a broad network of sloughs and channels, and the Mokelumne River delta merges with the San

Joaquin River delta on the eastern side of the Delta. On the southwest side of the Delta, the Marsh Creek delta merges with the San Joaquin River delta.

While flooding has always been a regular occurrence along the Sacramento River (Thompson 1957, 1960, 1961, 1965), the natural geomorphic processes and hydrologic regimes were completely disrupted by the enormous increase in sediment and debris generated by hydraulic mining operations in the central Sierra Nevada from 1853 to 1884 (Gilbert 1917; Mount 1995). Large volumes of mining sediment remain in the tributaries today (James 2004a; 2004b). The portion of the estimated 1.5 billion cubic feet of sediment that poured into the Sacramento Valley filled river channels and increased flooding severity and peak flows (Gilbert 1917; Kelley 1989; Mount 1995; James 2004a; Hitchcock et al. 2005; William Lettis & Associates 2005; James 2006; Central Valley Regional Water Quality Control Board 2008; James and Singer 2008; James et al. 2009). In the 1900s, another pulse of mining sediment was discharged into the Sacramento River watershed (James 1999). While it is often assumed the mining sediment has already passed through the Delta or is stored behind dams, large amounts remain within the system (James 1999, 2004a, 2004b, 2006; James and Singer 2008; James et al. 2009). Other Central Valley streams, such as the Cosumnes River, have been affected to a lesser extent by similar mining or agriculture-derived sources of sediment (Florsheim and Mount 2003). Historically, the initial pulse of sediment made its way into the San Francisco Estuary where it filled shallow tidal bays. However, with current reduced sediment loads into the estuary, the remaining sediments in the estuary are being eroded and transported into the Pacific Ocean (Cappiella et al. 1999; Ganju and Schoellhamer 2010).

Soils in the Delta are extremely variable in texture and chemical composition. In the interior of the Delta, soils are generally a combination of peat beds in the center of islands with relatively coarse textured inorganic sediments deposited in the channels and along the margins of the islands (William Lettis & Associates 2005; Unruh and Hitchcock 2009; Deverel and Leighton 2010). Ancient dune deposits on the islands and shoreline of the western Delta near the San Joaquin River predate the peat beds (Carpenter and Cosby 1939; San Francisco Estuary Institute 2010). The soils in the Suisun Marsh area are generally peat or fine textured mineral soils in and along the islands closest to Suisun Bay, and fine textured mineral soils are found closer to the border of the marsh where it abuts the uplands. The soils of the Cache Slough area are primarily mineral soils that are either fine-textured and of local origin, or coarse-textured material that is a legacy of gold mining in the Sierra Nevada and streams leading from the Sierra Nevada. The uplands north of Suisun Marsh and west of the Sacramento River are generally alkaline clays (Mann et al. 1911; Bryan 1923; Thomasson Jr. et al. 1960; Graymer et al. 2002). The soils of the Yolo Basin are alkaline clays on the west side, a mixture of clay, sand, and peat on the bottom of the basin, and silts with sand splays on the natural levee of the Sacramento River (Anonymous 1870; Mann et al. 1911; Andrews 1972). The soils along the southwestern border of the Delta are sands to the north and alkaline clays to the south (Carpenter and Cosby 1939; Natural Resources Conservation Service 2009; San Francisco Estuary Institute 2010). Along the eastern border of the Delta, the soils are heterogeneous patches of clays, loams, and peat (Florsheim and Mount 2003; Natural Resources Conservation Service 2009).

It is estimated that prior to reclamation actions (filling, levee construction, diking, and draining), nearly 60% of the Delta was inundated by daily tides. The tidal portion of the Delta consisted of backwater areas, tidal sloughs, and a network of channels that supported highly productive freshwater tidal marsh and other wetland habitats (Whipple et al. 2012). Similar complex drainage networks, ponds, and salt panes existed in tidal brackish marshes in Suisun Marsh and along the north shore of east Contra Costa County (Brown 2004; Whipple et al. 2012; San Francisco Estuary Institute 2010). The soils in these marshes were generally peat beds that accumulated and were preserved under anoxic conditions. In contrast, soils in channels and along the higher-energy channel margins of islands tend to be composed primarily of mineral sediment (William Lettis & Associates 2005; Unruh and Hitchcock 2009).

Reclamation occurred over vast areas in the Delta, Yolo Basin, Suisun Marsh, and the south shore of Suisun Bay between the 1850s and the early 1930s, completely transforming their physical structure (Thompson 1957, 1965; Suisun Ecological Workgroup 2001; Brown 2004; Whipple et al. 2012; San Francisco Estuary Institute 2010). Levee ditches were built to drain land for agriculture, human habitation, mosquito control, and other human uses while channels were straightened, widened, and dredged to improve shipping access to the Central Valley and to improve downstream water conveyance for flood management. During this period, over 300,000 acres of tidal marshes in the Delta were diked, drained, and converted to agriculture (Atwater et at. 1979). Thus, the complex, shallow, and dendritic marshlands were replaced by simplified, deep, and barren channels. This hydrogeomorphic modification fragmented aquatic and terrestrial habitats, and decreased the value and quantity of available estuarine habitat (Herbold and Vendlinski 2012; Whipple et al. 2012).

Floodplain includes areas that are inundated by overbank flow during the winter and spring peak flows. Inundation can last for up to several months. In presettlement times, floodplain was arguably one of the most productive natural communities in the Delta, and its loss can be linked to the decline of many native Delta species. Reclamation, channel modification for flood control, and water removals for agriculture and export have resulted in a substantial reduction in floodplain areas. Floodplains provide important habitat for rearing, migrating, and adult fish; migratory waterfowl; and amphibians, reptiles, and mammals native to the Delta.

Under natural conditions, inflows from both the Sacramento and San Joaquin Rivers to the Delta were much lower from July through November compared to the December to June period (The Bay Institute 1998), and in drought periods likely led to salinity intrusions. This difference was more dramatic in the San Joaquin River. The San Joaquin River has an upper watershed consisting of impermeable granitic rock that does not support dry season groundwater discharge. In contrast, the upper watershed of the Sacramento River is composed of permeable volcanic rock. As a result, groundwater discharge from this volcanic system historically maintained a summer base flow at Red Bluff of approximately 4,000 cfs, without which the Sacramento River would have nearly dried up each fall (The Bay Institute 1998).

Water diversions in the San Joaquin Valley began earlier than those in the Sacramento Valley, and by 1870, flows of the San Joaquin River were significantly reduced (California Department of Water Resources 1931; Jackson and Patterson 1977). Sacramento River diversions, particularly late spring and summer diversions for rice irrigation, increased dramatically from 1912 to 1929. The combination of significant drought periods and increased diversion during the annual low-flow period resulted in an unprecedented salinity intrusion into the Delta in fall 1918 (California Department of Water Resources 1931; Jackson and Patterson 1977; The Bay Institute 1998; Contra Costa Water District 2010). The economic impacts of these diversion-caused saltwater intrusions ultimately led to the creation of the Central Valley Project (CVP) and the construction of dams for the storage and release of fresh water to prevent salinity intrusion (Jackson and Patterson 1977). Between the 1930s and 1960s, construction of dams and diversions on all major rivers contributing to the Delta resulted in substantial changes to Delta hydrodynamics (The Bay Institute 1998; Contra Costa Water District 2010). Four dams (Shasta, Oroville, Trinity, and Monticello) in the Sacramento Valley have individual storage capacities greater than 1 million acre-feet (af) (12 million af total); an additional four dams (New Melones, Don Pedro, New Exchequer, and Pine Flat) with storage capacities greater than 1 million af (6.5 million af total) drain into the San Joaquin Valley (California Department of Water Resources 1993).

The main effect of this upstream water development was the dampening of the seasonal high flows during the winter and spring and low flows during the fall into the Delta (Contra Costa Water District 2010). Reclamation of the Delta and upstream water development also accentuated salinity intrusions into the Delta. Current water management regulations have reduced the annual fluctuations in saltwater intrusion but have also shifted the boundary between fresh and salt water farther into the Delta (Contra Costa Water District 2010). Reclamation, dam construction, flood management, and water projects have greatly transformed the geometry and hydrology of the Delta, as well as downstream locations including Suisun Bay and Suisun Marsh (California Department of Water Resources 2013a).

4.3.2 Physical Environment

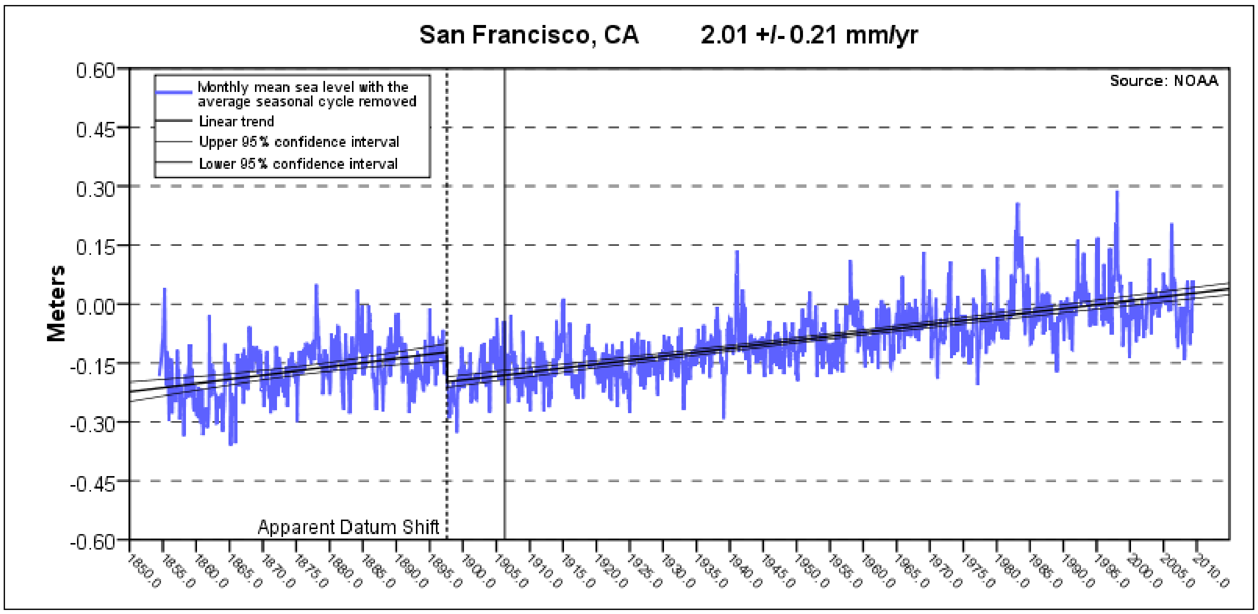
4.3.2.1 Climate Conditions

The climate in the Sacramento–San Joaquin Delta region is spatially variable, but is generally characterized as hot Mediterranean (Köppen climate classification) (Kottek et al. 2006). The general climate becomes milder from east to west due to marine influence as it is affected by winds off the Pacific Ocean.

Summers are hot with average summer highs in the upper 80 degrees Fahrenheit (°F) to lower 90°F, with little to no precipitation and low humidity. Heat waves are common in summer months, during which temperatures can reach triple digits for consecutive days. Periodically, a “Delta breeze” of cool and humid air from the ocean moves onshore and cools the Central Valley in the vicinity of the Delta by up to 7°F (3.9 degrees Celsius [°C]) (Pierce and Gaushell 2005). Winters are mild (average daily highs during November through March are in the mid-50 to mid-60°F) and wet. Approximately 80% of annual precipitation occurs from November to March. The primary origin of precipitation is the seasonal arrival of low-pressure systems from the Pacific Ocean. Very dense ground fog (tule fog) is common between periods of precipitation in the Delta from November through March.

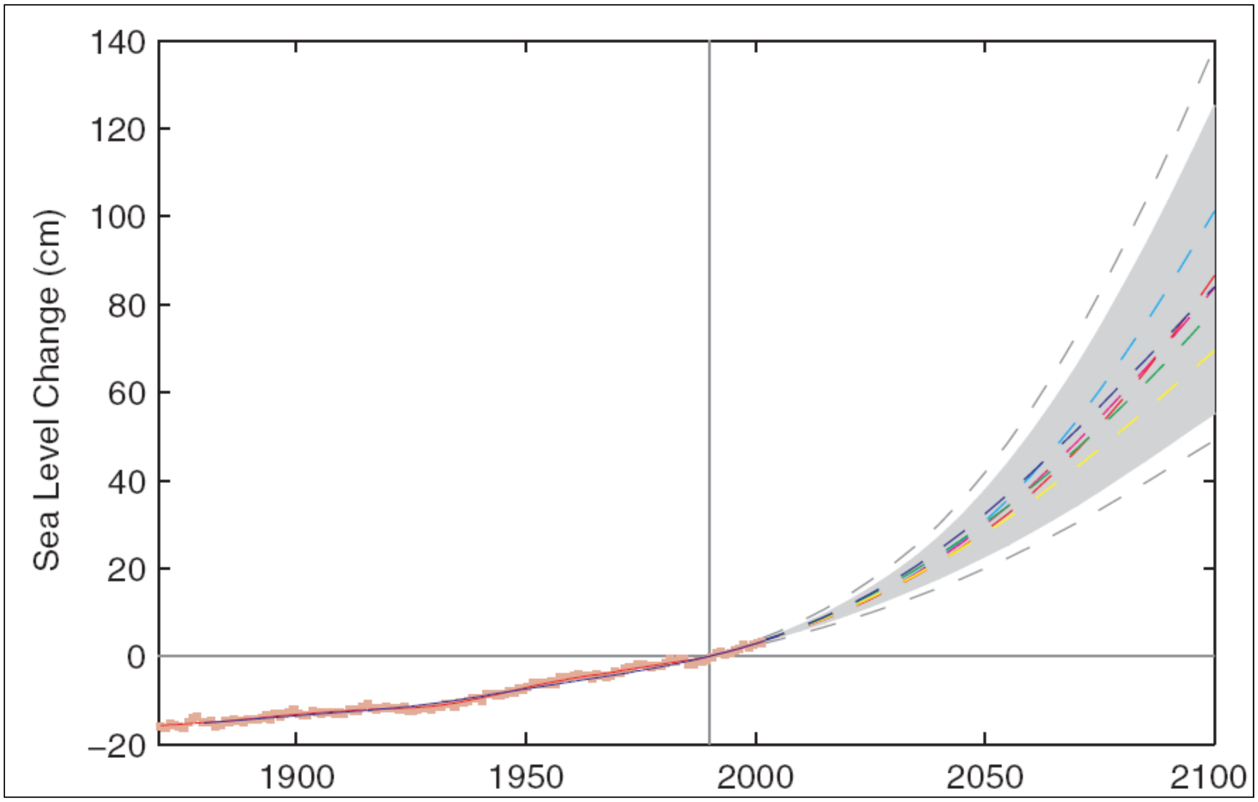
The climate of the Delta is predicted to change in complex ways. Although there is high uncertainty, temperatures in the Delta are projected to increase at an accelerating pace from 3.6 to 9°F (2 to 5°C) by the end of the century (Cayan et al. 2009). Depending upon the general-circulation model used, there are variable predictions for precipitation change, with most models simulating a slight decrease in average precipitation (Dettinger 2005; California Climate Change Center 2006). The Mediterranean seasonal precipitation experienced in the Delta is expected to continue, with most precipitation falling during the winter season and originating from North Pacific storms. Although the amount of precipitation is not expected to change dramatically over the next century, seasonal and interannual variation in precipitation will likely increase as it has over the past century (California Department of Water Resources 2006). This could lead to more intense winter flooding, greater erosion of riparian habitats, and increased sedimentation in wetland habitats (Field et al. 1999; Hayhoe et al. 2004).

Rahmstorf (2007) used a semi-empirical approach to project future sea level rise, yielding a projected sea level rise of 1.6 to 4.6 feet above 1990 levels by 2100 when applying the Third Assessment Report warming scenarios. Other recent estimates indicate global increases by 2100 of 1.6 to 3.3 feet (National Research Council 2010); 2.6 to 6.6 feet (Pfeffer et al. 2008); and 3.2 to 5.1 feet (Vermeer and Rahmstorf 2009) (Figure 4-3 and Figure 4-4).



Source: National Oceanic and Atmospheric Administration 2009

Figure 4-3. Observed Mean Sea Level Trend for the San Francisco Tide Gage near the Golden Gate



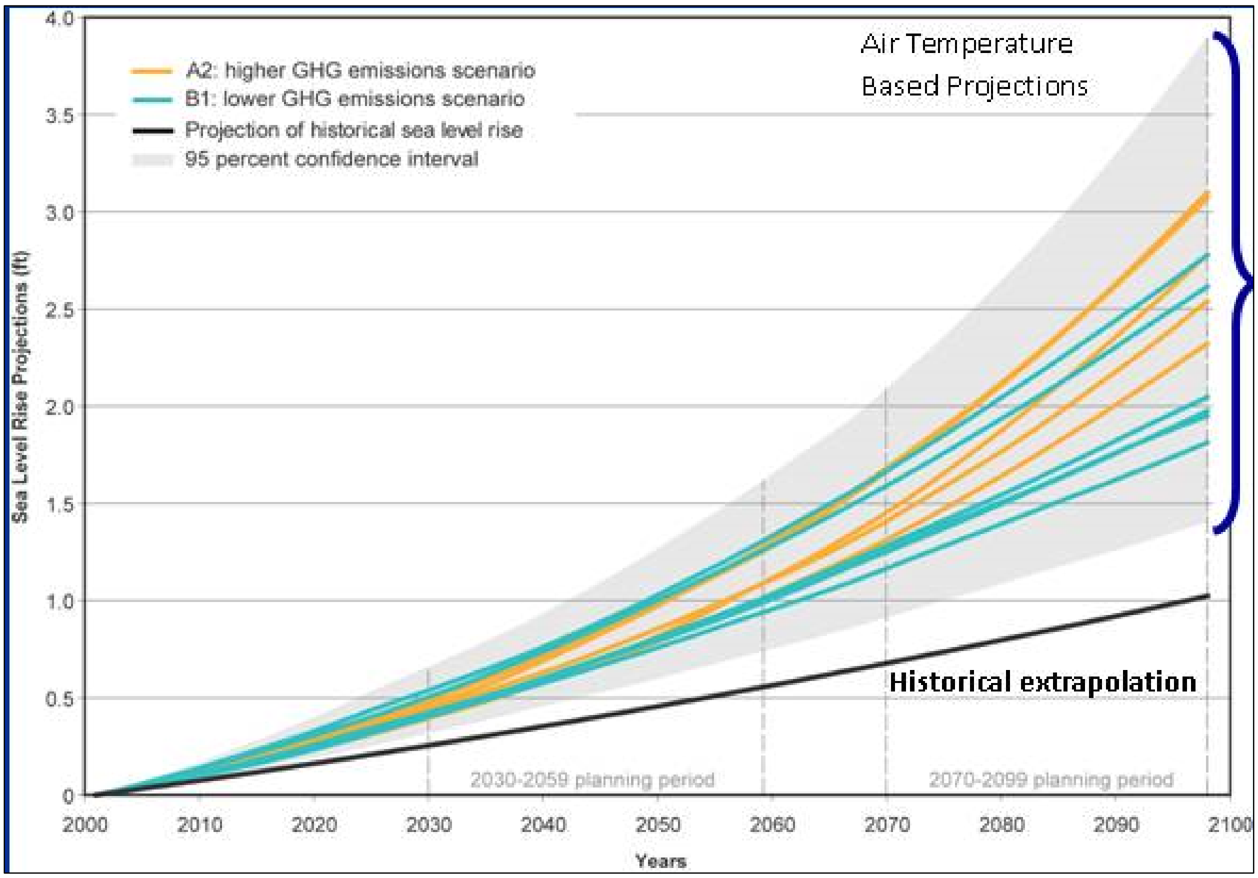
Source: Rahmstorf 2007

Figure 4-4. Past Global Mean Sea Level and Future Mean Sea Level Based on Global Mean Temperature Projections

Using the Rahmstorf (2007) method, the CALFED Bay-Delta Program (CALFED) Independent Science Board estimated ranges of sea level rise of 2.3 to 3.3 feet at midcentury and of 1.6 to 4.6 feet by the end of the century (CALFED Independent Science Board 2007). Some tidal gage and satellite data indicate that rates of sea level rise are increasing (Church and White 2006; Beckley et al. 2007). Scenarios modeled by the California Climate Action Team projected sea level rise increases along the California coast of 1.0 to 1.5 feet above 2000 levels by 2050 and 1.8 to 4.6 feet by 2100 (Cayan et al. 2009). However, if California's sea level continues to mirror global trends, increases in sea level during this century could be considerably greater. Increasing sea levels will seriously threaten the integrity of the Delta's levees and conveyance of water supplies through the Delta (Florsheim and Dettinger 2007).

For water planning purposes, the California Department of Water Resources (DWR) estimated sea level rise over the 21st century using the method of Rahmstorf (2007) and 12 climate projections selected by the California Climate Action Team (Chung et al. 2009). The historical 95% confidence interval was extrapolated to estimate the uncertainties in the future projections (Figure 4-5). Midcentury sea level rise projections ranged from 0.8 to 1.0 foot, with an uncertainty range spanning 0.5 to 1.2 feet. End-of-century projections ranged from 1.8 to 3.1 feet, with an uncertainty range of 1.0 to 3.9 feet. These estimates are slightly lower than those of Rahmstorf (2007) because DWR used a more limited ensemble of climate projections that did not include the highest projections of temperature increases (Chung et al. 2009).

Parker et al. (2011) observed that, in the Bay-Delta, other factors complicate sea level rise projections, including the Pacific Decadal Oscillation (PDO) and El Niño Southern Oscillation (ENSO) events. The PDO is characterized by cool or warm phase shifts in North Pacific sea surface temperatures that commonly persist for 20 to 30 years. Superimposed on the PDO cycles are smaller-scaled El Niño and La Niña events that persist for about a year. Climatic impacts associated with La Niña events are similar to those tied to the cool PDO phases, and climate conditions related to El Niño episodes parallel those of warm PDO phases. Parker et al. (2011) observed that rates of sea level rise slow during the negative (cool) phase and increase during the positive (warm) phase. They also noted that fluctuations in sea level rise, when combined with processes such as ENSO events, may have a greater effect on wetlands than a steady increase.



Source: Chung et al. 2009.

Figure 4-5. DWR-Generated Future Sea Level Rise Projections for the Bay Delta Using the Rahmstorf Method and Regionally Downscaled Data

Increasing sea level rise will increase saltwater intrusion into the Sacramento–San Joaquin River Delta (Delta), disrupting marsh and estuary ecosystems and reducing freshwater and terrestrial plant species habitat. Increased salinity also may increase mortality for species that are sensitive to salinity concentrations. Changes in salinity levels may place added stress on other species, reducing their ability to respond to disturbances. Increased frequency and severity of flood events combined with sea level rise can relocate species and damage or destroy species habitat. Lower ecosystem productivity from increased salinity will affect both phytoplankton-based and detritus-based foodwebs (Parker et al. 2011).

Sea level rise is predicted to be an especially significant factor in in the legal delta within the action area, where much of the land has subsided to below sea level and is protected from flooding by levees. In the Delta, sea level rise in combination with ongoing subsidence of Delta islands will increase the instability of the Delta's levee network, increasing the potential for island flooding and sudden landscape change in the Delta over the next 50 years (Mount and Twiss 2005). The current subsided island condition, combined with higher sea level, increased winter river flooding, and more intense winter storms, will significantly increase the hydraulic forces on the levees. With sea level rise exacerbating current conditions, a powerful earthquake in the region could collapse levees, leading to major seawater intrusion and flooding throughout the reclaimed lands of the Delta, altering the tidal prism, and causing substantial changes to the tidal perennial aquatic natural community (Mount and Twiss 2005; Florsheim and Dettinger 2007).

Predicted warmer temperatures will affect the rate of snow accumulation and melting in the snowpack of the Sierra Nevada. Some projections predict reductions in the Sierra Nevada spring snowpack of as much as 70 to 90% by the end of the century (California Climate Change Center 2006). Knowles and Cayan (2002) estimated that a projected warming of 3°F (1.6°C) by 2060 would cause the loss of one-third of the watershed's total April snowpack, whereas a 4°F (2.1°C) warming by 2090 would reduce April snowpack by 50%. Recent literature indicates a general decline in the April 1 snow water equivalent for the Pacific Northwest and northern Sierra locations, and increases in parts of the southern Sierra (Mote et al. 2008, Pederson et al 2011, Pierce et al. 2008). Measurements taken to track the water content of snow (snow water equivalent) since 1930 show that peak snow mass in the Sierra Nevada has been occurring earlier in the year by 0.6 day per decade (Kapnick and Hall 2009). These predicted changes in the dynamics of the snowpack will influence the timing, duration, and magnitude of inflow from the Sacramento and San Joaquin River watersheds. For example, with more precipitation falling as rain instead of snow and the snowpack melting earlier, greater peak flows will result during the rainy season and lower flows during the dry season. Knowles and Cayan (2004) predict that inflows will increase by 20% from October through February and decrease by 20% from March through September, compared to current conditions. Storm surges (tidal and wind-driven) associated with the more intense storms predicted for the future will also exacerbate Delta flooding. On April 1, 2015, DWR found no snow at the Phillips snow course during its early-April measurements. This was the first time in 75 years that no snow was found there. Readings found that the statewide snowpack held only 5% of the historical average of water content for April 1 (California Department of Water Resources 2015).

4.3.2.2 Hydrologic Conditions

The hydrology of the Delta is primarily influenced by tides, Delta inflow and outflow, diversion, and Delta Channel configuration (California Department of Water Resources 1999). Delta inflows are governed by several existing regulations including the current NMFS biological opinion (BiOp) (2009) for long-term coordinated operations of the CVP/SWP. The effects of these operations on fish are described in the species accounts included in Section 4.5, *Status of the Species/Environmental Baseline Summary*, and in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*. The Delta receives runoff from a watershed that includes more than 40% of the state's land area including the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras River tributaries.

4.3.2.2.1 River Hydrology

Multiple upstream tributaries to the Sacramento and San Joaquin Rivers influence flow into the Delta. The Feather and American Rivers and many large creeks drain directly into the Sacramento River, while the Cache and Putah Creeks drain into the Yolo Bypass, which joins the Sacramento River in the Cache Slough area. The Yuba and Bear Rivers drain into the Feather River before its confluence with the Sacramento River. The Calaveras, Stanislaus, Tuolumne, Merced, and Kings Rivers drain into the San Joaquin River upstream of the Delta. Eastside streams, particularly the Mokelumne River, also contribute inflows to the Delta. The Cosumnes River drains directly into the Mokelumne River, and both drain into the San Joaquin River after entering the Delta. In addition to the Sacramento and San Joaquin Deltas, the Mokelumne Delta in some ways can be viewed as a third important river delta.

Regardless of water year type[1], the large majority of unimpaired upstream flow into the Delta originates from the Sacramento River and its tributaries, and a lesser extent originates from the San Joaquin River and its tributaries. The Cosumnes and Mokelumne Rivers and other smaller tributaries, collectively called the eastside tributaries, contribute only a small percentage of inflows.

Numerous upstream dams and diversions greatly influence the timing and volume of water flowing into the Delta from rivers and tributaries. These values vary by water-year type and the inflows associated with the water year. For example, in the 2000 water year, an above-normal water year, 69% of water entering the Delta passed through the system as outflow, 6% was consumed within the Delta, less than 1% was diverted via the North Bay Aqueduct and by Contra Costa Water District (CCWD), and 24% was exported via CVP/SWP facilities. Additional water was withdrawn upstream of the Delta via upstream diversions and reservoirs, accounting for an additional 7,525 thousand af (California Department of Water Resources 2008). For comparison, in the 2001 water year, a dry year, approximately 51% of water entering the Delta passed through the system as outflow, 12% was consumed within the Delta, and 37% was exported via CVP/SWP facilities. Kimmerer (2002) shows that the proportion of inflow exported by the CVP/SWP decreases as inflow increases. As inflow decreases, the relationship between inflow and outflow strengthens because CVP/SWP exports can capture a larger proportion of the inflow (Kimmerer 2002a). Much of the precipitation that contributes to Delta inflow originates from the Sacramento River and its tributaries (85% median contribution), with smaller contributions from the San Joaquin River and its tributaries (11% median contribution) (Kimmerer 2002a).

The hydrograph of the Delta is highly variable both within and across years. Within years, water flow is generally greatest in winter and spring with inputs of wet season precipitation and snowpack melt from the Sierra Nevada and lowest during fall and early winter before significant rainfall. The construction of upstream dams and reservoirs for flood protection and water supply has dampened the seasonal variation in flow rates. Water is released from reservoirs year-round, and flooding is much less common than it was before dam and levee construction. As a result, the frequency of small- to moderate-sized floods has been significantly reduced since major dam

[1] Water-year type is determined using the Water Supply Index at <http://cdec.water.ca.gov/cgi-progs/iodir/WSI.2015>

construction, although the magnitude and frequency of large floods has not been significantly altered. Additionally, because of climatic changes, there have been more large floods in the last 50 years than the 50 years before then. Across years, extended wet and dry periods (defined as periods during which unimpaired runoff was above or below average, respectively, for 3 or more years) occurred numerous times in the last 100 years, and the duration and magnitude of extended wet and dry periods have increased in the last 30 years. This includes the 6-year drought of 1987 to 1992 and the prolonged periods of wetness in the early- to mid-1980s and middle-to-late 1990s (California Department of Water Resources 2007). As of 2015, California is currently in its fourth consecutive year of below-average rainfall and very low snowpack. The wet and dry periods recorded over the last 150 years, however, are less severe and shorter than the prolonged wet and dry periods of the previous 1,000 years.

The Yolo Bypass is an important physical feature affecting river hydrology during high-flow events in the Sacramento River watershed. The bypass is a 59,280-acre engineered floodplain that conveys flood flows from the Sacramento River, Feather River, American River, Sutter Bypass, and western tributaries and drains (Harrell and Sommer 2003). The leveed bypass protects Sacramento and other nearby communities from flooding during high-water events and can convey up to 80% of flow from the Sacramento basin during flood events (Sommer et al. 2001a). Most water enters the Yolo Bypass by spilling over the Fremont and Sacramento weirs and returns to the Sacramento River in the Delta approximately 5 miles upstream of Rio Vista. The Yolo Bypass floods seasonally in approximately 60% of years (Sommer et al. 2001b).

4.3.2.2.2 Tides

The Delta, lower portion of the Yolo Bypass, and Suisun Marsh are tidally influenced by the Pacific Ocean, although tidal range and influence decrease with increasing distance from the San Francisco Bay (Kimmerer 2004). Tides are mixed semidiurnal with two highs and two lows each day (i.e., one larger magnitude high and low and one lower magnitude high and low). A typical diurnal range is 3.3 to 4.6 feet (1 to 1.4 meters) in the western Delta (Orr et al. 2003). The entire tidal cycle is superimposed upon the larger 28-day lunar cycle with more extreme highs and lows during spring tides and depressed highs and lows during the neap tides. In addition, annual tidal elevations are highest in February and August. The multiple temporal scales at which these cycles occur causes significant variation in draining and filling of the Delta, and therefore, in patterns of mixing of the waters (Kimmerer 2004). Additionally, variation in mean sea level can also be caused by changes in atmospheric pressure and winds (Department of Water Resources 2013b).

4.3.2.2.3 Water Supply Facilities and Facility Operations

Over 3,000 diversions remove water from upstream and in-Delta waterways for agricultural, municipal, and industrial uses; 722 of these are located in the mainstem San Joaquin and Sacramento Rivers and 2,209 diversions are in the Delta (Herren and Kawasaki 2001). The CVP, managed by the Bureau of Reclamation (Reclamation), and SWP, managed by DWR, use the Sacramento and San Joaquin Rivers and other Delta channels to transport water from river flows and reservoir storage to two water export facilities in the south Delta (Figure 4-6). The C. W. "Bill" Jones Pumping Plant (herein referred to as the Jones Pumping Plant) is operated by the CVP and the Harvey O. Banks Delta Pumping Plant (herein referred to as the Banks Pumping Plant) is operated by the SWP. Water from these facilities is exported for urban and agricultural water supply demands throughout the San Joaquin Valley, Southern California, the Central

Coast, and the southern and eastern San Francisco Bay Area. The long-term operations of the CVP/SWP were included in the NMFS 2009 and USFWS 2008 BiOps, including Reasonable and Prudent Alternatives (RPA) to avoid jeopardy to listed fish species and adverse modification to their habitats. The effects of these operations are described in more detail in the applicable species accounts provided in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

Water enters the Banks Pumping Plant via the Clifton Court Forebay. Large radial arm gates control inflows to Clifton Court Forebay during the tidal cycle to reduce approach velocities, prevent scouring of adjacent channels, and allow water to enter the Clifton Court Forebay at times other than low tide, which reduces water level fluctuation in the south Delta (U.S. Fish and Wildlife Service 2005). The Banks Pumping Plant operates to move water from Clifton Court Forebay into the 440-mile (708-kilometer) California Aqueduct. Water in the California Aqueduct travels to O'Neill Forebay, where a portion of the water is diverted to the joint-use CVP/SWP San Luis Reservoir for storage. The remaining water flows southward via the joint-use San Luis Canal, and to the South Bay Pumping Plant and South Bay Aqueduct.

The Jones Pumping Plant pumps water from Old River in the Delta into the Delta-Mendota Canal. The Jones Pumping Plant facility does not have an associated forebay. The Delta-Mendota Canal sends water southward, providing irrigation water along the way, towards the O'Neill Forebay where a portion of the water is diverted into the San Luis Reservoir. The remaining water continues in the Delta-Mendota Canal, again providing water for irrigation and refuges, as well as municipal and industrial uses, until it reaches the Mendota Pool, where water is returned to the San Joaquin River to replenish downstream flows.

The Delta Cross Channel (DCC) is operated by Reclamation. The DCC is opened to augment through-Delta flows from the Sacramento River towards the pumping facilities in the south Delta and/or to improve water quality in the central and south Delta (Figure 4-6). Two large radial gates on the Delta Cross Channel can open or close to control flows into the central Delta. When the DCC is opened, water is diverted from the Sacramento River into Snodgrass Slough and southward through the forks of the Mokelumne River. Opening the DCC increases flows, but also increases the likelihood of Sacramento Basin juvenile salmonids being entrained towards the Central Delta (Perry et al. 2012). Opening the DCC may also lead to increased straying of adult Mokelumne River Hatchery Chinook salmon, though this topic is still under investigation. During winter and spring, the DCC is often closed to keep migrating juvenile salmonids within the Sacramento River and away from the Central Delta. The DCC is also closed during flood events to reduce scour and protect downstream levees.

The Barker Slough Pumping Plant is operated by the SWP and draws water from Barker Slough into the North Bay Aqueduct (Figure 4-6). The intake is located just upstream of where Barker Slough empties into Lindsey Slough, which is approximately 10 miles (16 kilometers) from the mainstem Sacramento River. The North Bay Aqueduct is operated by DWR as part of the SWP and delivers wholesale water to the Solano County Water Agency and the Napa County Flood Control and Water Conservation District. The 27.6-mile North Bay Aqueduct extends from Barker Slough to the end of the Napa Turnout Reservoir.

The South Delta Temporary Barriers project consists of the installation of four rock barriers each spring in south Delta channels: the head of Old River, Old River at Tracy, Grant Line Canal, and

Middle River. The head of Old River barrier is also installed during the fall for dissolved oxygen reasons. The head of Old River barrier is considered a fish barrier because it is installed to keep migrating juvenile Chinook salmon in the San Joaquin River. The other three barriers are agricultural barriers, meaning they are installed to maintain water quality and water levels for agricultural uses in the south Delta. The head of Old River barrier was not installed in spring 2009 or 2010 because the U.S. Fish and Wildlife Service (USFWS) BiOp (U.S. Fish and Wildlife Service 2008) prohibited the installation of the barrier for the protection of Delta Smelt. The rock barriers are not installed in years when San Joaquin River flows are high, such as during 1998.

The CCWD diverts water from the Delta to the Contra Costa Canal and the Los Vaqueros Reservoir using four intake locations: Rock Slough, Old River, Mallard Slough, and Middle River (on Victoria Canal) (Figure 4-6). The Contra Costa Canal and its pumping plants have a capacity of 350 cfs and were built by Reclamation from 1937 to 1948 as part of the CVP. The Contra Costa Canal is owned by Reclamation but operated and maintained by CCWD. The screened Old River Pump Station (250 cfs capacity) was built in 1997 as part of the Los Vaqueros Project to improve water quality for CCWD. The Old River Pump Station connects via pipelines to a transfer pump station (200 cfs) used to pump water into Los Vaqueros Reservoir (160,000 af capacity) and from the transfer station via gravity pipeline to the Contra Costa Canal. The screened Mallard Slough Intake and Pump Station (39 cfs capacity) were constructed in the 1920s and rebuilt to make it seismically protected in 2001. It is used primarily in winter and spring during wet periods when water quality is sufficiently high. The screened Middle River Intake and Pump --Station (250 cfs capacity) were completed in 2010 to provide additional operational flexibility and improved water quality. The Middle River Intake connects to the Old River Pump Station via a pipe that crosses Victoria Island and tunnels underneath Old River. The Middle River Intake is used primarily in late summer and fall to provide better water quality than is obtainable from the other three intakes.

The effects of the operations of these Delta CVP/SWP facilities on listed species have been evaluated as part of the current BiOps for the CVP/SWP Long-term Operations (U.S. Fish and Wildlife Service 2008; National Marine Fisheries Service 2009). They form part of the baseline described in Section 4.5, *Status of the Species/Environmental Baseline Summary*, and in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*.

East Contra Costa Irrigation District provides water supplies to the city of Brentwood, portions of Antioch and Oakley, the unincorporated community of Knightsen, and surrounding unincorporated rural areas. The East Contra Costa Irrigation District operates a diversion located at Indian Slough on Old River in combination with canals and pumping stations for distribution within the service area. The primary purpose of the diversion is to provide raw water for irrigation of cultivated lands, landscape, and recreational uses (e.g., golf courses). The district has agreements with CCWD and City of Brentwood to make surplus water available for municipal use.

The City of Antioch, located in eastern Contra Costa County, supplies water through diversions directly from the San Joaquin River, raw water purchased from CCWD that is delivered through the Contra Costa Canal, and treated water delivered through CCWD's Multi-Purpose Pipeline. Antioch receives approximately 85% of its water supplies from CCWD. The majority of the water is provided for municipal and residential use, with industrial (11%) and agricultural (13%) uses in the service area.

Byron-Bethany Irrigation District provides water for agricultural, industrial, and municipal uses to portions of Alameda, Contra Costa, and San Joaquin Counties (Byron-Bethany Irrigation District 2005 The district maintains two water diversions from the Delta under a pre-1914 appropriative water right and a riparian water right on Old River. Water diversions occur from the SWP intake channel, located between the Skinner Fish Protection Facility and the Banks Pumping Plant. Two diversions serve the Byron Division and the Bethany Division. The District also operates a series of pumping stations and canals for water distribution.

East Bay Municipal Utility District's Mokelumne Aqueduct traverses the Delta, carrying water from Pardee Reservoir on the Mokelumne River to the East Bay (Figure 4-6). East Bay Municipal Utility District, in partnership with Sacramento County, constructed a major new diversion from the Sacramento River at Freeport. This new diversion, sized at 185 million gallons per day capacity, feeds into the Mokelumne Aqueduct and the Vineyard Surface Water Treatment Plant for central Sacramento County use.

There are over 2,200 water diversions in the Delta, most of which are unscreened and are used for in-Delta agriculture irrigation (Herren and Kawasaki 2001). Industrial diversions in the Delta include the Mirant Power plants at Pittsburg and Antioch. Water from these diversions cools generators producing electric power at the plants.

Suisun Bay and Suisun Marsh are important ecosystems connected to the Delta, and habitat conditions and facility operations in Suisun Bay and Marsh can affect ecosystem conditions in the Delta. A system of levees, canals, gates, and culverts in Suisun Marsh was constructed in 1979–80 and is currently operated by DWR to lower salinity in privately managed wetlands in Suisun Marsh. The Suisun Marsh Salinity Control Gates are composed primarily of a set of radial gates that extend across the entire width of Montezuma Slough. The control gates are used to reduce salinity from Collinsville through Montezuma Slough and into the eastern and central parts of Suisun Marsh, and to reduce intrusion of saltwater from downstream into the western part of Suisun Marsh. In addition to radial gates, the Suisun Marsh Salinity Control Gates consist of permanent barriers adjacent to the levee on either side of the channel, flashboards, and a boat lock. The gates have been operated historically from September to May and open and close twice a day during full operation to take advantage of tidal flows. The gates are opened during ebb tides to allow fresh water from the Sacramento River to flow into Montezuma Slough and are closed during flood tides to prevent higher-salinity water from downstream from entering Montezuma Slough. Gate operations have been curtailed in recent years to allow for salmon passage while still meeting the salinity requirements outlined within State Water Resources Control Board Decision-1641 (D-1641).

4.3.2.3 Non-Water Supply Delta Infrastructure and Uses

The Delta supports a substantial amount of infrastructure related to urban development, transportation, agriculture, recreation, energy, and other uses. Portions of six counties are included in the legal Delta: Yolo, Sacramento, Solano, Contra Costa, Alameda, and San Joaquin (California Department of Water Resources 2006).

The major land use for the Delta is agriculture, which represents approximately two-thirds of all surface area. There is increasing residential, commercial, and industrial land use in the Delta, most of which occurs around the periphery of the Delta. Major urban developments within the cities of Sacramento, West Sacramento, Stockton, Tracy, Antioch, Brentwood, and Pittsburg are in the Delta. Small towns located wholly within the Delta are Clarksburg, Hood, Walnut Grove, Isleton, Collinsville, Courtland, Locke, Ryde, Bethel Island, and Discovery Bay. Much of the development occurs in the secondary zone of the Delta.

Several interstate highways (Interstates [I-] 5, 80, 205/580, and 680) and one state highway (State Route [SR] 99) are on the periphery of the Delta, and three state highways (SR 4, SR 12, and SR 160) and multiple county roads cut across the Delta. Three major railways cross through the Delta. The Delta contains a network of electrical transmission lines (over 500 miles [805 kilometers]) and gas pipelines (over 100 lines). Natural gas extraction and storage is another important Delta use. In addition to approximately 95 public and private marinas (Lund et al. 2007), two major ports (Stockton and Sacramento) and their associated maintained ship channels are in the Delta. These ports can handle high tonnage (55,000-ton class) ships to move cargo to and from the Pacific Ocean. Much of the Delta, including 635 miles (1,022 kilometers) of boating waterways, is used for a variety of recreational purposes including water sports, fishing, hunting, and wildlife viewing (Lund et al. 2007). The effects of this infrastructure on species are described in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, as applicable.

4.3.3 Reasonable and Prudent Alternative Actions under Existing Biological Opinions to Avoid Jeopardy and Adverse Modification of Critical Habitat

The coordinated long-term operations of the CVP/SWP are currently subject to the RPAs of BiOps issued by USFWS (2008) and NMFS (2009) pursuant to Section 7 of the Endangered Species Act (ESA). Each of these BiOps was issued with RPAs to avoid the likelihood of jeopardizing the continued existence of listed species or of resulting in the destruction or adverse modification of critical habitat that were the subject of consultation in each BiOp.

USFWS BiOp RPA. The USFWS BiOp concluded that the long-term operations of the CVP/SWP were likely to jeopardize the continued existence of Delta Smelt and were likely to destroy or adversely modify their designated critical habitat. Therefore, the USFWS BiOp included an RPA with five components comprising three types of actions to avoid jeopardy to Delta Smelt: require a reduction in the magnitude of reverse Old and Middle River (OMR) flows to reduce smelt entrainment; implement a “Fall X2” standard requiring that X2[2] be located at no

[2] X2 refers to the horizontal distance from the Golden Gate up the axis of the Delta estuary to where tidally averaged near-bottom salinity concentration of 2 parts of salt in 1,000 parts of water occurs; the X2 standard was established

greater than 46 and 50 miles (74 and 81 km) from Golden Gate in September, October, and November of wet and above normal years, respectively, to improve rearing conditions for Delta Smelt; and implement 8,000 acres of tidal restoration in Suisun Marsh and/or the north Delta to provide suitable habitat for Delta Smelt. The OMR and Fall X2 actions have been implemented, and a portion of the 8,000 acres of tidal restoration is currently in the planning and development stage. The USFWS BiOp requires that this restoration be completed within 10 years (i.e., 2018) and several non-federal agencies are involved in implementation, including DWR and the State and Federal Contractors Water Agency (SFCWA).

NMFS BiOp RPA. The NMFS BiOp concluded that the long-term operations of the CVP/SWP were likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead, Southern distinct population segment (DPS) of North American green sturgeon, and Southern Resident DPS of killer whale. In addition, the NMFS BiOp concluded that the long-term operations of the CVP/SWP were likely to destroy or adversely modify designated critical habitat for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead and proposed (subsequently designated) critical habitat for the Southern DPS of North American green sturgeon. Therefore, the NMFS BiOp included an RPA consisting of a suite of actions that addressed Delta and upstream conditions throughout the CVP/SWP to avoid jeopardy of these species and the destruction or adverse modification of critical habitat for these species. Many of the in-Delta activities are included in the PA (Table 3.1-1).

Several components of the NMFS BiOP RPA have been implemented or are in the planning stages. Examples include the Delta operational changes that have been implemented since 2009 that are intended to reduce entrainment loss of Chinook salmon and steelhead; current planning efforts for the restoration of the Yolo Bypass; changes in water operations to improve temperature conditions for aquatic resources in the Sacramento, American, and Stanislaus Rivers; adjustments to the operations of the Suisun Marsh Salinity Control Gates and the Delta Cross Channel Gates; investigation into the efficacy of non-physical barriers in the Delta to improve salmonid survival; upstream habitat improvement projects; and a host of monitoring activities, studies, and investigations to better understand the ongoing effects of CVP/SWP operations.

Many of the RPA actions are implemented in areas that are expected to be unaffected by the PA but they provide benefits to the species addressed in this biological assessment; thereby improving the viability of the species. These include actions such as operational (including flow ramping rates) and physical habitat restoration activities in the Upper Sacramento River, Clear Creek, American River, and Stanislaus River and a Battle Creek restoration project. Additionally, several actions in the RPA include climate change adaptation measures that are difficult to quantify or measure, but that when implemented, should substantially improve the resilience of these species to climate change and the ongoing effects of the CVP/SWP.

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to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta (Jassby et al. 1995).

4.3.4 Mitigation Measures Included in the 2009 State Water Project Longfin Smelt Incidental Take Permit

The 2009 SWP Longfin Smelt Incidental Take Permit (ITP) was issued by the California Department of Fish and Wildlife (CDFW) on February 23, 2009, subject to DWR's compliance with and implementation of Conditions of Approval. Several conditions have the potential to affect species addressed in this BA. Conditions include minimizing entrainment at SWP Banks Pumping Plant (Conditions 5.1 and 5.2), minimizing entrainment at Morrow Island Distribution System (MIDS) (in Suisun Marsh) (Condition 6.1), improving salvage efficiencies (Conditions 6.2 and 6.3), maintaining fish screens at North Bay Aqueduct (NBA), Roaring River Distribution System (RRDS), and Sherman Island diversions (Condition 6.4), fully mitigating through the restoration of 800 acres of inter-tidal and associated sub-tidal wetland habitat in a mesohaline part of the estuary (Conditions 7.1–7.3), and monitoring and reporting (Conditions 8.1-8.5). Conditions 5.1 and 5.2 are being implemented through DWR's participation in the smelt working group. Conditions 6.1 through 6.4 are currently being planned and implemented and are in various stages of completion. Conditions 7.1 through 7.3 are being planned consistent with the planning for restoration required for the USFWS BiOp (2008) RPA described above. Additionally, the various monitoring programs required in Conditions 8.1–8.5 are being planned or implemented consistent with the settlement agreement associated with the permit.

4.3.5 Recent Drought Activities

In 2014, California experienced its third year of drought conditions. This section describes some of the key activities that have occurred. Section 4.5, *Status of the Species/Environmental Baseline Summary*, below describes the species-specific effects caused by the drought and associated activities. Water year 2012 was categorized as below normal, calendar year 2013 was the driest year in recorded history for many parts of California, and water year 2014 began on a similar dry trend (State Water Resources Control Board 2014a). In May 2013, Governor Edmund G. Brown, Jr. issued Executive Order B-21-13, which directed the State Water Board and DWR to take immediate action to address dry conditions and water delivery limitations. The Department of Water Resources and the United States Bureau of Reclamation (collectively referred to as Petitioners) filed a Temporary Urgency Change Petition (TUCP) with the State Water Resources Control Board (State Water Board), Division of Water Rights on January 29, 2014, pursuant to California Water Code section 1435[3]. The TUCP was conditionally approved by the State Board on January 29, 2014 and modified on February 7, February 28, March 18, April 9, April 11, and April 18, 2014, to extend and change the conditions. On April 29, 2014, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441, which allows temporary change orders to be renewed for up to 180 additional days. On May 2, 2014, the State Water Board issued an Order approving the April 29, 2014 TUCP modification and renewal pursuant to Water Code section 1438(a), which allows the State Water Board to issue a temporary change order in advance of public noticing requirements. The May 2, 2014 Order: (1) extended a change to Delta outflow

[3] A full chronology of the TUCP and all of its modifications and associated materials (e.g., biological reviews for endangered species compliance) is provided by SWRCB at http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/index.shtml.

requirements to May and July[4]; (2) changed the Western Delta electrical conductivity requirement by moving the compliance point from Emmaton to Threemile Slough during May through August 15; and (3) changed the Sacramento River at Rio Vista flow requirement from 3,000 cubic feet per second (cfs) to 2,000 cfs during September through November 15 (State Water Resources Control Board 2014b). The State Board received eight Petitions for Reconsideration of the January 31, 2014 TUCP and subsequent modifications. The State Water Board denied these petitions; however, changes to the TUCP were made to improve planning and coordination based upon these petitions (State Water Resources Control Board 2014a).

As of 2015, California is in its fourth consecutive year of below-average rainfall and very low snowpack. Water Year 2015 is also the eighth of nine years with below-average runoff, which has resulted in chronic and significant shortages to municipal and industrial, agricultural, and refuge water supplies and historically low levels of groundwater. As of May 2015, 66% of the state was experiencing an Extreme Drought and 46% was experiencing an Exceptional Drought, as recorded by the National Drought Mitigation Center, U.S. Drought Monitor. Of particular concern is the state's critically low snow pack, which provides much of California's seasonal water storage. On April 1, 2015, DWR found no snow at the Phillips snow course for the first time in 75 years of early-April measurements (California Department of Water Resources 2015). The lack of precipitation over the last several years has also contributed to low reservoir storage levels in the Sacramento watershed. Lake Shasta on the Sacramento River, Oroville Reservoir on the Feather River, and Folsom Lake on the American River were at 55%, 46%, and 57% of capacity, respectively, on May 22, 2015 (64%, 55%, and 70% of average for February, respectively). Trinity Lake (water from the Trinity system is transferred to the Sacramento River system) on the Trinity River was at 36% of capacity and 48% of the February average. The San Joaquin River Watershed in particular has experienced severely dry conditions for the past three years as indicated by rainfall and snowpack (State Water Resources Control Board 2015).

As was done in 2013, California Governor Edmund G. Brown has issued a Drought Emergency Proclamation that is effective through May 31, 2016, and which directs the State Water Board to, among other things, consider petitions, such as the TUCPs to modify requirements for reservoir releases or diversion limitations that were established to implement a water quality control plan. On January 23, 2015, the Petitioners jointly filed a TUCP pursuant to Water Code section 1435 et seq., to temporarily modify requirements in their water right permits and license for the CVP/SWP for the next 180 days, with specific requests for February and March of 2015. The TUCP requested temporary modification of requirements included in State Water Board Revised D-1641 to meet water quality objectives in the Water Quality Control Plan (Plan) for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary. The TUCP requested modifications to water right requirements to meet the Delta outflow, San Joaquin River flow, DCC closure, and export limits objectives. The Petitioners requested these temporary modifications in February and March in order to respond to unprecedented critically dry hydrological conditions as California entered its fourth straight year of below-average rainfall and snowmelt runoff. The TUCP also identified possible future modification requests for the period from April to September (State Water Resources Control Board 2015).

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[4] The order approved modification in April and July to 3,000 cfs (instead of the 4,000 cfs that would otherwise be required).

On February 3, 2015, the State Water Board issued an order approving in part the TUCP[5], subject to conditions. The State Water Board then modified the February 3, 2015 Order on March 5, 2015, and on April 6, 2015. On May 21, 2015, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441, which allows temporary change orders to be renewed for up to 180 additional days. A July 3, 2015 Order approved the May 21, 2015 request. On February 3, 2015, the State Water Board issued an Order that took action on the January 23, 2015 TUCP. The February Order approved temporary changes to D-1641 requirements during February and March. On March 5, 2015, State Water Board issued an Order that modified the February 3 Order in response to the January 23, 2015 TUCP. On March 24, 2015, the Petitioners requested approval of additional changes to D-1641 flow and water quality requirements through November of 2015. On April 6, 2015, the State Water Board issued an Order, which extended the changes to Delta outflow and export requirements through June, and extended the change to the DCC Gate closure requirement through May 20, 2015. On May 18, 2015 Reclamation submitted an *Updated Project Description for July-November 2015 Drought Response Actions to Support Endangered Species Act Consultations* (Project Description), *Biological Review for Endangered Species Act Compliance of the WY 2015 Updated Drought Contingency Plan for July–November Project Description* (Biological Review), *Revised Sacramento River Water* Temperature Management Plan *June 2015* (Temperature Management Plan), and an *Updated Biological Information for June 2015 Temperature Management Plan* to NMFS and on June 25, 2015 requested concurrence that the operations described are within the limits of the Incidental Take Statement of the CVP/SWP 2009 BiOp and serves as the Contingency Plan under NMFS BiOp Action I.2.3.C through November 2015. On July 1, 2015, NMFS concurred that Reclamation's May 18, 2015 Project Description (with the exception of the Shasta Operations/Keswick Release Schedule, which was superseded with the June 25, 2015 Sacramento River temperature management plan) is consistent with RPA Action I.2.3.C and meets the specified criteria for a contingency plan (National Marine Fisheries Service 2015). On May 21, 2015, the Petitioners submitted a request to the State Water Board to modify and renew the TUCP Order pursuant to Water Code section 1441. The State Water Board issued an Order acting on this request on July 3, 2015.

Reclamation filed a TUCP with the State Water Board on June 17, 2015 in order to temporarily change terms of Reclamation's permits for the New Melones Project on the Stanislaus River requiring implementation of the dissolved oxygen objective on the Stanislaus River. Specifically, the TUCP requests temporary changes to permit conditions included in State Water Board Decisions 1422 and 1641, requiring that Reclamation attain the minimum dissolved oxygen objective on the Stanislaus River below Goodwin Dam as specified in the Central Valley Regional Water Quality Control Board's Plan for the Sacramento River and San Joaquin River Basins. This petition was approved by the State Water Board, subject to conditions, on August 4, 2015. On May 22, 2015 Reclamation submitted the Project Description and Biological Review to

[5] Specifically, during February–March, the order modified minimum monthly Delta outflows to 4,000 cfs; modified minimum monthly San Joaquin River flows at Vernalis to 500 cfs; allowed the DCC Gates to be opened consistent with triggers to protect fish species; and added export constraints to allow exports of 1,500 cfs when Delta outflows were below 7,100 cfs regardless of DCC Gate status and allowed exports up to D-1641 limits when Delta outflows were above 7,100 cfs and the DCC Gates are closed.

USFWS and on June 25, 2015 submitted supplemental information to USFWS and requested concurrence that the effects of the proposed operations in the May 22, 2015 Project Description are consistent with the range of effects analyzed in the USFWS BiOp. On June 26, 2015, USFWS accepted Reclamation's determination that the effects of operations in the Project Description were consistent with the effects analyzed in the USFWS BiOp (U.S. Fish and Wildlife Service 2015).

On July 2, 2015, CDFW confirmed that the existing October 14, 2011 consistency determinations for the USFWS BiOp and April 26, 2012 consistency determination for the NMFS BiOp remained in effect and no further authorization was necessary. Additionally, CDFW confirmed that operations under the Project Description would not affect California Endangered Species Act (CESA) coverage under the Longfin ITP, and that conditions in the Longfin ITP would not be affected (California Department of Fish and Wildlife 2015).The drought conditions over the last 4 years have had substantial impacts on fish and wildlife species and their habitats. As previously noted, Reclamation and DWR submitted biological reviews of listed fish species of concern for the TUCP, in order to review species status and assess potential effects of TUCP modifications. In 2015, these reviews included the *Smelt Supporting Information for Endangered Species Act Compliance for Temporary Urgency Change Petition Regarding Delta Water Quality* (Bureau of Reclamation 2015a) and the *Salmonid and Green Sturgeon Supporting Information for Endangered Species Act Compliance for Temporary Urgency Change Petition Regarding Delta Water Quality* (Bureau of Reclamation 2015b), which were submitted as part of the January 23, 2015, TUCP. Subsequent biological reviews were provided as part of the TUCP, and covered April through September[6] and July through November 15.[7] A summary of drought effects on each species covered in this BA is provided in Section 4.5, *Status of the Species/Environmental Baseline Summary*.

Please refer to Section 3.7, *Drought Procedures*, for a discussion of how any future drought conditions will be addressed under the PA.

4.4 Feather River Operations Consultation

As part of the SWP, DWR operates the Oroville Facilities on the Feather River under a license from the Federal Energy Regulatory Commission (FERC). As part of the FERC process for relicensing the Oroville Facilities, NMFS is consulting with FERC under ESA Section 7 regarding effects on listed species under NMFS' jurisdiction from FERC's proposed relicensing the Oroville Facilities. NMFS released a draft BiOp for FERC relicensing of the Oroville Facilities in July 2009. A final BiOp is scheduled for release in spring of 2016.

The original FERC license to operate the Oroville Facilities expired in January 2007. Since then, an annual license that renews automatically each year has been issued, authorizing DWR to continue operating to the terms of the original FERC license until the new license is issued. To prepare for the expiration of the original FERC license, DWR began working on the relicensing

[6] See http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/biorev2_aprsep.pdf.
[7] See http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp052115.pdf.

process in 2001. As part of the process, DWR entered into a Settlement Agreement (SA), signed in 2006, with state, federal, and local agencies; state water contractors; non-governmental organizations; a tribal government; and others to implement improvements within the FERC boundary. The FERC boundary includes all of the Oroville Facilities, including Lake Oroville, and extends downstream of Oroville Dam to include portions of the Low Flow Channel (LFC) on the lower Feather River and portions of the High Flow Channel (HFC) of the Lower Feather River downstream of the Thermalito Afterbay Outlet. In addition to the SA, a Habitat Expansion Agreement was negotiated with NMFS and others to address the effects of the Oroville Facilities on anadromous fish in the Feather River, and to provide an alternative to NMFS and USFWS exercising their authority to prescribe fish passage under Federal Power Act Section 18.

In 2010, the State Water Resources Control Board issued the Clean Water Act Section 401 Certification for FERC relicensing of the Oroville Facilities, analyzing the SA-proposed conditions. Although the new FERC license has not been issued, it is anticipated to include the SA license terms and conditions from Appendix A and the terms and conditions of the Clean Water Act Section 401 Certification. DWR will also comply with the requirements in the NMFS BiOp after it is issued to FERC and FERC relicenses the Oroville Facilities. It is anticipated that the new FERC license will be issued for a period of up to 50 years. The FERC license and its associated agreements and permits will be the primary regulatory drivers for operations at the Oroville Facilities. Operational requirements in the forthcoming license and associated permits are expected to include minimum channel flows, water temperature, and ramping rates. These requirements will need to be met, along with any other requirements imposed on the SWP through this consultation. The analysis below describes the similarities in the proposed operations in the FERC SA and the PA, and why no conflicts between these operations is expected.

The operations modeled for the No Action Alternative (NAA) and the PA in this BA are similar to the operations modeled in DWR's BA for FERC relicensing of the Oroville Facilities. The modeling assumptions for the NAA and the PA in this BA incorporated flow requirements specified in the SA (Table 4-1). Because the NMFS BiOp for FERC relicensing of the Oroville Facilities is not yet final, the draft BiOp terms and conditions were not included in the modeling assumptions. However, for purposes of understanding potential differences between what was assumed for the modeling of the NAA and the PA in this BA and what is expected to be included in the NMFS BiOp for FERC relicensing of the Oroville Facilities on the Feather River, various flow requirements were compared (Table 4-1). As shown, the majority of assumed criteria for Feather River minimum instream flow in the NAA and the PA modeling are the same as those included in the NMFS Draft BiOp for FERC Oroville Facilities relicensing. One exception is the pulse flow target flows in March, April, and May in the NMFS Draft BiOp, which were not part of the SA and were not assumed in the modeling of the NAA and the PA in this BA.

As shown, the pulse flow targets at the southern end of the FERC boundary range from 2-day pulses to 12-day pulses of 7,000 cubic feet per second (cfs) in wet and above normal water years. Based on the input from the Green Sturgeon Technical Subcommittee of the Feather River Technical Team, two additional 2-day (48-hour) pulse flows of sufficient magnitude and duration to improve passage impediments and facilitate upstream movement of adult sturgeon may be provided. There is uncertainty as to what future pulse flow specifications NMFS might include in the Final BiOp for FERC relicensing of the Oroville Facilities because of changing river bathymetric conditions. The 12-day pulse under the NMFS Draft BiOp in March requires approximately 165 TAF of flow released from Oroville Facilities. The two pulses in April and May require approximately 56 TAF and 28 TAF, respectively. Given that these short-duration pulse flows are limited to wetter conditions and relatively small in volume, their effect on the available coldwater pool in Lake Oroville for the months following the pulse is expected to be small. Should these pulse flow operations remain in the final NMFS BiOp for FERC relicensing of the Oroville Facilities, DWR will implement them in coordination with other SWP operations, including the PA described in this BA. Given the similarities between assumed Feather River operations criteria in the NAA and PA modeling for this BA, and the conditions in the NMFS Draft BiOp (Table 4-1), the PA is not expected to affect the ability to meet the conditions analyzed in the final NMFS BiOp for FERC relicensing of the Oroville Facilities.

Table 4-2 shows the availability of Temperature Control Actions (TCAs) from the FERC DEIR PA modeling. Because the Feather River flow requirements and all the water temperature objectives for the NAA in the current BA are the same as those analyzed in the FERC Oroville Facilities relicensing BA and the Oroville Facilities Relicensing Draft Environmental Impact Report Proposed Project Alternative (FERC DEIR PA) modeling, conditions under NAA would be similar to those of the FERC DEIR PA. Given that modeling for the PA would result in storage conditions in Oroville (Table 4-3) that would be similar to those of the NAA, as well as similar temperature conditions in the LFC (
Table 4-4 and Table 4-5), conditions under the PA at the two common water temperature compliance locations, the Feather River Fish Hatchery (FRFH) and Robinson Riffle, would be expected to be similar to the FERC DEIR PA.

Even if the Oroville storage conditions under the PA were lower than the conditions that were modeled in the FERC DEIR PA, the PA would utilize the TCAs described in the SA. As noted in the Table 4-2, not all the TCAs were required to meet the temperature requirements at FRFH and Robinson Riffle under FERC DEIR PA modeling; if needed, the PA can utilize the remaining TCAs. With ability to exercise various TCAs outlined in the SA, DWR is expected to have enough flexibility to meet the minimum instream flow and temperature requirements outlined in the NMFS Draft BiOp without significantly affecting the operations resulting from the PA.

In conclusion, modeling of the Oroville Facilities conducted as part of the Oroville Facilities Relicensing EIR, BA, and draft BiOp is consistent with modeling conducted for the PA in this BA. Although the TCAs taken to achieve the water temperatures could be different under the PA modeling, flows and temperatures in the Feather River LFC and FRFH are expected to be generally similar under the PA and the NMFS BiOp for relicensing of the Oroville Facilities. Therefore, no additional analysis of those operations and associated effects is included in this BA. However, the effects of the Oroville Facilities operations are considered as part of the status of the species and critical habitat as applicable.

Table 4-1. Feather River Minimum Instream Flow Requirements Included in the Oroville Facilities Settlement Agreement and California WaterFix BA PA Modeling Compared to the NMFS Draft BiOp.

	Oroville Facilities Settlement Agreement, and California WaterFix BA No Action Alternative and PA Modeling	NMFS Draft BiOp
Minimum Flow in Feather River LFC	700 cfs, except from September 9 to March 31 of each year to accommodate spawning of anadromous fish release (800 cfs).	Same
Minimum Flow in Feather River HFC	Consistent with existing license and 1983 DWR-CDFW agreement (750–1,700 cfs)	Same
Additional Pulse Flows	None	In wet and above normal water years, target flows: Mar 1–12: 7,000 cfs Apr 1–30: two 48-hour, 7,000 cfs pulse flows May 1–31: one 48-hour, 7,000 cfs pulse flow In below normal and dry water years, convene Green Sturgeon Technical Team and Feather River Technical Team to determine if pulse flows are warranted. In Mar–Apr, if directed, provide two 48-hour, 2,500 cfs pulse flows

Table 4-2. Annual Availability of Oroville Facilities Temperature Management Actions in the Oroville Facilities Relicensing DEIR PA Alternative Simulation.

Temperature Management Action	Number of Years Utilized	Remaining Years of Availability
Pumpback curtailment[1]	74	0
Remove all shutter on the Hyatt Intake[2]	2	72
Increase LFC flow to 1,500 cfs[3]	10	64
Release 1,500 cfs from the river valve[4]	3	71

Source: *Oroville Facilities Relicensing DEIR Proposed Project Simulation*.
Period of Record: 1992–1994.
[1] Pumpback curtailed for at least a portion of the year.
[2] All 13 shutters are removed from the Hyatt Intake.
[3] For Robinson Riffle water temperature objective only.
[4] For Feather River Fish Hatchery water temperature objective only; river valve is operational.

Table 4-3. End-of-Month Oroville Storage Modeling Results for the NAA and the PA

Statistic	End of Month Storage (TAF)																							
	October				November				December				January				February				March			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	2,051	2,070	19	1%	2,112	2,173	61	3%	2,712	2,706	-6	0%	2,788	2,788	0	0%	2,917	2,919	2	0%	3,035	3,049	14	0%
20%	1,779	1,915	136	8%	1,799	1,951	152	8%	2,031	2,175	144	7%	2,610	2,788	178	7%	2,788	2,788	0	0%	2,964	2,964	0	0%
30%	1,612	1,756	145	9%	1,656	1,760	104	6%	1,793	1,984	190	11%	2,287	2,356	69	3%	2,788	2,788	0	0%	2,897	2,933	37	1%
40%	1,364	1,526	161	12%	1,374	1,495	120	9%	1,583	1,720	137	9%	1,941	2,191	250	13%	2,553	2,658	105	4%	2,788	2,809	21	1%
50%	1,257	1,378	121	10%	1,249	1,355	107	9%	1,391	1,524	133	10%	1,703	1,875	172	10%	2,176	2,449	272	13%	2,646	2,777	132	5%
60%	1,165	1,248	83	7%	1,138	1,238	100	9%	1,252	1,259	7	1%	1,595	1,607	12	1%	1,892	1,976	84	4%	2,261	2,341	80	4%
70%	1,098	1,163	65	6%	1,022	1,118	96	9%	1,093	1,211	118	11%	1,298	1,342	44	3%	1,677	1,728	51	3%	2,041	2,133	92	5%
80%	999	1,059	60	6%	958	1,004	46	5%	983	1,083	100	10%	1,147	1,233	86	7%	1,432	1,473	41	3%	1,706	1,737	31	2%
90%	906	929	22	2%	890	921	31	3%	903	957	54	6%	1,007	1,076	69	7%	1,244	1,254	10	1%	1,491	1,518	27	2%
Long Term																								
Full Simulation Period[b]	1,399	1,480	81	6%	1,390	1,470	80	6%	1,565	1,644	79	5%	1,830	1,912	81	4%	2,146	2,209	64	3%	2,387	2,435	47	2%
Water Year Types[c]																								
Wet (32%)	1,919	1,978	58	3%	1,877	1,943	66	4%	1,996	2,079	83	4%	2,185	2,297	112	5%	2,830	2,858	28	1%	2,942	2,942	0	0%
Above Normal (16%)	1,507	1,602	95	6%	1,488	1,579	91	6%	1,583	1,675	91	6%	1,773	1,858	85	5%	2,516	2,612	96	4%	2,892	2,927	36	1%
Below Normal (13%)	1,239	1,412	173	14%	1,174	1,348	174	15%	1,301	1,459	158	12%	1,712	1,851	138	8%	2,125	2,228	103	5%	2,400	2,526	126	5%
Dry (24%)	1,079	1,155	76	7%	1,145	1,210	65	6%	1,501	1,553	52	3%	1,753	1,793	40	2%	1,583	1,659	76	5%	1,939	2,012	73	4%
Critical (15%)	836	873	37	4%	835	874	38	5%	961	991	30	3%	1,362	1,389	27	2%	1,218	1,269	51	4%	1,376	1,423	46	3%

Statistic	End of Month Storage (TAF)																							
	April				May				June				July				August				September			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	3,352	3,352	0	0%	3,538	3,538	0	0%	3,538	3,538	0	0%	3,037	2,944	-92	-3%	2,758	2,639	-119	-4%	2,217	2,242	24	1%
20%	3,298	3,298	0	0%	3,538	3,538	0	0%	3,535	3,528	-8	0%	2,952	2,889	-63	-2%	2,516	2,429	-87	-3%	1,960	2,094	133	7%
30%	3,268	3,274	6	0%	3,475	3,475	0	0%	3,357	3,202	-154	-5%	2,746	2,635	-111	-4%	2,313	2,201	-112	-5%	1,824	1,848	24	1%
40%	3,208	3,215	7	0%	3,312	3,375	63	2%	3,103	2,993	-110	-4%	2,468	2,384	-84	-3%	1,979	2,048	69	3%	1,522	1,734	212	14%
50%	2,925	3,044	120	4%	3,018	3,078	60	2%	2,831	2,798	-32	-1%	2,201	2,166	-35	-2%	1,718	1,802	84	5%	1,331	1,545	213	16%
60%	2,600	2,657	57	2%	2,690	2,779	89	3%	2,448	2,430	-18	-1%	1,821	1,866	45	2%	1,508	1,514	6	0%	1,256	1,394	139	11%
70%	2,218	2,283	66	3%	2,300	2,332	32	1%	2,015	2,101	86	4%	1,448	1,610	162	11%	1,247	1,279	32	3%	1,203	1,244	41	3%
80%	1,900	1,857	-43	-2%	1,860	1,933	72	4%	1,682	1,763	81	5%	1,241	1,294	53	4%	1,130	1,225	95	8%	1,075	1,136	61	6%
90%	1,661	1,654	-6	0%	1,512	1,578	65	4%	1,306	1,359	54	4%	1,138	1,218	80	7%	986	1,102	116	12%	897	977	80	9%
Long Term																								
Full Simulation Period[b]	2,654	2,695	41	2%	2,749	2,793	43	2%	2,602	2,593	-9	0%	2,118	2,108	-10	0%	1,817	1,815	-2	0%	1,512	1,601	89	6%
Water Year Types[c]																								
Wet (32%)	3,300	3,300	0	0%	3,486	3,488	1	0%	3,439	3,383	-56	-2%	2,958	2,876	-82	-3%	2,619	2,548	-71	-3%	2,102	2,163	61	3%
Above Normal (16%)	3,246	3,262	16	1%	3,392	3,410	18	1%	3,231	3,122	-109	-3%	2,598	2,497	-101	-4%	2,115	2,061	-54	-3%	1,657	1,738	81	5%
Below Normal (13%)	2,656	2,776	119	4%	2,716	2,832	116	4%	2,530	2,584	54	2%	1,922	1,960	38	2%	1,512	1,586	75	5%	1,307	1,503	196	15%
Dry (24%)	2,178	2,251	73	3%	2,209	2,288	78	4%	1,957	2,011	54	3%	1,476	1,544	68	5%	1,284	1,326	41	3%	1,146	1,247	102	9%
Critical (15%)	1,401	1,436	35	2%	1,388	1,423	35	3%	1,248	1,289	42	3%	1,028	1,097	68	7%	925	984	59	6%	874	912	38	4%

a Exceedance probability is defined as the probability a given value will be exceeded in any one year.

b Based on the 82-year simulation period.

c As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999); projected to Year 2030. WYT for a given water year is applied from Feb through Jan consistent with CALSIM II.

d There are 26 wet years, 13 above normal years, 11 below normal years, 20 dry years, and 12 critical years projected for 2030 under Q5 climate scenario.

Table 4-4. Modeled Feather River Low Flow Channel near Fish Dam Monthly Temperature for the NAA and the PA

Statistic	Monthly Temperature (Deg-F)																							
	October				November				December				January				February				March			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	57.9	58.2	0.3	1%	58.9	58.9	0.0	0%	54.8	54.3	-0.5	-1%	51.4	51.5	0.1	0%	51.5	51.5	0.0	0%	53.4	53.4	0.0	0%
20%	56.0	55.6	-0.4	-1%	57.8	57.4	-0.4	-1%	54.0	53.4	-0.6	-1%	50.4	50.5	0.1	0%	50.9	51.1	0.2	0%	52.7	52.8	0.1	0%
30%	54.8	54.6	-0.2	0%	56.6	56.0	-0.6	-1%	53.1	53.0	-0.1	0%	49.8	49.9	0.1	0%	50.5	50.8	0.3	1%	51.7	51.9	0.2	0%
40%	54.1	54.0	-0.1	0%	56.0	55.2	-0.8	-1%	52.6	52.3	-0.3	-1%	49.4	49.4	0.0	0%	50.0	50.0	0.0	0%	51.4	51.3	-0.1	0%
50%	54.0	53.6	-0.4	-1%	55.4	54.8	-0.6	-1%	52.2	51.9	-0.3	-1%	49.2	49.3	0.1	0%	49.6	49.8	0.2	0%	50.8	50.8	0.0	0%
60%	53.7	53.4	-0.3	-1%	55.0	53.6	-1.4	-3%	51.6	51.5	-0.1	0%	48.8	48.8	0.0	0%	49.3	49.4	0.1	0%	50.1	50.2	0.1	0%
70%	53.3	53.2	-0.1	0%	54.2	52.8	-1.4	-3%	51.3	51.0	-0.3	-1%	48.1	48.2	0.1	0%	48.9	49.0	0.1	0%	49.6	49.7	0.1	0%
80%	53.2	53.1	-0.1	0%	52.8	52.5	-0.3	-1%	50.8	50.5	-0.3	-1%	47.5	47.7	0.2	0%	48.5	48.4	-0.1	0%	49.3	49.0	-0.3	-1%
90%	53.0	52.9	-0.1	0%	52.3	52.2	-0.1	0%	49.6	49.5	-0.1	0%	47.0	47.0	0.0	0%	47.6	47.7	0.1	0%	48.4	48.5	0.1	0%
Long Term																								
Full Simulation Period[b]	55.0	54.8	-0.2	0%	55.6	55.0	-0.6	-1%	52.2	52.0	-0.2	0%	49.1	49.2	0.1	0%	49.6	49.7	0.1	0%	50.9	50.9	0.0	0%
Water Year Types[c]																								
Wet (32%)	53.5	53.4	0.0	0%	54.7	54.3	-0.5	-1%	52.9	52.6	-0.4	-1%	50.1	50.1	0.0	0%	48.7	48.8	0.1	0%	49.4	49.4	0.0	0%
Above Normal (16%)	53.5	53.3	-0.1	0%	54.5	54.1	-0.5	-1%	51.9	51.8	-0.2	0%	48.8	49.0	0.1	0%	45.9	45.9	0.0	0%	46.1	46.0	0.0	0%
Below Normal (13%)	54.5	54.3	-0.2	0%	55.6	54.5	-1.1	-2%	52.2	51.5	-0.7	-1%	48.2	48.3	0.1	0%	50.2	50.3	0.1	0%	51.6	51.8	0.2	0%
Dry (24%)	55.5	54.9	-0.6	-1%	55.9	55.2	-0.7	-1%	52.1	52.0	-0.1	0%	46.5	46.6	0.1	0%	49.9	50.1	0.2	0%	52.3	52.2	-0.1	0%
Critical (15%)	59.5	59.3	-0.3	0%	57.8	57.4	-0.4	-1%	51.2	51.3	0.1	0%	48.1	48.2	0.1	0%	50.3	50.4	0.1	0%	52.1	52.0	-0.1	0%

Statistic	Monthly Temperature (Deg-F)																							
	April				May				June				July				August				September			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	53.8	53.6	-0.2	0%	56.9	56.9	0.0	0%	58.8	58.7	-0.1	0%	62.7	62.4	-0.3	0%	62.7	62.9	0.2	0%	59.8	58.3	-1.5	-3%
20%	53.1	52.8	-0.3	-1%	56.5	56.6	0.1	0%	58.5	58.4	-0.1	0%	61.9	62.0	0.1	0%	62.0	62.2	0.2	0%	57.1	57.3	0.2	0%
30%	52.4	52.4	0.0	0%	56.2	56.3	0.1	0%	58.3	58.2	-0.1	0%	61.4	61.5	0.1	0%	61.5	61.5	0.0	0%	56.8	56.7	-0.1	0%
40%	52.2	52.2	0.0	0%	56.0	56.0	0.0	0%	58.2	57.9	-0.3	-1%	61.2	61.3	0.1	0%	60.8	61.0	0.2	0%	55.5	56.4	0.9	2%
50%	51.9	51.9	0.0	0%	55.9	55.9	0.0	0%	58.0	57.8	-0.2	0%	61.1	61.1	0.0	0%	60.4	60.7	0.3	0%	54.9	56.1	1.2	2%
60%	51.7	51.7	0.0	0%	55.7	55.8	0.1	0%	57.8	57.5	-0.3	-1%	61.1	61.0	-0.1	0%	60.3	60.4	0.1	0%	54.7	55.3	0.6	1%
70%	51.3	51.3	0.0	0%	55.3	55.3	0.0	0%	57.6	57.4	-0.2	0%	60.9	61.0	0.1	0%	60.1	60.2	0.1	0%	54.6	55.0	0.4	1%
80%	50.6	50.7	0.1	0%	54.9	54.9	0.0	0%	57.5	57.3	-0.2	0%	60.9	60.9	0.0	0%	59.9	60.0	0.1	0%	54.5	54.8	0.3	1%
90%	50.2	50.2	0.0	0%	54.5	54.5	0.0	0%	57.2	57.0	-0.2	0%	60.8	60.7	-0.1	0%	59.7	59.7	0.0	0%	54.3	54.6	0.3	1%
Long Term																								
Full Simulation Period[b]	52.0	51.9	0.0	0%	55.8	55.8	0.0	0%	58.0	57.8	-0.2	0%	61.4	61.4	0.0	0%	61.0	61.0	0.0	0%	56.1	56.3	0.2	0%
Water Year Types[c]																								
Wet (32%)	50.9	51.0	0.0	0%	55.1	55.1	0.0	0%	57.8	57.5	-0.2	0%	61.3	61.2	-0.1	0%	60.5	60.6	0.2	0%	54.5	54.8	0.3	0%
Above Normal (16%)	48.0	47.9	-0.1	0%	51.9	51.9	0.0	0%	53.6	53.3	-0.4	-1%	56.2	56.2	0.0	0%	55.3	55.5	0.2	0%	50.3	50.7	0.4	1%
Below Normal (13%)	52.6	52.5	-0.1	0%	55.9	55.9	0.0	0%	58.1	57.8	-0.3	0%	61.0	61.0	0.0	0%	60.4	60.6	0.2	0%	56.0	57.0	1.0	2%
Dry (24%)	52.6	52.7	0.0	0%	56.0	56.0	0.0	0%	57.9	57.9	-0.1	0%	61.3	61.4	0.1	0%	61.5	61.3	-0.2	0%	56.8	57.0	0.2	0%
Critical (15%)	52.4	52.4	-0.1	0%	56.4	56.4	0.0	0%	58.6	58.6	0.1	0%	62.8	62.7	-0.1	0%	62.8	62.5	-0.2	0%	60.2	59.3	-0.9	-2%

a Exceedance probability is defined as the probability a given value will be exceeded in any one year.

b Based on the 82-year simulation period.

c As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999); projected to Year 2030. WYT for a given water year is applied from Feb through Jan consistent with CALSIM II.

d There are 26 wet years, 13 above normal years, 11 below normal years, 20 dry years, and 12 critical years projected for 2030 under Q5 climate scenario.

Table 4-5. Modeled Feather River Low Flow Channel at Robinson Riffle Monthly Temperature for the NAA and the PA

Statistic	Monthly Temperature (Deg-F)																							
	October				November				December				January				February				March			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	59.7	59.6	-0.1	0%	58.3	58.2	-0.1	0%	53.3	53.1	-0.2	0%	50.7	50.7	0.0	0%	52.4	52.3	-0.1	0%	54.9	54.8	-0.1	0%
20%	58.1	58.2	0.1	0%	57.1	56.8	-0.3	-1%	52.9	52.4	-0.5	-1%	50.0	49.9	-0.1	0%	51.5	51.5	0.0	0%	54.1	54.2	0.1	0%
30%	56.9	56.8	-0.1	0%	56.3	55.8	-0.5	-1%	52.1	51.9	-0.2	0%	49.5	49.7	0.2	0%	51.0	51.2	0.2	0%	53.5	53.5	0.0	0%
40%	56.6	56.6	0.0	0%	55.8	54.8	-1.0	-2%	51.7	51.3	-0.4	-1%	49.0	49.1	0.1	0%	50.7	50.7	0.0	0%	52.8	52.8	0.0	0%
50%	56.3	56.1	-0.2	0%	55.2	54.6	-0.6	-1%	51.1	51.1	0.0	0%	48.7	48.8	0.1	0%	50.3	50.5	0.2	0%	52.1	52.2	0.1	0%
60%	56.0	55.9	-0.1	0%	54.8	53.8	-1.0	-2%	50.6	50.5	-0.1	0%	48.2	48.3	0.1	0%	50.0	50.1	0.1	0%	51.9	51.8	-0.1	0%
70%	55.7	55.5	-0.2	0%	54.4	53.5	-0.9	-2%	50.4	50.2	-0.2	0%	47.8	47.8	0.0	0%	49.7	49.8	0.1	0%	51.4	51.3	-0.1	0%
80%	55.2	55.1	-0.1	0%	53.5	52.9	-0.6	-1%	50.1	49.8	-0.3	-1%	47.4	47.5	0.1	0%	49.0	49.0	0.0	0%	50.9	50.9	0.0	0%
90%	54.8	54.8	0.0	0%	52.6	52.3	-0.3	-1%	49.1	48.9	-0.2	0%	46.3	46.6	0.3	1%	48.2	48.2	0.0	0%	50.1	50.1	0.0	0%
Long Term																								
Full Simulation Period[b]	57.0	56.8	-0.2	0%	55.4	54.9	-0.5	-1%	51.3	51.1	-0.2	0%	48.6	48.7	0.1	0%	50.3	50.3	0.1	0%	52.5	52.5	0.0	0%
Water Year Types[c]																								
Wet (32%)	55.6	55.6	0.0	0%	54.7	54.3	-0.4	-1%	51.9	51.6	-0.3	-1%	49.6	49.6	0.0	0%	49.6	49.6	0.1	0%	51.2	51.2	0.0	0%
Above Normal (16%)	55.7	55.5	-0.1	0%	54.3	53.9	-0.4	-1%	50.9	50.8	-0.1	0%	48.3	48.4	0.1	0%	46.5	46.5	0.0	0%	47.8	47.8	0.0	0%
Below Normal (13%)	56.6	56.5	-0.2	0%	55.5	54.6	-0.9	-2%	51.1	50.5	-0.6	-1%	47.7	47.8	0.1	0%	50.6	50.7	0.1	0%	53.0	53.1	0.1	0%
Dry (24%)	57.5	57.0	-0.5	-1%	55.8	55.2	-0.6	-1%	51.3	51.3	-0.1	0%	46.1	46.2	0.1	0%	50.5	50.6	0.1	0%	53.6	53.5	0.0	0%
Critical (15%)	60.7	60.5	-0.2	0%	57.3	56.9	-0.3	-1%	50.2	50.3	0.1	0%	47.8	47.8	0.1	0%	50.9	51.1	0.1	0%	53.6	53.5	0.0	0%

Statistic	Monthly Temperature (Deg-F)																							
	April				May				June				July				August				September			
	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.	NAA	PA	Diff.	Perc. Diff.
Probability of Exceedance[a]																								
10%	57.6	57.4	-0.2	0%	62.1	62.1	0.0	0%	66.1	65.9	-0.2	0%	69.6	69.5	-0.1	0%	68.8	68.7	-0.1	0%	63.0	62.5	-0.5	-1%
20%	56.5	56.3	-0.2	0%	61.6	61.6	0.0	0%	65.8	65.6	-0.2	0%	69.1	69.0	-0.1	0%	68.0	68.1	0.1	0%	61.6	62.0	0.4	1%
30%	56.0	56.0	0.0	0%	61.2	61.2	0.0	0%	65.4	65.2	-0.2	0%	68.7	68.8	0.1	0%	67.6	67.7	0.1	0%	61.1	61.5	0.4	1%
40%	55.5	55.6	0.1	0%	60.8	60.8	0.0	0%	65.1	64.9	-0.2	0%	68.6	68.5	-0.1	0%	67.1	67.2	0.1	0%	60.7	61.0	0.3	0%
50%	55.0	55.0	0.0	0%	60.6	60.6	0.0	0%	64.6	64.3	-0.3	0%	68.2	68.3	0.1	0%	66.6	66.9	0.3	0%	60.4	60.7	0.3	0%
60%	54.6	54.7	0.1	0%	60.3	60.4	0.1	0%	64.2	64.0	-0.2	0%	68.0	68.1	0.1	0%	66.3	66.4	0.1	0%	60.1	60.4	0.3	0%
70%	54.4	54.4	0.0	0%	60.0	60.0	0.0	0%	63.8	63.8	0.0	0%	67.8	67.7	-0.1	0%	66.1	66.1	0.0	0%	59.6	60.0	0.4	1%
80%	54.0	53.9	-0.1	0%	59.8	59.8	0.0	0%	63.4	63.3	-0.1	0%	67.3	67.4	0.1	0%	65.8	65.7	-0.1	0%	59.4	59.6	0.2	0%
90%	53.4	53.3	-0.1	0%	59.1	59.1	0.0	0%	62.8	62.9	0.1	0%	67.0	66.9	-0.1	0%	65.3	65.3	0.0	0%	58.8	59.1	0.3	1%
Long Term																								
Full Simulation Period[b]	55.3	55.3	0.0	0%	60.7	60.7	0.0	0%	64.5	64.4	-0.1	0%	68.4	68.4	0.0	0%	66.9	66.9	0.0	0%	60.7	60.9	0.1	0%
Water Year Types[c]																								
Wet (32%)	54.0	54.0	0.0	0%	60.2	60.2	0.0	0%	64.0	63.8	-0.2	0%	68.4	68.4	0.0	0%	66.7	66.9	0.1	0%	59.8	59.9	0.2	0%
Above Normal (16%)	51.2	51.2	0.0	0%	56.4	56.5	0.0	0%	59.9	59.6	-0.2	0%	62.6	62.6	0.0	0%	60.9	61.1	0.1	0%	54.8	55.1	0.3	1%
Below Normal (13%)	56.2	56.2	0.0	0%	60.5	60.5	0.0	0%	64.9	64.7	-0.2	0%	68.3	68.3	0.0	0%	66.7	66.8	0.1	0%	60.8	61.5	0.7	1%
Dry (24%)	55.9	55.9	0.0	0%	60.9	61.0	0.0	0%	64.9	64.8	0.0	0%	68.1	68.1	0.1	0%	67.1	67.0	-0.1	0%	61.1	61.3	0.2	0%
Critical (15%)	55.9	55.8	0.0	0%	60.9	60.9	0.0	0%	64.6	64.7	0.1	0%	69.4	69.3	-0.1	0%	68.1	68.0	-0.1	0%	63.5	62.9	-0.7	-1%

a Exceedance probability is defined as the probability a given value will be exceeded in any one year.

b Based on the 82-year simulation period.

c As defined by the Sacramento Valley 40-30-30 Index Water Year Hydrologic Classification (SWRCB D-1641, 1999); projected to Year 2030. WYT for a given water year is applied from Feb through Jan consistent with CALSIM II.

d There are 26 wet years, 13 above normal years, 11 below normal years, 20 dry years, and 12 critical years projected for 2030 under Q5 climate scenario.

4.5 Status of the Species/Environmental Baseline Summary

Environmental baseline, as defined in 50 CFR 402.02, "includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process." This section describes the environmental baseline for each species, with additional detail provided in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, particularly with respect to threats to the species.

Table 1-3 includes a summary of listed species addressed in this BA. Some of the detailed baseline description is contained within Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, due to the large size of the action area, which in some cases encompasses the freshwater geographic range of a listed fish species.

The PA would not begin operations until after at least a decade of construction activities, as described in Chapter 3, *Description of the Proposed Action*. A number of other processes have the potential to change the environment in which the PA would operate, but either these are not reasonably certain to occur, or they have not yet been developed in sufficient detail to assess their likely effect upon listed species and their critical habitat. These include the Water Quality Control Plan (WQCP) Update currently underway by the State Water Resources Control Board (SWRCB) and the implementation of the California Water Action Plan. Changes in the environmental baseline are also likely to occur during the timeframe leading up to the PA, and during performance of the PA, in response to changes in the natural environment and include climate change and potential natural events such as earthquakes, floods, and droughts. Additionally, while considered part of the baseline for this consultation, the Long-term Operations BiOps are not fully implemented and some components of the RPAs (e.g., fish passage) may fundamentally change CVP management. It is also possible that other substantial federal actions may occur prior to implementation that could alter the environmental baseline: possible examples include consultation on system-wide CVP operations, or construction of substantial new water storage facilities in the Central Valley watershed. Potential changes in the environmental baseline that are not foreseeable but are conceivable in the context of such changes include increased flows on the Sacramento River, changes in Delta outflow criteria, warmer waters throughout the CVP and SWP, and changes in access to spawning areas above major dams. Collectively, these could result in substantial variance from the outcomes evaluated in this BA. In consideration of this possibility, the PA would operate in compliance with the operational criteria set forth in 3.3, *Operations and Maintenance of New and Existing Facilities*, or other criteria developed as part of these other processes and/or adjustments made through the Collaborative Science and Adaptive Management Program described in Section 3.4.7, *Collaborative Science and Adaptive Management Program*.

4.5.1 Chinook Salmon, Sacramento River Winter-Run ESU

The Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), currently listed as endangered, was initially listed as a threatened species under emergency provisions of the ESA on August 4, 1989 (54 FR 32085), and in a final rule in 1990 (55 FR 46515; November 5, 1990). On January 4, 1994, NMFS re-classified Sacramento River winter-run Chinook salmon as an endangered species (59 FR 440). NMFS concluded that winter-run Chinook salmon in the Sacramento River warranted listing as an endangered species due to several factors, including (1) the continued decline and increased variability of run sizes since its first listing as a threatened species in 1989; (2) the expectation of weak returns in future years as the result of two small year classes (1991 and 1993); and (3) continued threats to the "take" of winter-run Chinook salmon (August 15, 2011, 76 FR 50447).

The Sacramento River winter-run Chinook salmon ESU currently consists of only one population that is confined to the upper Sacramento River, spawning downstream of Shasta and Keswick Dams in California's Central Valley. In addition, an artificial propagation program at the Livingston Stone National Fish Hatchery (LSNFH) produces winter-run Chinook salmon that are part of this ESU (June 28, 2005, 70 FR 37160). All historical spawning and rearing habitats have been blocked since the construction of Shasta Dam in 1943. Most components of the winter-run Chinook salmon life history (e.g., spawning, incubation, freshwater rearing) have been compromised by this habitat blockage. Remaining spawning and rearing areas are completely dependent on cold-water releases from Shasta Dam in order to sustain the remnant population.

NMFS designated critical habitat for Sacramento River winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat includes the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Delta; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. Critical habitat includes the bottom and water of these waterways, and the adjacent riparian zone (Figure 4.A.1-2 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*).

Physical or biological features (PBFs)[8] of winter-run Chinook salmon critical habitat are discussed in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.1.2, *Critical Habitat*. Within the action area, and as described by NMFS (2009), many of the PBFs of

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[8] The designations of critical habitat for listed species have generally used the term primary constituent elements (PCEs). NMFS and USFWS' recently issued a final rule amending the regulations for designating critical habitat (81 FR 7414; February 11, 2016), which replaced the term PCEs with physical or biological features (PBFs). In addition, NMFS and USFWS' recently issued a final rule revising the regulatory definition of "destruction or adverse modification" of critical habitat (81 FR 7214; February 11, 2016), which refers to PBFs, not PCEs. The shift in terminology does not change the approach used in conducting an analysis of the effects of the proposed action on critical habitat, which is the same regardless of whether the original designation identified PCEs or PBFs. In this biological assessment, we use the term PBFs to include PCEs, as appropriate for the specific critical habitat, for NMFS species.

critical habitat are impaired and provide limited conservation value. In the upper Sacramento River, above-optimal water temperatures can constrain the extent of suitable spawning habitat, and unscreened water diversions provide a risk of entrainment to juvenile winter-run Chinook salmon, with riparian habitat often degraded by channelization, levee construction, and rip-rap bank protection; some complex, productive habitats with floodplains remain in parts of the system (e.g., Yolo and Sutter Bypasses) (National Marine Fisheries Service 2009: 181). NMFS (2009: 183) concluded that critical habitat in the Sacramento River is degraded and has low conservation value. NMFS (2009: 203) also noted that critical habitat within the Delta is degraded because channelized, leveed, and riprapped channels typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. NMFS (2009: 205) also noted that opening of the DCC (leading to the low-survival interior Delta) and water diversions from unscreened intakes leading to entrainment also degrade winter-run Chinook salmon critical habitat in the Delta. The discussion provided in Appendix 4.A, Section 4.A.1.4, *Threats and Stressors*, in also generally discusses baseline conditions that are relevant to critical habitat for winter-run Chinook salmon.

Good *et al.* (2005) described the threats to the winter-run Chinook salmon ESU as follows: That there is only a single extant population that is spawning outside of its historical range within an artificial habitat that is vulnerable to drought and other catastrophic conditions such as loss of cold-water pool and temperature control.

As described in more detail in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.1.3.6, *Status and Trends*, estimates of the winter-run Chinook salmon population reached nearly 120,000 adult fish in the late 1960s before declining to under 200 fish in the 1990s (Fisher 1994; California Department of Fish and Wildlife 2014) in Appendix 4.A). Adult abundance remained very low through the mid-1990s, and was less than 500 fish in some years (California Department of Fish and Wildlife 2014). From the mid-1990s through 2006, adult escapement showed a trend of increasing abundance, up to around 20,000 fish in 2005 and 2006. However, recent population estimates have declined since the 2006 peak, with escapement estimates for 2007 through 2014 ranging from 738 adults (2011) to 5,959 (2013). The 2011 estimate of 738 was the lowest since the all-time low of 144 in 1994. Poor ocean productivity (Lindley et al. 2009), drought conditions during 2007–2009, and low in-river survival (National Marine Fisheries Service 2011a) are suspected to have contributed to the recent decline in escapement of adult winter-run Chinook salmon.

Lindley *et al.* (2007) assessed that the Sacramento River winter-run Chinook salmon ESU was at moderate risk of extinction based on a population viability analysis criterion (>5% risk of extinction within 100 years) and at low risk of extinction based on other criteria, including population size, population decline, rate and effect of catastrophe on population, and hatchery influence. However, Lindley *et al.* (2007: 13) noted that "an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. A single catastrophe could extirpate the entire Sacramento River winter-run Chinook salmon ESU, if its effects persisted for four or more years. The entire stretch of the Sacramento River used by winter-run Chinook salmon is within the zone of influence of Mt. Lassen. Some other possible catastrophes include a prolonged drought that depletes the cold water storage of Lake Shasta or some related failure to manage cold water storage, a spill of toxic materials with effects that persist for four years, or a disease outbreak." Trends in the criteria described by Lindley *et al.*

(2007) include continued low abundance, a negative growth rate within the population over the last two generations (6 years), and an increased risk from catastrophic events (wildfires, oil spills, extended drought conditions, poor ocean rearing conditions) as the population has declined. Hatchery influence on wild stocks, although not a problem with present stocks, could become a problem if cohorts of wild fish were to experience lowered survival, similar to the loss of eggs and alevins as the result of temperature control failure in the upper Sacramento River in 2014, or other reductions in overall population. During times when the ESU is in decline due to marine and freshwater conditions, naturally reproducing winter-run Chinook salmon are less able to withstand high harvest rates (California Hatchery Scientific Review Group 2012). Impacts from the salmon ocean fishery, consistent with the fishery operation since 2000, would not be expected to negatively affect the abundance during periods of positive population growth, but during times of negative population growth the impacts of the fishery at levels over the last decade would appreciably increase the risk of extinction. Therefore, NMFS, which addresses the ocean harvest impacts on this ESU from commercial and recreational ocean salmon fisheries managed under the Pacific Coast Salmon Fishery Management Plan, concluded the fisheries were likely to jeopardize the continued existence of the ESU, and included a reasonable and prudent alternative (RPA) that required NMFS to implement an interim RPA for the 2010 and 2011 fishing years and develop and implement a new management framework for the ocean fishery addressing impacts to Sacramento River winter-run Chinook salmon before the 2012 ocean salmon fishery season (National Marine Fisheries Service April 30, 2012 memo).

The most recent 5-year status review (National Marine Fisheries Service 2011) on winter-run Chinook salmon concluded that the ESU continues to be at high risk of extinction. Williams *et al.* (2011) concluded that the ESU status remains the same as when it was examined by Good *et al.* (2005), *i.e.*, “in danger of extinction” and will remain so until another low-risk population is established within its historical spawning range. The most recent biological information suggests that the extinction risk for the winter-run Chinook salmon ESU has not decreased since 2005 (previous status review), and that several listing factors have contributed to the recent decline in abundance, including drought and poor ocean conditions (National Marine Fisheries Service 2011).

Extreme drought conditions in California are causing increased stress to winter-run Chinook in the form of low flows reducing rearing and migratory habitats, higher water temperatures affecting survival, and likely higher-than-normal predation rates (State Water Resources Control Board 2015). Limited cold water storage and loss of temperature control out of Keswick Dam from mid-August through the fall, resulting in an increased potential for incubation mortality over the 15 year average of 73% (e.g., mortality of 95% of winter-run Chinook salmon eggs and fry) occurred in 2014(SWRCB 2015; Rea pers. comm.). Additionally, the Net Delta Outflow Index (NDOI) was modified from an outflow 7,100 cfs to no less than 4,000 cfs during the months of April through June and no less than 3,000 cfs in July (SWRCB 2015). Reductions in outflow in an effort to preserve the cold-water pool may have the potential to reduce survival of out-migrating winter-run Chinook salmon during their migration through the North Delta, through via increased predation mediated by hydrodynamic and habitat mechanisms (State Water Resources Control Board 2015). Reduced outflow increases tidal excursion upstream (reduced daily proportion of positive velocities) into the waterways in the North Delta region, leading to a reduction in the proportion of positive daily flows passing Georgiana Slough and/or an open Delta Cross Channel, which may increase juvenile entrainment into Georgiana Slough and, if open, the Delta Cross Channel (State Water Resources Control Board 2015). Survival of migrating juvenile salmonids has been shown to be lower when salmon are entrained into these two migration routes as compared to the Sacramento River and Steamboat Slough (Singer *et al.* 2013; Perry *et al.* 2010).

4.5.2 Chinook Salmon, Central Valley Spring-Run ESU

Central Valley (CV) spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon program has been included as part of the CV spring-run Chinook salmon ESU in the most recent CV spring-run Chinook salmon listing decision (70 FR 37160, June 28, 2005). Although there have been observations of springtime running Chinook salmon returning to the San Joaquin tributaries in recent years, there is insufficient information to determine the specific origin of these fish, and whether or not they are straying into the basin or returning to natal streams (NMFS 2016: 8). More information is needed when considering whether or not the presence of these fish would warrant a change to the ESU boundary (NMFS 2016: 8-9). Additionally, there may be interest in modifying the ESU boundary in the future when spring-run Chinook salmon are successfully reintroduced into the San Joaquin River Basin and/or into Central Valley habitats upstream of currently impassable barriers (NMFS 2016: 9; 78 FR 79622; NMFS 2014). Based on the most recent 5-year status review, NMFS (2016: 9) is not recommending a change to the boundary of this ESU at present (2016). Note that the analyses presented in Chapter 5, *Effects Analysis for Chinook Salmon, Central Valley Steelhead, Green Sturgeon, and Killer Whale*, considers potential effects of the PA on San Joaquin River spring-run Chinook salmon, which are considered to represent both the reintroduced population as part of the San Joaquin River Restoration Program, and springtime running Chinook salmon mentioned above.

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488). Critical habitat for the CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba, and American Rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear Creeks, and the Sacramento River, as well as portions of the northern Delta (Figure 4.A.2-2 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*).

The PBFs of spring-run Chinook salmon critical habitat are discussed in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.2.2, *Critical Habitat*. Within the action area, and as described by NMFS (2009: 185), in the mainstem Sacramento River, critical habitat is degraded by overlap of spring-run Chinook salmon with fall-run spawning, with additional degradation by relatively warm water releases from Shasta Reservoir. Rearing and migration habitats are affected by levee construction leading to loss of natural river function and floodplain connectivity, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use (National Marine Fisheries Service 2009: 185). Within the Delta, NMFS (2009: 205) noted that the status of spring-run Chinook salmon critical habitat in the Delta is highly degraded and that substantial changes (e.g., as shown by the pelagic organism decline) are occurring, but noted that it was not immediately clear how such changes affect spring-run Chinook salmon. Other degradation of critical habitat within the Delta is more apparent and includes the elimination of the fringing marshes (leading to less availability of forage species, for example) and habitat simplification by levee construction and riprapping (National Marine Fisheries Service 2009: 103-104), which may reduce shelter from predation, for example. NMFS (2009: 103-104) also noted degradation of critical habitat within the Delta from SWP/CVP operations, e.g., direct (entrainment loss) and indirect (predation, contaminants, entrainment of phytoplankton and zooplankton) effects. Additional degradation of spring-run Chinook salmon critical habitat within the Delta occurs from heavy urbanization and industrial activities that lower water quality and introduce contaminants (National Marine Fisheries Service 2009: 104). The discussion provided in Appendix 4.A Section 4.A.2.5, *Threats and Stressors*, in also generally discusses baseline conditions that are relevant to critical habitat for spring-run Chinook salmon.

Good et al. (2005) described the threats to the CV spring-run Chinook salmon ESU as falling into three broad categories: loss of historical spawning habitat, degradation of remaining habitat, and genetic threats from the Feather River Fish Hatchery spring-run Chinook salmon program. Other likely important threats and stressors include nonnative predators, commercial and recreational harvest, entrainment at water withdrawal facilities, toxin exposure, and increased water temperatures. Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.2.5, *Threats and Stressors*, in discusses these issues in more detail.

The CV spring-run Chinook salmon ESU has displayed broad fluctuations in adult abundance between 1960 and recent years (Figure 4.A.2-4 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*). The total spring-run Chinook salmon escapement count for Feather River Fish Hatchery, Butte Creek, Mill Creek, Deer Creek, Antelope Creek, Cottonwood Creek, Clear Creek, and Battle Creek in 2013 was 23,697 adults, which was the highest count since 2005 (23,093 adults) and over three times that of 2011 (7,408 adults) (California Department of Fish and Wildlife 2014). However, abundance declined considerably in 2014 (9,901 adults) and even more so in 2015 (5,635 adults) (California Department of Fish and Wildlife 2016). Sacramento River tributary populations in Mill, Deer, and Butte Creeks are probably the best trend indicators for the Central Valley spring-run Chinook ESU as a whole because these streams contain the primary independent populations in the ESU. Generally, there was a positive trend in escapement in these waterways between 1992 and 2005, after which there was a steep decline until 2010 (Figure 4.A.2-5 in Appendix 4.A). Adult spring-run salmon escapement to Mill, Deer, and Butte Creeks in was estimated to be 18,135 fish in 2013; 6,592 fish in 2014; and only 964 fish in 2015 (California Department of Fish and Wildlife 2016). Escapement numbers are dominated by Butte Creek returns, with the contribution of Butte Creek fish to total numbers in these three creeks being >90% in 2013, 77% in 2014, and ~60% in 2015 (California Department of Fish and Wildlife 2016). In 2012, Battle Creek saw the highest number of returns in recent history (799 fish), with declines to 608 fish in 2013, 429 fish in 2014, and 181 fish in 2015 (California Department of Fish and Wildlife 2014). Individuals have only recently begun spawning in Battle Creek, where they spawned historically, and greater access upstream for spawning and rearing has been facilitated by some of the initial actions from the Battle Creek Salmon and Steelhead Restoration Project, scheduled for full completion in 2020 (NMFS 2016: 19).

The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS's 2016 status review (National Marine Fisheries Service 2016). This review found that on balance the biological status of the ESU had probably improved since the last status review

(2010) through 2014, with two of the three extant independent populations improving from high extinction risks to moderate extinction risks. The third extant independent population, Butte Creek, has remained at low risk, and all viability metrics had been trending in a positive direction, up until 2015 (NMFS 2016: 17). The Butte Creek spring-run Chinook salmon population has increased in part due to extensive habitat restoration and the accessibility of floodplain habitat in the Sutter-Butte Bypass for juvenile rearing in the majority of years. Additionally, spring-run Chinook salmon in both Battle Creek and Clear Creek continue to repopulate those watersheds, and now fall into the moderate extinction risk category for abundance. In contrast, most dependent spring-run populations have been experiencing continued and somewhat drastic declines (NMFS 2016: 17).

Extreme drought conditions are causing increased stress to spring-run Chinook salmon populations in the form of low flows reducing rearing and migratory habitats, higher water temperatures affecting survival, and likely higher-than-normal predation rates. Modification to flow and operational criteria may reduce through-Delta survival of juvenile migrating spring-run Chinook salmon and may modify their designated critical habitat during April and May (State Water Resources Control Board 2015). Changes in Sacramento River outflow during April and May can possibly delay adult spring-run Chinook salmon migration. Low export levels are not expected to appreciably affect survival of juvenile spring-run Chinook salmon emigrating through the Delta (State Water Resources Control Board 2015). Drought conditions and current reservoir storage levels have been forecasted to impact suitable water temperatures in the Upper Sacramento River and Clear Creek. Temperature effects on Clear Creek and in the Upper Sacramento may lead to higher pre-spawn mortality of adult spring-run Chinook salmon and reduced egg viability if temperatures exceed 60°F during August and early September, as well as greater mortality of incubating eggs and pre-emergent fry if temperatures exceed 56°F after September 15 (State Water Resources Control Board 2015).

As described by NMFS (2016: 18), the CV spring-run Chinook salmon ESU has experienced two drought periods over the past decade. From 2007 to 2009, and now 2012 to 2015, the Central Valley experienced drought conditions and low river and stream discharges, which are generally associated with lower survival of Chinook salmon. The impacts of the recent drought years and warm ocean conditions on the juvenile life stage will not be fully realized by the viability metrics until they manifest in potential low run size returns in 2015 through 2018. This is already being realized with very low returns in 2015 (NMFS 2016: 18).

4.5.3 Steelhead, California Central Valley DPS

California Central Valley (CCV) steelhead (*O. mykiss*) were originally listed as threatened on March 19, 1998 (63 FR 13347). On June 14, 2004, after a complete status review of 27 west coast salmonid ESUs and DPSs, NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). Following a new status review (Good et al. 2005), on January 5, 2006, NMFS reaffirmed the threatened status of CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain “markedly separated” as a consequence of physical, ecological, and behavioral factors, and therefore warranted delineation as separate DPSs (71 FR 834). In addition, NMFS added the Feather River Fish Hatchery and Coleman National Fish Hatchery steelhead hatchery programs as part of the listed DPS on January 5, 2006 (71 FR 834). On August 15, 2011, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (National Marine Fisheries Service 2011a).

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope Creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta (Figure 4.A.3-2 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*).

The PBFs of CCV steelhead critical habitat are discussed in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.3.3, *Critical Habitat*. As with winter-run and spring-run Chinook salmon, and as previously described by NMFS (2009), critical habitat for CCV is degraded, generally because of the same issues outlined for Chinook salmon. In the mainstem Sacramento River, critical habitat for rearing and migration is degraded by levee construction leading to loss of natural river function and floodplain connectivity, direct loss of floodplain and riparian habitat, and effects to water quality associated with agricultural, urban, and industrial land use (National Marine Fisheries Service 2009: 186). In the American River, NMFS (2009: 192) noted that there is general consensus that critical habitat for CCV steelhead is impaired, with particular concern being CVP operational effects: warm water temperatures during embryo incubation, rearing, and migration; flow fluctuations during embryo incubation and rearing; and limited flow-dependent habitat availability during rearing. Recent gravel augmentation efforts have resulted in improvements to the spawning habitat function of the lower American River (Zeug *et al.* 2014). Within the Delta, NMFS (2009: 112-113) noted similar types of degradation of CCV steelhead critical habitat as previously described for spring-run Chinook salmon with respect to degradation of the migration corridor and estuarine areas, such as direct/indirect effects of SWP/CVP operations in the south Delta (e.g., entrainment risk and associated predation) and entry into the interior Delta through the DCC, as well as other effects such as seasonal agricultural diversions and water quality impairment from municipal/agricultural discharge.

The primary threat to CCV steelhead is the loss of historical adult staging/holding, spawning, and rearing habitat that is no longer accessible to upstream migrating steelhead. Access to this habitat has been blocked by artificial structures (i.e., dams and weirs) associated with water storage and conveyance; diversions; flood control; and municipal, industrial, agricultural, and hydropower purposes (Figure 4.A.3-1 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*) (McEwan and Jackson 1996; McEwan 2001; Reclamation 2004; Lindley et al. 2006; National Marine Fisheries Service 2007). These impediments and barriers to upstream passage limit the geographic distribution of steelhead to lower elevation habitats in the Central Valley, which not only lack the boulders, large wood, gravel riffles, and side channels of upstream areas, but also are more prone to temperature effects when reservoir levels cannot be maintained for water temperature control below dams. Lack of access to higher-elevation and cooler aquatic habitat (most of which is above dams) will increase the risk that catastrophic climate change events pose to CCV steelhead. Other limiting factors that affect steelhead distribution, abundance, and survival are high water temperatures, low flows and flow fluctuations, limited spawning and rearing habitat, poor quality of the remaining rearing habitat, blocked or delayed passage, unscreened river diversions, predation, contaminants, harvest, hatchery operations, and disease.

Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resilience to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (National Marine Fisheries Service 2011a). The genetic diversity of CCV steelhead has likely been affected by low population sizes and high numbers of hatchery fish relative to wild fish. Status reviews of this DPS have identified hatchery fish influence as a significant threat to its genetic integrity and diversity. Williams et al. (2011) identify the increasing dominance of hatchery fish relative to naturally produced fish as a significant concern. Potential threats to natural steelhead from hatchery programs include (1) mortality of natural steelhead in fisheries targeting hatchery origin fish, (2) competition for prey and habitat, (3) predation by hatchery origin fish on younger natural fish, (4) disease transmission, and (5) genetic introgression by hatchery-origin fish that spawn naturally and interbreed with local natural populations. Overall, impacts from hatcheries continue to be an ongoing threat to this DPS. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

In its latest 5-year status review, NMFS determined that the CCV steelhead DPS should remain classified as threatened. However, NMFS (2011a) determined that the status of the CCV steelhead DPS had worsened since the previous review (Good et al. 2005), and that the DPS faces an even greater extinction risk (National Marine Fisheries Service 2011a). This review found that the decline in natural production of steelhead had continued unabated since the 2005 status review, and the level of hatchery influence on the DPS corresponds to a moderate risk of extinction (National Marine Fisheries Service 2011a). As a result, NMFS recommended that its status be reassessed in 2–3 years if the DPS did not positively respond to improved environmental conditions and management actions.

Drought conditions are causing increased stress on steelhead populations in the form of low flows reducing rearing and migratory habitats, above-normal water temperatures affecting survival, and likely higher-than-normal predation on juvenile steelhead. Steelhead survival is expected to be low in 2015 in all tributaries and migratory pathways and is likely to result in a smaller returning year class of steelhead from those juvenile steelhead emigrating this year (State Water Resources Control Board 2015).

4.5.4 Green Sturgeon, Southern DPS

There are two DPSs of North American green sturgeon: the Northern DPS, which includes all populations in the Eel River and northward; and the Southern DPS, which includes all populations south of the Eel River. The Northern DPS currently spawns in the Klamath River in California and the Rogue River in Oregon, and is listed as a Species of Concern (69 FR 19975;

April 15, 2004). Only the Southern DPS is found in the Delta and the Sacramento River and its tributaries.

In its final rule to list the Southern DPS as threatened (71 FR 17757; April 7, 2006), NMFS cited threats of concentration of the only known spawning population into a single river (Sacramento River), loss of historical spawning habitat, mounting threats with regard to maintenance of habitat quality and quantity in the Delta and Sacramento River, and an indication of declining abundance based upon salvage data at the State and Federal salvage facilities. Included in the listing are green sturgeon originating from the Sacramento River basin, including the spawning population in the Sacramento River and green sturgeon living in the Sacramento River, the Delta, and the San Francisco Estuary.

On September 8, 2008, NMFS proposed critical habitat for the Southern DPS (73 FR 52084). NMFS made a final critical habitat designation for the Southern DPS on October 9, 2009 (74 FR 52300). Designated areas include the Sacramento River, lower Feather River, and lower Yuba River; the Delta; and Suisun, San Pablo, and San Francisco Bays (Figure 4.A.4-2 in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*). The PBFs of Southern DPS critical habitat are discussed in Appendix 4.A, Section 4.A.4.3, *Critical Habitat*. NMFS (2009: 134) concluded that critical habitat for the Southern DPS is degraded over its historical condition, and that it does not provide the full extent of conservation values necessary for the recovery of the species, particularly in the upstream riverine habitat. The types of critical habitat degradation that have occurred are similar to those described previously for winter-run and spring-run Chinook salmon, and are also described generally in Appendix 4.A, Section 4.A.4.4, *Threats and Stressors*. NMFS (2009: 134) noted that alterations to critical habitat in the Delta also may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon because of the protracted rearing time in the Delta and estuary.

The primary threat to the Southern DPS is the reduction in habitat and spawning area due to dams (such as Keswick, Shasta, and Oroville). The Anderson-Cottonwood Irrigation District irrigation dam is not thought to be passable to green sturgeon and could possibly block access to 15% of the remaining spawning habitat in the Upper Sacramento River. Spawning is limited to one population in the Sacramento River, making green sturgeon highly vulnerable to catastrophic events. Continuing threats include migration barriers, insufficient flow, increased water temperatures, juvenile entrainment in water export facilities, nonnative forage species, competitors, predators, poaching, pesticides and heavy metals, and local harvest (Biological Review Team 2005). As long-lived, late maturing fish that spawn periodically, green sturgeon are particularly susceptible to threats from overfishing. Green sturgeon are regularly caught in the sport, commercial, and tribal fisheries, particularly in Oregon and Washington commercial fisheries.

Relatively little is known about the North American green sturgeon, particularly those that spawn in the Sacramento River (The Nature Conservancy et al. 2008). Adult populations in the less-altered Klamath and Rogue Rivers are fairly constant, with a few hundred spawning adults typically harvested annually by tribal fisheries. In the Sacramento River, the green sturgeon population is believed to have declined over the last two decades, with current spawning run size estimated to be in the hundreds (Biotelemetry Laboratory 2014). In the Feather and Yuba rivers, green sturgeon sightings are extremely limited. Spawning in these watersheds is rarely recorded, although spawning in the Feather River was documented in 2011 (Seesholtz et al. 2012). In the San Joaquin and South Fork Trinity Rivers, the green sturgeon population appears to be extirpated.

Green sturgeon juveniles, subadults, and adults are widely distributed in the Delta and estuary areas including San Pablo Bay (Beamesderfer et al. 2004). The Delta serves as a migratory corridor, feeding area, and juvenile rearing area for North American green sturgeon in the southern DPS. Adults migrate upstream primarily through the western edge of the Delta into the lower Sacramento River between March and June (Adams et al. 2002). Larvae and post-larvae are present in the lower Sacramento River and North Delta between May and October, primarily in June and July (California Department of Fish and Game 2002). Juvenile green sturgeon have been captured in the Delta during all months of the year (Borthwick et al. 1999; California Department of Fish and Game 2002). Catches of 1- and 2-year-old Southern DPS green sturgeon on the shoals in the lower San Joaquin River, at the CVP/SWP fish salvage facilities, and in Suisun and San Pablo Bays, indicate that some fish rear in the estuary for at least 2 years (California Department of Fish and Game 2002). Larger juvenile and subadult green sturgeon occur throughout the estuary, possibly temporarily, after spending time in the ocean (California Department of Fish and Game 2002; Kelly et al. 2007). Green sturgeon have been observed throughout the action area at various life stages in sample data from young-of-the-year collected in spring and summer at Red Bluff Division Dam in the Sacramento River, juveniles salvaged from CVP/SWP water projects, and subadults sampled by the California Department of Fish and Wildlife in San Pablo Bay. Adult green sturgeon have been documented in the Yolo Bypass, but these individuals usually end up stranded against the Fremont Weir (Thomas et al. 2013), and if not rescued, could have population effects.

The Southern DPS is at substantial risk of future population declines (Adams et al. 2007). The potential threats faced by the green sturgeon include enhanced vulnerability due to the reduction of spawning habitat into one concentrated area on the Sacramento River; lack of good empirical population data; vulnerability of long-term cold water supply for egg incubation and larval survival; loss of juvenile green sturgeon to entrainment at the project fish collection facilities in the South Delta and agricultural diversions within the Sacramento River and Delta systems; alterations of food resources due to changes in the Sacramento River and Delta habitats; and exposure of juvenile, sub-adult, and adult life stages to various sources of contaminants throughout the basin.

Modifications to flow and water quality are not likely to reduce riverine or through-Delta survival of juvenile green sturgeon (State Water Resources Control Board 2015). Modification of flows from April through May have the possibility of delaying migration of juvenile, sub-adult and adult green sturgeon (State Water Resources Control Board 2015).

Effects of low flow on green sturgeon likely plays an important role in population performance, and although the mechanism is not completely understood, the NMFS 2002 and 2005 status reviews documented it as a potential threat to the viability of the Southern DPS of green sturgeon (Adams et al. 2002; National Marine Fisheries Service 2005).

4.5.5 Killer Whale, Southern Resident DPS

Three distinct forms of killer whales, termed residents, transients, and off shores, are recognized in the northeastern Pacific Ocean. Resident killer whales in U.S. waters are distributed from Alaska to California, with four distinct communities recognized: Southern, Northern, Southern Alaska, and Western Alaska (Kahn et al. 2002, 2004). Of these, only the Southern Resident DPS is listed as endangered under the ESA.

NMFS listed the Southern Resident killer whale DPS as endangered under the ESA on November 18, 2005 (70 FR 69903). Their range in the Northeastern Pacific Ocean overlaps with other that of the transient, resident, and offshore populations. The Southern Resident DPS consists of three pods designated J, K and L, each containing 25, 19, and 35 members, respectively (Center for Whale Research 2015). These pods generally spend late spring, summer, and fall in inland waterways of Washington State and British Columbia. They are also known to travel as far south as central California and as far north as the Queen Charlotte Islands. Winter and early spring movements are largely unknown for this DPS.

NMFS designated critical habitat for the Southern Resident DPS under the ESA on November 29, 2006 (71 FR 69054). NMFS identified the following PBFs essential for conservation of the Southern Resident DPS: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow migration, resting, and foraging. The critical habitat designation includes three specific marine areas of Puget Sound, Washington, but does not include any areas in California (Appendix 4.A, *Status of the Species and Critical Habitat Accounts*).

As discussed in the original listing notice (70 FR 69903 November 18, 2005) the three main human-caused factors that may continue to impede the recovery of this species and have affected the Southern Resident DPS population are contaminants, vessel traffic, and reductions in prey availability. Southern Resident DPS are thought to rely heavily upon salmon as their main source of prey (about 96% of their diet) throughout the areas and times for which reliable data on prey consumption is available (Ford and Ellis 2006). Studies have indicated that Chinook salmon generally constitute a large percentage of the Southern Resident DPS diet, with some indications that Chinook are strongly preferred at certain times in comparison to other salmonids (Ford and Ellis 2006; Hanson et al. 2010). Results have also suggested that Southern Residents are consuming Chinook salmon from ESUs from California to British Columbia (Hanson et al. 2010). The historical abundance of Southern Residents was estimated based on genetic data to have ranged from 140 to 200 individuals (Kahn et al. 2002; National Marine Fisheries Service 2008). The population was depleted by live captures for aquarium programs during the 1960s and 1970s (Balcombe et al. 1982;). Following a steep decline of 20% between 1996 and 2001 (from 97 whales to 78) (Krahn et al. 2002, 2004), the population was listed as endangered in the United States and Canada. As of summer 2015, the population totaled 81 individuals (Center for Whale Research 2015). Because the population is small and the probability of quasi-extinction[9]

[9] Quasi-extinction is defined as the stage at which 10 or fewer males or females remain, or a threshold from which the population is not expected to recover (National Marine Fisheries Service 2009).

is sufficiently likely, NMFS (2008) has determined that representation from all three pods is necessary to meet biological criteria for Southern Resident DPS downlisting and recovery.

Many Chinook salmon populations have declined substantially from historical levels of abundance and are listed as threatened or endangered under the ESA. Drought conditions will only exacerbate problems that already exist inland and in the coastal ocean, leading to less prey resources for killer whales. Studies have shown that whales travelled over a greater area and their movement patterns were more complex in the late 1990s, when prey availability was low. Researchers have found that survival and birth rates in the Southern Resident DPS of killer whale population are correlated with coast-wide abundance of salmon. High levels of legacy pollutants (dichlorodiphenyltrichloroethane [DDT], polychlorinated biphenyls [PCBs], and polybrominated diphenyl ethers [PBDEs]) may be keeping the whale population from increasing at the rate required for recovery of the population. Increased energy expenditure or insufficient prey may result in poor nutrition, which could lead to reproductive or immune effects or, if severe enough, death. A reduction in prey is also likely to work in concert with other threats to produce an adverse effect. For example, insufficient prey could cause whales to rely upon their fat stores, which contain high contaminant levels, impairing reproductive success or compromising immune function. Searching more aggressively for prey will increase the probability of encountering vessel traffic, which is known to interfere with the ability to communicate and find food, affecting their health and survival.

4.5.6 Delta Smelt

The description of the environmental baseline for Delta Smelt was adapted from the environmental baseline presented in the Biological Assessment of Potential Effects on Listed Fishes from the West False River Emergency Drought Barrier Project (ICF International 2015).

4.5.6.1 Status of the Species within the Action Area

The Action Area functions as a migratory corridor, as rearing habitat, and as spawning habitat for Delta Smelt. A summary of the general spatial distribution of life stages was provided by Merz et al. (2011), and is shown in Table 4-6. Given the long list of stressors discussed in the USFWS (2008) OCAP BO, the range-wide status of the Delta Smelt is currently declining. Although there was a spike in the population in 2011, the declining abundance of Delta Smelt is clear (Figure 4-6). The 2014 fall midwater trawl index was the second lowest ever; the 2015 index was the lowest ever. The 2016 Spring Kodiak Trawl index is the lowest since the survey began in 2002, and the 2015 20-mm Survey Index is also the lowest since the survey began in 1995. The 2015 Summer Townet Survey age–0 Delta Smelt abundance index is 0.0, which is the lowest index reported in the history of this survey (implemented in 1959) and is consistent with the downward trend observed in recent years (Figure 4-6). This abundance trend has been influenced by multiple factors, some of which are affected or controlled by CVP and SWP operations and others that are not (U.S. Fish and Wildlife Service 2008:189). Although long-term decline of the Delta Smelt was strongly affected by ecosystem changes caused by non-indigenous species invasions and other factors influenced but not controlled by CVP and SWP operations, the CVP and SWP have played an important direct role in that decline, especially in terms of entrainment and habitat-related impacts that add

Table 4-6. Average Annual Frequency (Percent) of Delta Smelt Occurrence by Life Stage, Interagency Ecological Program Monitoring Program, and Region

Region	Average Annual Frequency (%)										
Life Stage:	**Larvae (<15 mm)**	**Sub-Juvenile (≥15, <30 mm)**		**Juvenile (30–55 mm)**			**Sub-Adult (>55 mm)**	**Mature Adults (>55 mm)**		**Pre-Spawning[a]**	**Spawning[a]**
Monitoring Program:	**20-mm**	**20-mm**	**STN**	**20-mm**	**STN**	**FMWT**	**FMWT**	**BS**	**BMWT**	**KT**	**KT**
Years of Data Used:	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2006**	**2002–2009**	**2002–2009**
Time Period:	**Apr–Jun**	**Apr–Jul**	**Jun–Aug**	**May–Jul**	**Jun–Aug**	**Sep–Dec**	**Sep–Dec**	**Dec–May**	**Jan–May**	**Jan–Apr**	**Jan–May**
San Francisco Bay	NS	NS	NS	NS	NS	NS	NS	0.0	0.0	NS	NS
West San Pablo Bay	NS	NS	NS	NS	NS	0.2	0.0	0.0	1.2	NS	NS
East San Pablo Bay	0.0	1.0	0.0	2.8	3.6	0.7	0.6	NS	2.7	NS	NS
Lower Napa River	7.3	7.7	3.3	13.3	14.0	1.7	0.8	NS	NS	14.3	11.8
Upper Napa River	11.6	21.2	NS	12.0	NS	NS	NS	NS	NS	NS	NS
Carquinez Strait	5.7	9.3	1.1	24.4	33.7	1.9	3.3	NS	5.4	16.7	0.0
Suisun Bay (SW)	17.8	18.3	1.3	17.5	26.9	4.3	4.3	NS	4.3	23.3	5.6
Suisun Bay (NW)	2.2	8.9	1.1	21.7	34.8	7.3	10.0	NS	8.7	23.3	5.6
Suisun Bay (SE)	19.5	24.9	11.0	20.9	45.7	11.0	12.1	NS	6.5	28.3	6.9
Suisun Bay (NE)	17.8	19.2	33.6	29.7	66.7	20.3	29.3	NS	28.3	48.3	13.9
Grizzly Bay	16.3	27.6	17.9	42.9	72.8	15.0	19.6	NS	30.4	30.0	5.6
Suisun Marsh	21.4	33.6	14.2	18.5	19.2	22.8	27.2	NS	NS	62.0	23.1
Confluence	35.7	41.6	25.7	29.2	36.1	20.2	24.5	1.8	17.4	30.0	10.4
Lower Sacramento River	16.5	37.0	43.3	26.2	55.5	22.9	37.1	NS	18.8	54.4	17.8
Upper Sacramento River	10.8	8.2	1.3	0.0	0.0	2.7	8.0	5.8	16.7	21.7	15.3
Cache Slough and Ship Channel	17.2	47.3	NS	54.3	NS	9.8	26.7	NS	NS	33.9	21.1
Lower San Joaquin River	28.0	24.5	4.1	5.1	5.6	2.6	3.5	0.9	12.6	30.6	9.7
East Delta	14.6	8.8	0.0	1.2	0.0	0.0	0.0	1.6	NS	5.7	2.3
South Delta	18.4	10.8	0.0	1.4	0.3	0.0	0.0	0.3	NS	7.1	1.1
Upper San Joaquin River	NS	NS	NS	NS	NS	NS	NS	0.2	NS	NS	NS
Sacramento Valley	NS	NS	NS	NS	NS	NS	NS	0.2	NS	NS	NS

Region	**Average Annual Frequency (%)**										
Life Stage:	**Larvae (<15 mm)**	**Sub-Juvenile (≥15, <30 mm)**		**Juvenile (30–55 mm)**			**Sub-Adult (>55 mm)**	**Mature Adults (>55 mm)**		**Pre-Spawning[a]**	**Spawning[a]**
Monitoring Program:	**20-mm**	**20-mm**	**STN**	**20-mm**	**STN**	**FMWT**	**FMWT**	**BS**	**BMWT**	**KT**	**KT**
Years of Data Used:	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2009**	**1995–2006**	**2002–2009**	**2002–2009**
Time Period:	**Apr–Jun**	**Apr–Jul**	**Jun–Aug**	**May–Jul**	**Jun–Aug**	**Sep–Dec**	**Sep–Dec**	**Dec–May**	**Jan–May**	**Jan–Apr**	**Jan–May**

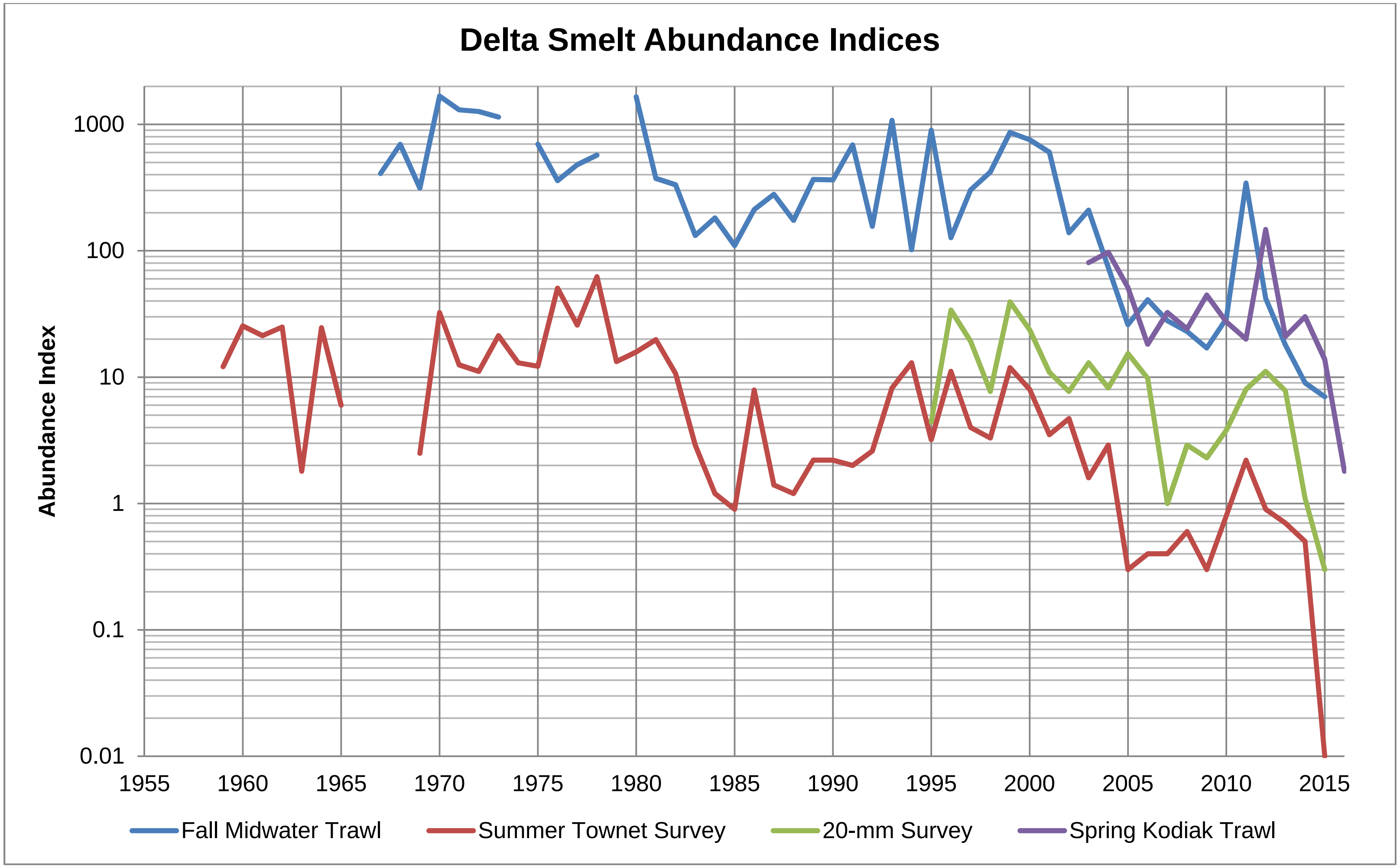
[a] Gonadal stages of male and female Delta Smelt found in Spring Kodiak Trawl database were classified by California Department of Fish and Wildlife following Mager (1996). Descriptions of these reproduction stages are available at: <http://www.dfg.ca.gov/delta/data/skt/eggstages.asp>.

Mature adults, pre-spawning: Reproductive stages[a]: females 1–3; males 1–4.

Mature adults: spawning: Reproductive stages[a]: females 4; males 5.

20-mm = 20-millimeter Townet
BMWT = Bay Midwater Trawl.
BS = Beach Seine.
FMWT = Fall Midwater Trawl.
Source: Merz et al. 2011

KT = Kodiak Trawl.
NS = indicates no survey conducted in the given life stage and region.
SKT = Spring Kodiak Trawl.
STM = Summer Tow-Net.



Source: ftp://ftp.delta.dfg.ca.gov/Delta%20Smelt/, https://www.wildlife.ca.gov/Regions/3, and http://www.dfg.ca.gov/delta/data/skt/bibliography.asp Accessed: 10/27/2015 and 6/29/2016 .Note: The Summer Townet Survey index for 2015 is 0.0, but is shown as 0.01 to allow plotting on the logarithmic scale.

Figure 4-6. Delta Smelt Abundance Indices

increments of additional mortality to the stressed Delta Smelt population (U.S. Fish and Wildlife Service 2008: 189). Past CVP and SWP operations have been one of the factors influencing Delta Smelt abiotic and biotic habitat suitability, health, and mortality (U.S. Fish and Wildlife Service 2008: 189).

While CVP and SWP operations and introduction of non-native species into the Delta have contributed to the long term decline in Delta Smelt abundance, other factors may be influencing trends in abundance as well. Climate change has become an ever-growing concern as it relates to potential effects to listed fish species. Increasing air temperature, sea level rise, and increased variability in hydrology are predicted to occur under future climatic conditions. Changes in each of these can influence the extent, availability, and quality of Delta Smelt habitat, which may affect the distribution of Delta Smelt in the estuary and other biological characteristics such as the timing of the spawning window (Brown et al. 2013). In particular, drought conditions, which can amplify various Delta Smelt stressors in the Delta, are expected to occur more frequently in the future. Some of these effects have already been observed during the current drought.

As described in DWR and Reclamation's March 2015 Biological Review for Endangered Species Act Compliance with the WY 2015 Drought Contingency Plan April through September Project Description, written as part of the March 24 Temporary Urgency Change Petition to SWRCB[10], research presented at the Interagency Ecological Program (IEP) workshop (March 18–20, 2015) showed that the current drought impacts Delta Smelt in a number of ways. The following is adapted from the summary in the Biological Review, which provides references to the specific presentations providing the information presented below[11]. The drought can reduce the area of habitat to which Delta Smelt migrate or disperse for spawning and reduce food availability for adults and for juveniles moving there to rear. Drought can indirectly impact reproductive potential by lowering the number of oocytes females produce. This is brought about by a link between dryer hydrological conditions and elevated water temperature, which may increase metabolic needs, resulting in less energy available for oocyte production. Generally, water temperatures in the Delta are driven by ambient atmospheric conditions (e.g., air temperature and insolation), although water temperatures at shorter time and smaller spatial scales can also be influenced by riverine flow (Wagner et al. 2011). Warming water temperature shortens the spawning window, which causes fewer clutches to be produced per female. Both of these mechanisms combine with low adult abundance to impair population fecundity. Lower outflow also tends to reduce turbidity. Delta smelt use turbid water to avoid predators and they also use it as foraging habitat. Otolith analysis has revealed that since 1999, Delta Smelt experienced an 8% decline in growth between dry and wet years and spawning is more successful in the north Delta during drought. The quality of Delta Smelt habitat is further compromised by concentrations of herbicides such as diuron and hexazinone, which may be present in higher concentrations during low outflow conditions (due to a limited dilution effect) and have synergistic effects that reduce food availability for juveniles. Furthermore, warm, slow

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[10] Available at: http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/biorev2_aprsep.pdf. Accessed: 10/27/2015. The sources of the specific statements are provided in that document.

[11] Additional information to that presented in the Biological Review is provided, with appropriate citation as necessary.

moving water characterized by drought promotes conditions in which parasites like Ich (*Ichthyophthirius multifiliis*) and cyanobacteria like *Microcystis* thrive. Ich causes skin lesions to form on a variety of fish and has an increased prevalence among captive Delta Smelt above 17°C. *Microcystis* is a cyanobacterium that can produce toxic hepatotoxins that became established throughout the Delta in 2000; it thrives in water above 17°C with low turbulence. This highly toxic cyanobacterium is known to kill phytoplankton, zooplankton and compromise fish health. *Microcystis* is typically observed during the late summer and is found in the south Delta, east Delta, and lower San Joaquin River subregions. However, *Microcystis* blooms extended into December of 2014, presumably due to higher water temperatures associated with the drought. Finally, the abundance of non-native Delta Smelt predators, such as black bass, increased in the Delta in response to the drought in 2014, mainly because it expanded their preferred habitat. The same pattern was found for non-native competitors, such as clams like *Corbicula*, which seem to be expanding throughout the Delta despite the drought.

4.5.6.2 Status of Critical Habitat within the Action Area

The existing physical appearance and hydrodynamics of the Action Area have changed substantially from the environment in which native fish species like Delta Smelt evolved. The Action Area once consisted of tidal marshes with networks of diffuse dendritic channels connected to floodplains of wetlands and upland areas (Moyle 2002). The in-Delta channels were further connected to drainages of larger and smaller rivers and creeks entering the Action Area from the upland areas. In the absence of upstream reservoirs, freshwater inflow from smaller rivers and creeks and the Sacramento and San Joaquin Rivers were highly seasonal and more strongly and reliably affected by precipitation patterns than they are today. Consequently, variation in hydrology, salinity, turbidity, and other characteristics of the Delta aquatic ecosystem was greater in the past than it is today (Kimmerer 2002b). For instance, in the early 1900s, the location of maximum salinity intrusion into the Delta during dry periods varied from Chipps Island in the lower Delta to Stockton along the San Joaquin River and Merritt Island in the Sacramento River (DWR Delta Overview[12]). Operations of upstream reservoirs have reduced spring flows while releases of water for Delta water export and increased flood control storage have increased late summer and fall inflows (Knowles 2002), though Delta outflows have been increasingly constrained during late summer-fall over the past several decades (Cloern and Jassby 2012). The USFWS (2008) OCAP BO aimed to ensure greater variability in Delta outflow and the extent of the low salinity zone by inclusion of an RPA action setting X2 and reservoir operation requirements in fall of wet and above normal water years.

Channelization, conversion of Delta islands to agriculture, and water operations have substantially changed the physical appearance, water salinity, water clarity, and hydrology of the Action Area. As a consequence of these changes, most life stages of the Delta Smelt are now distributed across a smaller area than historically (Arthur et al. 1996, Feyrer et al. 2007). Wang (1991) noted in a 1989 and 1990 study of Delta Smelt larval distribution that, in general, the San Joaquin River was used more intensively for spawning than the Sacramento River. Though not restricting spawning per se, based on particle tracking modeling, export of water by the CVP and SWP would usually restrict reproductive success of spawners in the San Joaquin River by

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[12] http://baydeltaoffice.water.ca.gov/sdb/tbp/deltaoverview/delta_overview.pdf

entraining most larvae during downstream movement from spawning sites to rearing areas (Kimmerer and Nobriga 2008). Prior to the USFWS (2008) OCAP BO, there was one, non-wet year exception to this generalization: in 2008, Delta Smelt entrainment was managed under a unique system of restrictions imposed by the Court in NRDC v Kempthorne. The USFWS (2008) OCAP BO subsequently limited CVP/SWP operations to reduce entrainment of adult, larval, and early juvenile Delta Smelt.

As described in recent BOs such as the USFWS (2014) BO on the Georgiana Slough Floating Fish Guidance Structure, a number of factors in addition to SWP/CVP have affected Delta Smelt critical habitat in the Action Area, e.g., contaminants and *Microcystis*, both of which may affect Delta Smelt prey. Introduced species have also impacted the Action Area in several ways including added predation to adult and juvenile Delta Smelt from introduced piscivorous fishes, changes in prey composition due to the introduction of several copepod species, added competition for food resources from introduced filter feeders, and submerged aquatic vegetation (particularly *Egeria densa*) that traps sediment and provides habitat for introduced piscivorous fishes. The USFWS (2008) OCAP BO included an RPA action to restore 8,000 acres of tidal habitat in order to mitigate for Delta productivity lost because of the hydrodynamic influence of the south Delta export facilities. Additional restoration actions are planned under the State's EcoRestore program, which are likely to provide benefits to Delta Smelt habitat conditions.

In addition to the general status of critical habitat in the action area described above, further information on drought-related impacts was provided in the Section 4.5.6.1, *Status of the Species within the Action Area*.

4.5.7 Riparian Brush Rabbit

A habitat assessment was performed on December 18, 2015 for the riparian brush rabbit at the proposed Head of Old River Gate construction site. No suitable habitat for the riparian brush rabbit was found at or near the proposed Head of Old River Gate construction area. See Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.5.7, *Head of Old River Gate Habitat Assessment*, for complete details. Riparian brush rabbit (*Sylvilagus bachmani riparius*) was listed as endangered under the ESA on February 23, 2000 (65 FR 8881). It is also listed as endangered under the CESA. Critical habitat has not been designated for riparian brush rabbit.

One of eight subspecies of brush rabbit in California, the riparian brush rabbit occupies a range that is disjunct from other brush rabbits, near sea level on the northwestern floor of the San Joaquin Valley (U.S. Fish and Wildlife Service 1998). Its historical distribution may have extended along portions of the San Joaquin River and its tributaries on the valley floor from at least Stanislaus County to the Sacramento–San Joaquin River Delta (Delta) (Orr 1935 in U.S. Fish and Wildlife Service 1998). Populations are known to have historically occurred in riparian forests on the valley floor along the San Joaquin and Stanislaus Rivers and some tributaries of the San Joaquin River (U.S. Fish and Wildlife Service 1998). One population estimate within this historical range was about 110,000 individuals (U.S. Fish and Wildlife Service 1998).

Remaining populations of riparian brush rabbits occur in only two locations in San Joaquin County. One population is at an approximately 258-acre (104-hectare) patch in Caswell

Memorial State Park on the Stanislaus River immediately southeast of the action area. The other population is located in several small, isolated or semi-isolated patches immediately west and southwest of Lathrop, totaling approximately 270 acres (109 hectares) along Paradise Cut and Tom Paine Slough and channels of the San Joaquin River in the south Delta (Kelly, pers. comm. 2015; Kelly et al. 2011; Williams et al. 2002), see Figure 6.2-1 for the locations of riparian brush rabbit occurrences relative to the PA. In addition, a captive breeding program has established a population on Faith Ranch, which is owned by the winemaking Gallo family (U.S. Fish and Wildlife Service 2007c).

The primary threats to the survival of riparian brush rabbit are the limited extent of its existing habitat, extremely low numbers of individual animals, and few extant populations. The small sizes of its remaining populations, the localization of the behavior of the subspecies, and the highly limited and fragmented nature of remaining habitat restrict natural dispersal and put the species at risk from a variety of environmental factors. The existing population sizes do not meet the minimum population sizes that Thomas (1990) suggests are required to assure the medium- to long-term persistence of birds or mammals (i.e., the geometric mean of population size should be 1,000 for species with normally varying numbers and about 10,000 for species exhibiting a high variability in population size). Therefore, the species is considered at a high risk of imminent extinction from several consequent threats related to population genetics, demographics, and environmental stochasticity (U.S. Fish and Wildlife Service 1998).

The south Delta population (Paradise Cut and Tom Paine Slough) of riparian brush rabbit is located south of the action area, near Mossdale (See Figure 6.2-1). This area is on private land, and watercourses are managed for flood control, not wildlife management. Surveys conducted by the Endangered Species Recovery Program (ESRP) under contract with DWR have identified the known occurrences of riparian brush rabbit in the action area (see Figure 6.2-1); these surveys are considered incomplete because of lack of property access. However, riparian brush rabbit suitable habitat does not occur in the construction footprint of the Head of Old River (HOR) gate or adjacent area as described in Appendix 4.A, *Status of the Species and Critical Habitat Accounts*, Section 4.A.5.7, *Head of Old River Gate Habitat Assessment*.

4.5.8 San Joaquin Kit Fox

San Joaquin kit fox (*Vulpes macrotis mutica*) was listed as endangered under the ESA on March 11, 1967 (32 FR 4001). It was listed as threatened species under the CESA in 1971. In 2010, USFWS completed a 5-year review for this species, and determined that the San Joaquin kit fox continues to meet the definition of endangered. Critical habitat has not been designated for San Joaquin kit fox.

San Joaquin kit fox historically occurred in alkali scrub/shrub and arid grasslands throughout the level terrain of the San Joaquin Valley floor from southern Kern County north to Tracy in San Joaquin County, and up into more gradual slopes of the surrounding foothills and adjoining valleys of the interior Coast Range (U.S. Fish and Wildlife Service 2010: 1). Currently, the entire range of the San Joaquin kit fox appears to be similar to what it was at the time of the 1998 Recovery Plan; however, population structure has become more fragmented, and at least some of the resident satellite subpopulations, such as those at Camp Roberts, Fort Hunter Liggett, Pixley National Wildlife Refuge (NWR), and the San Luis NWR, have apparently been locally extirpated, and portions of the range now appear to be frequented by dispersers rather than resident animals (U.S. Fish and Wildlife Service 2010: 15).

Habitat loss and fragmentation from urbanization and agricultural expansion are the principal factors in the decline of the San Joaquin kit fox in the San Joaquin Valley (Laughrin 1970; Jensen 1972; Morrell 1975; Knapp 1978). By 1979, an estimated 6.7% of the San Joaquin Valley floor's original native habitat south of Stanislaus County remained untilled and undeveloped (U.S. Fish and Wildlife Service 1983). Cypher et al. (2013) estimated that only 4,267km^2 of high suitable habitat and 5,569km^2 of medium suitable habitat remain, with much of the habitat highly fragmented. The majority of these habitat areas were located in the southern portion of the kit fox range, with 67% and 35% of this high and medium suitable habitat occurring in Kern and San Luis Obispo counties, respectively. In the northern range, continued urbanization, primarily in Contra Costa and Alameda Counties, water storage and conveyance projects, road construction, energy development, and other activities continue to reduce and fragment remaining grassland habitats. These land conversions contribute to kit fox declines through displacement, isolation of remaining populations, creation of barriers to movement, mortality, and a reduction of prey populations (U.S. Fish and Wildlife Service 1998).

4.5.8.1 Occurrences of San Joaquin Kit Fox in the Action Area

Available occurrence data indicates that the density of the San Joaquin kit fox population north of Santa Nella is very low; kit fox in the Northern Range have either experienced extirpation or have fallen below detectable numbers (Clark, et al 2007). The population density north of I-580 along the east coast range foothills is extremely low, if the species has not been extirpated from that area altogether. Orloff et al. (1986) found kit fox in Alameda and San Joaquin counties, but were unable to document the presence of kit foxes in Contra Costa County (Smith, et al 2006).

From 1991 to 1992, Bell and Ralls observed kit foxes at 3 sites in Contra Costa County, and 1 site in San Joaquin County, and a possible kit fox track was recorded at one site that encompassed both Alameda and San Joaquin counties. However, subsequent work in Alameda and Contra Costa counties with baited camera stations on public land and spotlight surveys on roads through potential kit fox habitat found no evidence of kit fox presence, even in areas where they had been documented earlier (Smith, et al 2006).

Smith et. al. (2006) surveyed 213 km within 24 properties in Alameda, Contra Costa, and San Joaquin counties using trained scat detection dogs, a proven effective survey technique for San Joaquin kit fox. Additionally, aircraft surveys were conducted to locate dens. No evidence for kit fox was found in the northern range. The study concluded that kit fox occur in the northern range in extremely low densities or only intermittently, if they have not been extirpated (Smith et al 2006). Currently, kit fox observations in the Northern Range are rare and no populations are known to occur there (Cypher et al 2013).

In February 2003, the Endangered Species Recovery Program surveyed DWR's property using scat detection dogs, including DWR land north of the intake channel, around Clifton Court Forebay, around Banks PP, and along the California Aqueduct to the south extent of Bethany Reservoir. No kit fox sign was observed and no kit fox scats were found.

In 1992 and 1993, DWR staff surveyed a 500 foot corridor from Clifton Court Forebay and Old River and along the South Bay Aqueduct to the city of Fremont. Several hundred burrows large enough to be classified as potential kit fox dens were identified. Using track medium, the burrows were monitored for 3 consecutive days. No kit fox tracks were observed at any of the burrows or anywhere in the alignment, and no other sign of kit fox were observed. (Bradbury, unpubl data).

In 1994, DWR and CDFG completed spotlight and camera surveys around Clifton Court Forebay, along the Banks Pumping Plant intake channel, along the length of the California Aqueduct to Patterson, CA, and along the length of the South Bay Aqueduct through Livermore. Additionally, because culverts are often used as artificial dens, every culvert along the California Aqueduct and Southbay Aqueduct in those same areas were searched for kit fox; culverts occur approximately every 1/10 mile. No San Joaquin kit fox were observed or photographed (Bradbury unpubl data). In Kern County, San Joaquin kit fox are readily observed and photographed along the California Aqueduct, and often use culverts for artificial dens (Bradbury pers obs 1989-2013).

There are limited records of San Joaquin Kit Fox in the CNDDB for the species' northern range, and only 28 records of the species north of I-580/205, which span almost 50 years; many are questionable in reliability relative to location accuracy and identification. Clark et al. 2007 analyzed CNDDB records of San Joaquin kit foxes and their results indicate that many of the records may be misidentification of coyote pups. Most of the records from the northern range are more than 30 years old and were apparently re-creations of recalled occurrences, and at least some have factual errors.

An example of a likely factual error is record #561 from 1987, which states that the fox was observed near a wind generator, but there have been no wind generators in the area delineated for the occurrence. Additionally, only 2 records are of kit fox in agricultural areas (based on occurrence delineation and description of habitat):

1. "1 juvenile kit fox observed during daylight in Jun 1991" in an agricultural field north of the town of Byron (record #575); it is unlikely that a juvenile kit fox would be away from its den at such a young age, especially during the day;

2. One along an Old River levee in 1991 (record #60), based on a print on a track pad; it is unlikely a kit fox would be in a riparian zone almost 3 miles from suitable grassland habitat. Neither record is confirmed by follow-up surveys.

Based on the description of the sighting on number 1, and the location and basis for number 2, both records have a high potential to be identification error.

There are just 5 records for kit fox north of I-580/205 in the last 20 years, although there have been numerous surveys completed during that time. Two records are based on tracks, with no apparent confirmation through follow-up surveys.

Only one record is of kit fox in an area consistent with the project location and habitat type: record #34 adjacent to the Tracy Pumping Plan intake. This record well indicates the likelihood of mistaken records in the CNDDB from observers unfamiliar with the species:

- Observer indicates there were 40 dens in what is approximately a 3 acre area, including approximately 10 “recent dens.”
- Observer notes hearing a “yip”, indicating a kit fox was present.
- Observer concludes that the small area supports a small population of kit fox, for several years.
- Observer cites observations of kit fox by Western Area Power Administration employees.

What the observer is describing is a cluster of holes created by a colony of California ground squirrels, with potentially a coyote or red fox in the area, based on the following.

- The observer is obviously counting holes, not dens. Ten “recent [kit fox] dens” in an area that size is highly unlikely; kit fox are not colonial and dens are spread among very large areas.
- An observer familiar with the species would know that kit fox have a very distinct “roop” call; a “yip” is more characteristic of a red fox or coyote.
- Kit fox are not communal like ground squirrels; the small area would not support a “small population” of kit fox.
- Non-biologists regularly mistake red foxes and young coyotes for kit foxes (pers ob). Red foxes and coyotes are much more likely to be active during the day than kit fox, when workers are likely to see them. Biologists without sufficient experience with kit foxes will also sometimes mistake coyote pups with kit foxes, as coyote pups can look remarkably similar to adult kit foxes (Clark et al. 2007).

On February 4, 2016, DWR staff with kit fox life history expertise surveyed the site; there were approximately 30 burrow holes, and 6 showed signs of recent excavation, but all were too small for kit fox use and were obviously ground squirrel burrows. Canid scats was observed at two locations in the immediate area but were too large for kit fox, and were identified as red fox scat. The conclusion based on the above analysis is that the record is unreliable.

On June 30, 2016, California Department of Fish and Wildlife indicated that some experts believe San Joaquin kit fox may still occur in the action area (pers. comm. Brooke Jacobs).

4.5.8.2 Suitability of Kit Fox Habitat in the Action Area

Kit fox are optimally adapted to arid environments with sparse vegetation. Cypher et al 2013 evaluated habitat in the kit fox range based on habitat use where kit fox populations were robust and persistent. Desert scrub, grassland, and short ruderal grassland had the highest habitat values to the species. Field crops, vineyards, and pasture had low value, as did riparian habitats. Kit fox are unable to use croplands to any significant extent (Warrick, et al 2007). Higher rainfall totals in the Northern Range support higher and increasing densities of competitors and predators such as coyotes, red fox, gray fox and bobcats, which puts the arid habitat-adapted kit fox at a great disadvantage (Orloff et al 1986).

Kit fox in the northern range, if they persist there at all, have large home ranges (USFWS 1998); Cypher suggests this is due to moderate to poor quality habitat available in the region (Cypher 2013). Kit fox family groups require between 1,500 and 2,000 acres of optimal habitat, and considerably more habitat where habitat quality is moderate or poor (Spiegel Bradbury 1992, Cypher et al. 2007); for the entire counties of Contra Costa and Alameda combined, there are less than 5,000 acres of high suitability habitat (Cyper et al. 2013), only enough to support a few family groups of kit fox (Spiegel Bradbury 1992, Cypher et al. 2007), and only if it is contiguous and accessible (Cypher et al. 2013).

The northern range habitat that is usable by kit fox is characterized by medium suitability habitat grasslands which may not be able to sustain populations of kit fox (Cypher 2013). The grassland habitats of the northern range may lack important components needed by kit fox, and this may prevent it from surviving in the region (Clark et al. 2007). Grassland vegetation is often taller and more dense than optimal for kit fox use (Cypher et al. 2013).

Irrigated agricultural fields in northern San Joaquin County were the result of conversion of marsh and riparian forest; kit fox probably did not occupy these irrigated fields to any extent, if at all (Clark et al. 2007). The rocky, clay soils in the Northern Range are not optimal for kit fox denning, typically harder than Southern Range soils; the species relies on enlarging California ground squirrel burrows due to the hard soils (Clark et al. 2007). Orloff found that kit fox use up to 20 or more dens in their home range, so the species would be limited to areas with active ground squirrel colonies (Clark et al. 2007). Additionally, kit fox in the Northern Range rely on California ground squirrels as primary prey (in the Southern Range, where kit fox populations persist, the primary prey is kangaroo rats, which are not present in the Northern Range); California ground squirrels are a diurnal species (kit fox are nocturnal) and not considered an optimal prey species; they are also susceptible to reduced populations from poisoning campaigns (Orloff et al 1986, Clark et al 2007)

Irrigated agricultural lands are typically devoid of kit fox (Warrick et al. 2007, Jensen 1973, Morrell 1975). Cultivated and irrigated agricultural lands may be used as accessory areas adjacent to and in association with expansive natural lands, but kit fox require large blocks of high suitable natural lands and are unable to rely solely on agricultural lands for survival (Cypher et al 2007, 2013). Irrigated and cultivated land limit availability of dens through disking, flooding, and squirrel control (Warrick et al. 2007, Cyper et al. 2007). Dens are a necessity for the species to escape interspecific domination, predation and displacement by coyotes and red fox which are well adapted to use irrigated and cultivated lands, and are primary causes of mortality for kit fox (Orloff et al 1986, Clark et al 2007). Furthermore, cultivated lands have low prey availability for kit fox (Warrick et al. 2007).

Grassland and agricultural habitats common in the Northern Range often have dense vegetation greater than 18 inches high that reduces visibility for the fox and likely increases risk of predation by coyotes and red fox, and thus are avoided by kit fox (Cypher et al. 2007). Non-grazed grasslands in the Northern Range associated with levees, fallow and idle lands have tall, dense vegetation that kit fox would avoid. Vineyards are problematic because of vegetation height, density, lack of visibility in all directions, and force movement in one direction (Cypher et al. 2007).

Significant barriers interfere with kit fox movement north from populated areas, and east and west between fragments of available habitat, including major interstate and other highways, aqueducts and large canals, reservoirs, housing development, dense and or tall agriculture vegetation, utility centers and other human structures with impassable fences (Bradbury, pers obs). High densities of wind generators and associated infrastructure reduce available habitat, prey, and dens (Orloff et al. 1986), and produce extremely loud noise on frequent windy nights that may interfere with kit fox hunting adaptation (ability to hear prey) (Bradbury, pers ob).

If kit fox persist north of I-580/205, they are likely relegated to the large tracts of grazed grassland west of the California Aqueduct where barriers to movement are minimal, increasing their ability to use the large home ranges needed to survive (Orloff et al 1986, Clark et al 2007, Cypher et al 2007, 2013).

The area around the project construction footprint is primarily characterized by unsuitable denning and foraging habitat. The available moderate to high quality habitat is highly fragmented and surrounded by multiple barriers, including numerous waterbodies and waterways, human development and activity areas, high use roadways, and non-traversable (by kit fox) agricultural lands such as vineyards. Much of the naturals lands are characterized by tall and weedy ruderal vegetation, large shrubs, and wetlands. The traversable agricultural lands are irrigated and cultivated, habitats avoided by kit fox.

4.5.9 California Least Tern

The California least tern (*Sternula antillarum browni*) is listed as endangered under both ESA and CESA. The species was listed by the California Fish and Game Commission pursuant to CESA) (Fish and Game Code, Sections 2050 *et seq.)* on June 27, 1971, and by the USFWS pursuant to the ESA on October 13, 1970 (35 FR 8491). The California least tern is also designated as a state fully protected species. Critical habitat has not been designated for this species.

The historical breeding range of the California least tern extends along the Pacific Coast from approximately Moss Landing to the southern tip of Baja California (Grinnell and Miller 1944). However, since about 1970, colonies have been reported north to San Francisco Bay (U.S. Fish and Wildlife Service 2006b). The nesting range in California is somewhat discontinuous as a result of the availability of suitable estuarine shorelines, where California least terns often establish breeding colonies. Marschalek (2006) identified six geographic population clusters along the Pacific Coast in California, including San Diego, Camp Pendleton, Los Angeles/Orange County, Ventura County, San Luis Obispo/Monterey County, and San Francisco Bay. The majority of the California population is concentrated in three counties: San Diego, Orange, and Los Angeles.

Statewide surveys in 2010 estimated a minimum of 6,437 breeding pairs, with about 85% of the breeding colonies occurring in Southern California and only a small percentage (6.3% or 406 breeding pairs) occurring in the San Francisco Bay Area (Marschalek 2011). Statewide, the growth of the breeding population has been dramatic since state and federal listing of the California least tern, from only several pairs in the late 1960s to a current minimum of 6,437 pairs (Marschalek 2011). Marschalek (2011) reported on monitoring activities at six active breeding colonies in the San Francisco Bay Area in 2010, with a total number of breeding pairs estimated at approximately 406.

The loss, degradation, and disturbance of suitable coastal strand and estuarine shoreline habitat are the primary reasons for the historical reduction of California least tern populations. Most extant colonies occur on small patches of degraded nesting habitat surrounded on all sides by human activities. The majority of colony sites are in areas that were incidentally created during development projects. Further expansion and recovery of the California least tern population may require the creation or restoration of habitat (U.S. Fish and Wildlife Service 2006b).

Recently, three California least tern nesting sites have been reported from the vicinity of the action area, Pittsburg Power Plant, Bufferlands, and Montezuma Wetlands (see Figure 6.4-1) (Marschalek 2011). The Pittsburg Power Plant nesting location in Pittsburg is over 15 miles from the nearest water conveyance facility on the very western edge of the action area. This nesting location is not considered successful, in 2010, Marschalek (2011) documented no breeding pairs at this site. This was the third time in the last 4 years that least terns did not nest at this site.

The Bufferlands, a part of the Sacramento Regional Wastewater Treatment Facility, is approximately three miles from the northernmost extent of the water conveyance facility. This site supported one successful breeding pair for three years (2009, 2010, and 2011) (Marschalek 2010 and 2011; Frost 2013). In 2012, one breeding pair created two unsuccessful nests and in 2013, no nesting was attempted (Frost 2014). There are no breeding records beyond 2013. Because this site hosted only one nesting pair, it is not considered a colony.

California least terns have nested at the Montezuma Wetlands on the eastern edge of Suisun Marsh near Collinsville since 2006. This colony is over 15 miles from the nearest covered activity location. This colony site was unintentionally created as part of a wetlands restoration project that requires increasing the elevation of certain areas prior to flooding (Marschalek 2008). A pile of sand and shells, formed during excavation of the wetland restoration site, attracted terns to the site, which to date has prevented completion of the restoration project. Marschalek (2011) reports 23 breeding pairs (0.036%), 17 nests, and at least five fledglings from this breeding colony in 2010.

There is one record of a California least tern foraging in the Clifton Court Forebay from 1994 (Yee et al. 1995). However, California least tern is not expected to be foraging at the forebay because it is 20 miles from the nearest nesting site (Pittsburg), which is currently not supporting breeding.

The action area is on the eastern fringe of the more successful breeding area of South San Francisco Bay. The locations of current or historic colonies are greater than 2 miles from construction areas, the typical distance California least terns will travel from their colonies to forage (Atwood and Minsky 1983). For this reason, it is very unlikely that California least terns will forage in or near the water conveyance facility footprint.

4.5.10 Western Yellow-billed Cuckoo

The Western distinct population segment (DPS) of the yellow-billed cuckoo (*Coccyzus americanus occidentalis*) was listed as threatened under the ESA on October 2, 2014 (79 FR 59991-60038). Western yellow-billed cuckoo is also listed as an endangered species under the CESA.

The historical distribution of the western yellow-billed cuckoo extended throughout the Central Valley, where Belding (1890) still considered the species common. In the mid-1940s, Grinnell and Miller (1944) still considered the Central Valley distribution to extend from Bakersfield to Redding.

Currently, the only known breeding populations of western yellow-billed cuckoo are in several disjunct locations in California, Arizona, and western New Mexico (Halterman 1991; Johnson *et al.* 2007; Dettling *et al.* 2015; Stanek 2014; Parametrix Inc. and Southern Sierra Research Station 2015). Yellow-billed cuckoos winter in South America from Venezuela to Argentina (Hughes 1999; Sechrist *et al.* 2012) after a southern migration that extends from August to October (Laymon 1998). They migrate north and arrive at California breeding grounds between May and July, but primarily in June (Gaines and Laymon 1984; Hughes 1999; 78 FR 61621).

Studies conducted in 1986 and 1987 indicate that at that time there were approximately 31 to 42 pairs in California (Laymon and Halterman 1987). While a few occurrences have been detected elsewhere recently, including near the Eel River, the only locations in California that currently sustain breeding populations include the Colorado River system in Southern California, the South Fork Kern River east of Bakersfield, and isolated sites along the Sacramento River in California just north of the action area (See Figure 2A.25-1 in California Department of Water Resources 2013a) (Laymon and Halterman 1989; Laymon 1998; Halterman 2001; Hammond 2011; Dettling *et al.* 2014; Stanek 2014; Parametrix Inc. and Southern Sierra Research Station 2015). In 2013, there were two unconfirmed audible occurrences along the American River Parkway approximately 5 miles from the action area. These two occurrences were less than 5 miles apart along the river and heard on the same day (EBird 2015). In 2015 there was a confirmed visual occurrence along the American River located in proximity to both the 2013 audible occurrences and approximately 5 miles from the action area (EBird 2015).

Designation of critical habitat for the Western DPS of yellow-billed cuckoo was published in the Federal Register on August 15, 2014 (57 FR 48547-48652). There is no designated critical habitat for the Western DPS of yellow-billed cuckoo in the action area.

Historical declines of the western yellow-billed cuckoo are attributed to the removal of riparian forests in California for agricultural and urban expansion. Habitat loss and degradation continue to be the most significant threats to remaining populations. Habitat loss continues as a result of bank stabilization and flood control projects, urbanization along edges of watercourses, agricultural activities, and river management that alter flow and sediment regimes. Nesting cuckoos are also sensitive to habitat fragmentation that reduces patch size (Hughes 1999). Pesticide use associated with agricultural practices may affect behavior and cause death or potentially affect prey populations (Hughes 1999). Predation is a significant source of nest failures, which have been recorded at 80% in some areas (Hughes 1999). Fragmentation of occupied habitats could make nest sites more accessible and more vulnerable to predation. Nestlings and eggs are vulnerable to predation by snakes, small mammals, and birds.

While there are only two historical records in the action area (California Department of Fish and Wildlife 2013), the species is known to have been historically common in riparian habitat throughout the Central Valley, from Kern County north to Redding (Laymon 1998) (see Figure 2A.25-2 in California Department of Water Resources 2013a).

There are no recently confirmed western yellow-billed cuckoo breeding locations in the action area. In summer 2009, DWR detected one and possibly two yellow-billed cuckoos in a remnant patch of riparian forest near Delta Meadows (Delta Habitat Conservation and Conveyance Program 2011). However, breeding status was not confirmed. The two historic sightings and the two recent sightings of yellow-billed cuckoo near the action area are presumed to be migrating birds.

Most riparian corridors in the action area do not support sufficiently large riparian patches or the natural geomorphic processes that provide suitable cuckoo breeding habitat (Greco 2013); however, the species likely continues to migrate along the Sacramento River and other drainages to northern breeding sites in the Sutter Basin and Butte County. Several remnant riparian patches near Mandeville and Medford Islands provide suitable riparian vegetation for cuckoos, but may not provide sufficiently large patch size to support breeding cuckoos.

4.5.11 Giant Garter Snake

Giant garter snake (*Thamnophis gigas*) was listed as threatened under the ESA on October 20, 1993 (58 FR 54033). Giant garter snake is also listed as threatened under the CESA. The *Draft Recovery Plan for the Giant Garter Snake* was completed in 1999 (U.S. Fish and Wildlife Service 1999b) and a 5-year review was completed in 2012 (U.S. Fish and Wildlife Service 2012). USFWS is currently preparing a revised draft recovery plan for the giant garter snake. Critical habitat has not been designated for giant garter snake.

Occurrence records indicate that giant garter snakes are distributed in 13 unique population clusters coinciding with historical flood basins, marshes, wetlands, and tributary streams of the Central Valley (Hansen and Brode 1980; Brode and Hansen 1992; U.S. Fish and Wildlife Service 1999b). These populations are isolated, without protected dispersal corridors to other adjacent populations. USFWS recognizes these 13 extant populations (58 FR 54053) as including Butte Basin, Colusa Basin, Sutter Basin, American Basin, Yolo Basin-Willow Slough, Yolo Basin-Liberty Farms, Sacramento Basin, Badger Creek-Willow Creek, Coldani Marsh, East Stockton Diverting Canal and Duck Creek, North and South Grassland, Mendota, and Burrel-Lanare. These populations extend from Fresno north to Chico and include portions of 11 counties: Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo (U.S. Fish and Wildlife Service 1999b:9, 11–12).

Habitat loss and fragmentation, flood control activities, changes in agricultural and land management practices, predation from introduced and native species, parasites, and water pollution are the main causes for the decline of giant garter snake. Conversion of Central Valley wetlands for agriculture and urban uses has resulted in the loss of as much as 95% of historical habitat for giant garter snake (Wylie et al. 1997). In areas where giant garter snake has adapted to agriculture, maintenance activities such as vegetation and rodent control, bankside grading or dredging, and discharge of contaminates, threaten their survival (Hansen and Brode 1980; Hansen and Brode 1993; U.S. Fish and Wildlife Service 1999b; Wylie et al. 2004). In developed areas, threats of vehicular mortality also are increased. Paved roads likely have a higher rate of mortalities than dirt or gravel roads due to increased traffic and traveling speeds. The loss of wetland habitat is compounded by elimination or compaction of adjacent upland and associated bankside vegetation cover, as well as water fouling; these conditions are often associated with cattle grazing (Thelander 1994). While irrigated pastures may provide the summer water that giant garter snakes require, high stocking rates may degrade habitat by removing protective plant cover and underground and aquatic retreats such as rodent and crayfish burrows (Hansen 1986; U.S. Fish and Wildlife Service 1999b; Szaro et al. 1985). However, cattle grazing may provide an important function in controlling invasive vegetation that can compromise the overall value of wetland habitat.

The action area is in the Mid-Valley Recovery Unit identified in the draft recovery plan (U.S. Fish and Wildlife Service 1999b), and three of the 13 giant garter snake populations identified by USFWS are located in the action area along the periphery of the Delta, including the Yolo Basin-Willow Slough, Yolo Basin-Liberty Farms, and Coldani Marsh-White Slough populations (Figure 6.6-1) (U.S. Fish and Wildlife Service 1999b). The rarity and isolation of giant garter snake from within the remainder the Delta suggest the lack of other extant populations in the area. While giant garter snakes may have occupied this region at one time, longstanding reclamation of wetlands for intense agricultural applications has eliminated most suitable habitat (Hansen 1986). Recent sightings of giant garter snakes in the Central Delta on Webb and Empire Tracts and on Jersey and Bradford Islands (Hansen pers. comm. 2015), however, suggest giant garter snakes are using portions of the Central Delta previously thought to be unoccupied.

4.5.12 California Red-legged Frog

California red-legged frog (*Rana draytonii*) was listed as threatened pursuant to the ESA in 1996 (61 FR25813). A recovery plan was prepared for this species by USFWS in 2002 (U.S. Fish and Wildlife Service 2002), and a 5-year review was initiated in 2011 (76 FR 30377). California red-legged frog is also considered a species of special concern by CDFW.

The historical range of the California red-legged frog generally extends south along the coast from the vicinity of Point Reyes National Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California, southward along the interior Coast Ranges and Sierra Nevada foothills to northwestern Baja California, Mexico (U.S. Fish and Wildlife Service 2007b). While there are a few historical records from several Central Valley locales (Jennings and Hayes 1994), Fellers (2005) considers persistent occupancy in the lowlands of the Central Valley unlikely due to extensive annual flooding.

The current range is generally characterized based on the current known distribution. USFWS (2007b) notes that while the California red-legged frog is still locally abundant in portions of the San Francisco Bay Area and the Central Coast, only isolated populations have been documented elsewhere within the species' historical range, including the Sierra Nevada, northern Coast Ranges, and northern Transverse Ranges.

Final designation of critical habitat for California red-legged frog was published in the Federal Register on March 17, 2010 (75 FR 12816–12959). There is no designated critical habitat for California red-legged frog in the action area. Critical habitat unit ALA-2 is located west of Clifton Court Forebay near the action area.

Habitat loss, degradation, and fragmentation are significant factors in declining populations of California red-legged frogs. Conversion of lands to agricultural and urban uses, overgrazing, mining, recreation, and timber harvesting have all contributed to habitat losses and disturbances. Urbanization often fragments habitat and creates barriers to dispersal (U.S. Fish and Wildlife Service 2002). Road densities generally increase because of urbanization. Roads can create significant barriers to frog dispersal (Reh and Seitz 1990) and reduce population densities due to mortality caused by automobile strikes (Fahrig et al. 1995; Yolo County Habitat Conservation Plan/Natural Community Conservation Plan Joint Powers Agency 2009).

In the action area, California red-legged frog has been detected only in aquatic habitats within the grassland landscape west and southwest of Clifton Court Forebay and in the vicinity of Brentwood and Marsh Creek along the west-central edge of the action area, and in some upland sites in the vicinity of Suisun Marsh (See Figure 6.7-1). These areas are within the easternmost edge of the current range of California red-legged frog within the Coast Ranges. While there are several recent records of the species in the Sierra Nevada foothills, California red-legged frog is not known to occur in the agricultural habitats of the Central Valley. The California Natural Diversity Database (CNDDB) contains records for several occurrences along Marsh Creek and Clifton Court Forebay and the western edge of the Suisun Marsh (California Department of Fish and Wildlife 2013). Occupied habitats are characterized by grassland foothills with stock ponds and slow-moving perennial drainages. The species is not known to occur, nor is it expected to occur, elsewhere in the action area.

4.5.13 California Tiger Salamander

The Central California distinct population segment of California tiger salamander (which overlaps with the action area) is federally listed as threatened (50 FR 47212–47248, August 4, 2004). California tiger salamander is also listed as threatened under the California Endangered Species Act (CESA).

Historically, California tiger salamander occurred throughout the grassland and woodland areas of the Sacramento and San Joaquin River Valleys and surrounding foothills, and in the lower elevations of the central Coast Ranges (Barry and Shaffer 1994). The species is found in relatively dry landscapes where its range is limited by its aestivation and winter breeding habitat requirements, which are generally defined as open grassland landscapes with ephemeral pools and with ground squirrel and pocket gopher burrows (Barry and Shaffer 1994).

Within the coastal range, the species currently occurs from southern San Mateo County south to San Luis Obispo County, with isolated populations in Sonoma and northwestern Santa Barbara Counties (California Department of Fish and Wildlife 2010). In the Central Valley and surrounding Sierra Nevada foothills, the species occurs from northern Yolo County southward to northwestern Kern County and northern Tulare and Kings Counties (California Department of Fish and Wildlife 2010).

Final designation of critical habitat for the Central California Population of California tiger salamander was published in the Federal Register on August 23, 2005 (70 FR 49380-49458). There is no designated critical habitat for California tiger salamander in the action area. Critical habitat Unit 2, the Jepson Prairie Unit, is located west of the action area.

Conversion of land to residential, commercial, and agricultural activities is considered the most significant threat to California tiger salamanders, resulting in destruction and fragmentation of upland and/or aquatic breeding habitat and killing of individual California tiger salamanders (Twitty 1941; Shaffer et al. 1993; Jennings and Hayes 1994; Fisher and Shaffer 1996; Loredo and van Vuren 1996; Davidson et al. 2002; California Department of Fish and Game 2010). Roads can fragment breeding habitats and dispersal routes in areas where they traverse occupied habitat. Features of road construction, such as solid road dividers, can further impede migration, as can other potential barriers such as berms, pipelines, and fences.

Several occurrences of California tiger salamander are located immediately west of Clifton Court Forebay, near the action area (See Figure 6.8-1). Current occupancy of some of these sites was confirmed by larval surveys conducted between 2009 and 2011 by DWR. There are numerous additional occurrences of California tiger salamander in vernal pool and pond habitats in the grassland foothills west of the action area and south of Antioch. Vernal pool habitats in Yolo and Solano Counties west of Liberty Island and in the vicinity of Stone Lakes in Sacramento County also provide suitable habitat for the species.

4.5.14 Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is listed as threatened under the ESA (45 FR 52803). On October 2, 2006, the USFWS, in their 5-year review, recommended this species be removed from the endangered species list (U.S. Fish and Wildlife Service 2006a). On October 2, 2012, USFWS issued a proposed rule to remove the species from the endangered species list (77 FR 60238). However, USFWS withdrew the proposed rule on September 17, 2014 based on their determination that the proposed rule did not fully analyze the best available information (79 FR 55873).

Valley elderberry longhorn beetle is one of three species of *Desmocerus* in North America and one of two subspecies of *D. californicus*. The valley elderberry longhorn beetle subspecies is a narrowly defined, endemic taxon, limited to portions of the Central Valley generally below 3,000 feet in elevation (U.S. Fish and Wildlife Service 1999a).

Historically, valley elderberry longhorn beetle presumably occurred throughout the Central Valley from Tehama County to Fresno County (79 FR 55880). The historic range was recently revised to no longer include Tulare and Shasta Counties (79 FR 55880). Little is known about the historical abundance of valley elderberry longhorn beetle. The extensive destruction of its habitat, however, suggests that the beetle’s range has been largely reduced and fragmented (U.S. Fish and Wildlife Service 1984).

The current distribution of valley elderberry longhorn beetle is similar to its historic range, though it is “uncommon or rare, but locally clustered”. Currently, valley elderberry longhorn beetle is known from 17 hydrologic units and 36 discrete geographical locations within the Central Valley (79 FR 55872-55873).

The USFWS promulgated the final ruling designating critical habitat for valley elderberry longhorn beetle on August 8, 1980 (45 FR 52804). Two critical habitat areas were designated along portions of the American River in Sacramento County (the Sacramento Zone and the American River Parkway Zone). Critical habitat for valley elderberry longhorn beetle is not located within the action area.

The current distribution of valley elderberry longhorn beetle in the action area is largely unknown. There are only three reported occurrences of valley elderberry longhorn beetle in the action area, including one along Middle River north of Tracy and two occurrences along small drainages between the Sacramento River and the Sacramento Deep Water Ship Channel in the vicinity of West Sacramento (See Figure 6.9-1(California Department of Fish and Wildlife 2013). There are additional historical occurrences from along the Sacramento River corridor and Putah Creek in Yolo County (Jones & Stokes 1985, 1986, 1987; U.S. Fish and Wildlife Service 1984; Barr 1991; Collinge et al. 2001). Comprehensive surveys for the species or its host plant, elderberry, have not been conducted and thus the population size and location of the species in the action area is unknown. Distribution is typically based on the occurrence of elderberry shrubs, which are known to occur along riparian corridors throughout the action area, including the Sacramento River, Stanislaus River, San Joaquin River, and along smaller natural and channelized drainages, as well as in upland habitats.

4.5.15 Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp is listed as threatened under the ESA throughout its range (59 *Federal Register* [FR] 48136). In September 2007, USFWS published a 5-year review recommending that the species remain listed as threatened. In addition, on May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered.

There is little information on the historical range of vernal pool fairy shrimp. The species is currently known to occur in a wide range of vernal pool habitats in the southern and Central Valley areas of California, and in two vernal pool habitats in the Agate Desert area of Jackson County, Oregon (U.S. Fish and Wildlife Service 2005). It has the largest geographical range of listed fairy shrimp in California, but is seldom abundant (Eng et al. 1990). The species is currently found in fragmented habitats across the Central Valley of California from Shasta County to Tulare and Kings Counties, in the central and southern Coast Ranges from Napa County to Los Angeles County, and inland in western Riverside County, California (U.S. Fish and Wildlife Service 2005, 2007a; California Department of Fish and Wildlife 2013).

The final rule designating critical habitat for vernal pool fairy shrimp was published in the Federal Register on February 10, 2006 (71 FR 7118–7316). Designated critical habitat for vernal pool fairy shrimp is located along the northern margin of Suisun Marsh and west of Clifton Court Forebay near Byron. The designated critical habitat for vernal pool fairy shrimp is in Unit 11D (10,707 total acres; an estimated 9,579 acres in the action area). The primary constituent elements (PCEs) of critical habitat for vernal pool fairy shrimp include: (1) topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools; (2) depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum time period (18 days for vernal pool fairy shrimp); (3) food sources, such as detritus occurring in the pools, single-celled bacteria, algae, and dead organic matter; and (4) structure within the pools vernal pools consisting of organic and inorganic materials that provide shelter.

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other because of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Vernal pool fairy shrimp has been reported from several locations in the action area (See Figure 6.10-1) (U.S. Fish and Wildlife Service 2005, 2007a; California Department of Fish and Wildlife 2013). In general, in the action area, vernal pools that may support the species occur in Jepson Prairie, in the CDFW Tule Ranch Unit of the Yolo Bypass Wildlife Area, in the Stone Lakes Wildlife Refuge, west of Clifton Court Forebay near the town of Byron, and along the eastern and northern boundary of Suisun Marsh. Other potential vernal pool habitat occurs along the eastern boundary of Stone Lakes (See Figure 2A.37-2 in California Department of Water Resources 2013a). Vernal pool fairy shrimp were observed at seven locations in the south Stone Lakes area and in three locations in the Clifton Court Forebay during 2009 surveys conducted by the DWR (Appendix 4.C, *Vernal Pool Surveys*). A comprehensive survey of vernal pools or habitat for vernal pool fairy shrimp has not been conducted in the action area.

4.5.16 Vernal Pool Tadpole Shrimp

Vernal pool tadpole shrimp (*Lepidurus packardi*) was listed as endangered throughout its range under the ESA on September 19, 1994 (59 FR 48136). In September 2007, USFWS published a 5-year review recommending that the species remain listed as endangered. In addition, on May 25, 2011, USFWS initiated a new 5-year review to determine if the species should remain listed as endangered.

Historically, vernal pool tadpole shrimp probably did not occur outside of the Central Valley and Central Coast regions (U.S. Fish and Wildlife Service 2005). Currently, vernal pool tadpole shrimp occurs in the Central Valley of California and in the San Francisco Bay Area (See Figure 2A.38-1 in California Department of Water Resources 2013a). The species has a patchy distribution across the Central Valley of California from Shasta County southward to northwestern Tulare County (U.S. Fish and Wildlife Service 2007a). In the Central Coast Vernal Pool Region, the vernal pool tadpole shrimp is found the San Francisco National Wildlife Refuge and on private land in Alameda County near Milpitas (U.S. Fish and Wildlife Service 2007a; California Department of Fish and Wildlife 2013). The largest concentration of vernal pool tadpole shrimp occurrences is found in the Southeastern Sacramento Vernal Pool Region, where the species occurs on a number of public and private lands in Sacramento County (U.S. Fish and Wildlife Service 2005, 2007a).

Final designation of critical habitat for vernal pool tadpole shrimp was published in the Federal Register on February 10, 2006 (71 FR 7118–7316). Designated critical habitat for vernal pool tadpole shrimp is located along the northern margin of Suisun Marsh, outside the action area. The PCEs of critical habitat for vernal pool tadpole shrimp include: (1) topographic features characterized by mounds and swales, and depressions within a matrix of surrounding uplands that result in complexes of continuously, or intermittently, flowing surface water in the swales connecting the pools; (2) depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water for a minimum time period (41 days for vernal pool tadpole shrimp); (3) food sources, such as detritus occurring in the pools, and single-celled bacteria, algae, and dead organic matter; and (4) structure within the pools vernal pools consisting of organic and inorganic materials that provide shelter.

Habitat loss and fragmentation were identified as the largest threats to the survival and recovery of vernal pool species. Habitat loss generally is a result of agricultural conversion from rangelands to intensive farming, urbanization, aggregate mining, infrastructure projects (such as roads and utility projects), and recreational activities (such as off-highway vehicles and hiking) (U.S. Fish and Wildlife Service 2005). Habitat fragmentation occurs when vernal pool complexes are broken into smaller groups or individual vernal pools and become isolated from each other because of activities such as road development and other infrastructure projects (U.S. Fish and Wildlife Service 2005).

Vernal pool tadpole shrimp has been reported from several locations in the action area (See Figure 2A.38-2 in California Department of Water Resources 2013a) (U.S. Fish and Wildlife Service 2005, 2007a; California Department of Fish and Wildlife 2013). In general, within the action area, vernal pools that may support the species occur in Jepson Prairie, in CDFW's Tule Ranch Unit of the Yolo Bypass Wildlife Area, in the Stone Lakes, and along the eastern and northern boundary of Suisun Marsh (See Figure 6.10-1)). Vernal pool tadpole shrimp was found in six locations in the Stone Lakes area during 2009 surveys conducted by DWR (Appendix 4.C, *Vernal Pool Surveys*). No vernal pool tadpole shrimp were found in vernal pools surveyed near Clifton Court Forebay. A comprehensive survey of vernal pools or habitat for the vernal pool tadpole shrimp has not been conducted throughout the action area.

4.5.17 Least Bell's Vireo

Activities associated with north delta intakes, reusable tunnel material areas, the HOR gate, Clifton Court Forebay modification, water conveyance facilities, transmission lines, geotechnical exploration, and unsited safe haven intervention sites may affect least Bell's vireo. Effects on modeled least Bell's vireo habitat is described in Section 6.11 *Effects on Least Bell's Vireo*. Modeled habitat is described in Section 4.A.15.7 *Species Habitat Suitability Model*.

Least Bell's vireo (*Vireo bellii pusillus*) was listed as endangered under the ESA on May 2, 1986 (51 FR 16474-16482). The species is also listed as endangered under the CESA. Least Bell's vireo is one of four subspecies of Bell's vireo and is the only subspecies that breeds entirely in

California and northern Baja California. Arizona Bell's vireo (*V. bellii arizonae*) is found along the Colorado River and may occur on the California side, but otherwise occurs throughout Arizona, Utah, Nevada, and Sonora, Mexico (Kus 2002a).

Since ESA listing in 1986, populations have gradually increased and the subspecies has recolonized portions of its historical range. Increases are attributed primarily to riparian restoration and efforts to control the brood parasite brown-headed cowbird (Kus 1998 and Kus and Whitfield 2005 in Howell et al. 2010). By 1998, the total population was estimated at 2,000 pairs and recolonization was reported along the Santa Clara River in Ventura County, the Mojave River in San Bernardino County, and sites in Monterey and Inyo Counties (Kus and Beck 1998; Kus 2002a; U.S. Fish and Wildlife Service 2006c). A single nest was reported from Santa Clara County near Gilroy in 1997 (Roberson et al. 1997). Still, the distribution remained largely restricted to San Diego County (76%) and Riverside County (16%) (U.S. Fish and Wildlife Service 2006c).

By 2005, the population had reached an estimated 2,968 breeding pairs (U.S. Fish and Wildlife Service 2006c) with increases in most southern California Counties and San Diego County (primarily Camp Pendleton Marine Corps Base) supporting roughly half of the current population (U.S. Fish and Wildlife Service 2006c). Recent occurrences have suggested a range expansion to the northern extent of the subspecies' historical breeding range.

Final designation of critical habitat for least Bell's vireo was published in the Federal Register on February 2, 1994 (59 FR 14845-4867). There is no designated critical habitat for least Bell's vireo in the action area.

A major factor leading to declines in populations of least Bell's vireo is the loss and degradation of riparian woodland habitat throughout the species' range. Habitat loss and degradation can occur through clearing of vegetation for agriculture, timber harvest, development, or flood control (U.S. Fish and Wildlife Service 1998).

Other than recent activity in the Yolo Bypass Wildlife Area, are no records of least Bell's vireos breeding in the action area since at least the 1970s. Two singing males were detected in the Yolo Bypass Wildlife Area in mid-April 2010, and again in 2011 (California Department of Fish and Wildlife 2013). In 2010, a vireo was seen in this area carrying nesting material, a sign of breeding (Whistler, pers. comm. 2015). However, no least Bell's vireos were detected in the Yolo Bypass Wildlife Area during surveys in 2012. One singing male was detected in 2013, and surveys were not conducted in 2014. The next-nearest most recent occurrence (noted above) is approximately 7 miles south of the action area at the San Joaquin River National Wildlife Refuge in the San Joaquin and Tuolumne River floodplain (Howell et al. 2010). This occurrence includes three nests sites between 2005 and 2007, all on a recently restored portion of San Joaquin River National Wildlife Refuge lands known as Hagemann's Fields 6 and 9. The 2005 and 2006 nests were successful, and the 2007 nest was not. The 2005 and 2006 nest sites were in a 3-year-old arroyo willow with understory plants including mugwort, sunflower, gumplant, and creeping wild rye. The 2007 nest was in a dead arroyo willow (Howell et al. 2010).

4.6 References

4.6.1 Written References

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4.6.2 Personal Communications

Bradbury, Mike. pers. comm. Statement made at a TTT meeting on July 2, 2015. Mr. Bradbury is the California WaterFix permitting lead for 404/2081/Section 7 compliance, and a Program Manager II.

Hansen, E.C. March 2015—Phone conversation regarding presences of Giant Garter Snakes in the Delta.

Kelly, Patrick. Professor at California State University at Stanislaus and Director of Endangered Species Recovery Program. December 2015—email to Heather Swinney with a shapefile attachment containing RBR records for the South Delta (and elsewhere) including data submitted to the CNDDB and one more recent record at Durham Ferry from Patrick Kelly (Endangered Species Program at Stanislaus State University) which was then forward to Rebecca Sloan at ICF.

Rea, Maria. Assistant Regional Administrator, West Coast Region, National Marine Fisheries Service. January 16, 2015—letter to Mr. Ron Milligan, Operations Manager, Central Valley Project, U.S. Bureau of Reclamation, regarding estimated number of juvenile Sacramento River winter-run Chinook salmon expected to enter the Sacramento-San Joaquin Delta during water year 2015.

Whisler, Edward. July 13, 2015—Email regarding survey effort and results for Least Bells' Vireo in the Yolo Bypass. Williams, D. F. 1988. *Ecology and Management of the Riparian Brush Rabbit in Caswell Memorial State Park.* California Department of Parks and Recreation, Lodi, CA. Interagency Agreement 4-305-6108.