San Luis Low Point Improvement Project Environmental Impact Statement / Environmental Impact Report

Appendix L1: Fish Resources in the Area of Analysis

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Appendix L1
Fish Resources in the Area of Analysis

Aquatic habitats throughout the area of analysis provide vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species. Key life stages and needs of the species of primary management concern with the greatest potential to be affected by the San Luis Low Point Improvement Project (SLLPIP) alternatives are discussed below. These species collectively represent a diversity of life histories and environmental/habitat requirements, and they are among the most sensitive to environmental perturbation; therefore, findings from assessments of these species can be effectively used to make inferences about other fish species in the project area.

L1.1 Special-status Fish Species

Several native anadromous and resident species have been listed as threatened or endangered under the Federal Endangered Species Act (ESA) or the California Endangered Species Act (CESA) or are candidates for listing. Seven fish species listed under ESA or CESA have the potential to occur in the watercourses in the area of analysis, as shown in Table L1-1. One of these species, longfin smelt, is a candidate for federal listing in addition to its current CESA listing. Additionally, three species have the potential to occur in the watercourses in the area of analysis that are listed as either federal or State species of concern (Table L1-1).

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Central Valley Steelhead	*Oncorhynchus mykiss*	FT/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Sacramento River, American River, San Joaquin Valley, Delta

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
California Central Coast/South-Central Coast Steelhead	*Oncorhynchus mykiss*	FT/—	Anadromous species using riverine, estuarine, and saltwater habitat. Migration potentially occurs year-round.	Coastal Mountains, San Francisco Bay Area; documented in SCVWD Service Area in Upper Penitencia, Pacheco, and Coyote creeks and Guadalupe River and Pajaro River
Central Valley Chinook salmon, fall/late fall-run	*Oncorhynchus tshawytscha*	SC/CSC	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration occurs mainly from September through December but has been observed as late as June. Primary juvenile outmigration occurs from January through June.	Sacramento River, American River, Delta, San Francisco Bay Area, San Joaquin Valley
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	FT/ST	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from March through May. Juvenile outmigration occurs from November through April.	Sacramento River, Delta, San Joaquin Valley
Sacramento River winter-run Chinook salmon	*Oncorhynchus tshawytscha*	FE/SE	Anadromous species using riverine, estuarine, and saltwater habitat. Adult migration potentially occurs from January through May. Juvenile outmigration occurs from November through mid-March.	Sacramento River, Delta
Green sturgeon	*Acipenser medirostris*	FT/CSC	Green sturgeon are an anadromous species, migrating from the ocean to freshwater to spawn. They exist in the Sacramento River system, as well as in the Eel, Mad, Klamath, and Smith rivers in the northwest portion of California.	Sacramento River, American River, San Francisco Bay Area, Delta, San Joaquin Valley
Delta smelt	*Hypomesus transpacificus*	FT/SE	Spends most of its life in the Sacramento–San Joaquin estuary. Spawns in shallow, fresh or slightly brackish water upriver from the mixing zone, including in the Sacramento River, Mokelumne River system, Cache Slough region, San Francisco Bay Delta, and Montezuma Slough area.	Sacramento River, American River, Delta

Table L1-1. Special-Status Fish Species with the Potential to Occur within the Area of Analysis.

Common Name	Scientific Name	Status (Federal/ State)	Primary Habitat and Critical Seasonal Periods	Occurrence in Area of Analysis
Longfin smelt	*Spirinchus thaleichthys*	—/ST	The longfin smelt is an anadromous species that spawns in the Delta and rears in the brackish areas of the San Francisco Bay and Delta.	Delta, San Francisco Bay Area
California / San Joaquin Roach	*Lavinia symmetricus* ssp. 1	—/CSC	Occurs in small, warm tributaries, to larger streams that flowed through open foothill woodlands of oak and foothill pine. Located in the foothills in much of the same region that contains the pikeminnow-hardhead-sucker assemblage.	Occurs upstream of large reservoirs or in tributary streams that would not be affected by the project.
Sacramento perch	*Archoplites interruptus*	—/CSC	Historically found in the sloughs, slow moving rivers, and lakes of the central valley. Prefer warm water. Aquatic vegetation is essential for young. (Within native range only)	Found in isolated quarry lakes in the Livermore Valley and has been found in San Luis Reservoir.
Pacific Lamprey	*Lampetra tridentata*	—/CSC	An anadromous species that, like steelhead, migrate into freshwater to spawn and juveniles return to the ocean to mature.	Pajaro River
Monterey roach	*Lavinia symmetricus subditus*	—/CSC	Generally found in small streams and are adapted to life in intermittent watercourses where dense populations are frequently observed in isolated pools.	Pajaro RIver
Monterey hitch	*Lavinia exilicauda harengus*	—/CSC	Can occupy a wide variety of habitats, but are most abundant in lowland areas with large pools or in small reservoirs.	Pajaro River

Sources: CDFW 2016; Moyle 2002
Key to Status Codes:

Federal Status:	State Status:
SC: Species of Concern	SE: Endangered
FE: Endangered	ST: Threatened
FT: Threatened	CSC: Species of Special Concern

L1.1.1 Central Valley Steelhead

National Marine Fisheries Service (NMFS) has divided steelhead into six distinct groups, called DPS, based on genetic testing and life history patterns. Recognition of these groups helps conserve diversity in the various life history adaptations. The Central Valley DPS includes all naturally spawned populations of steelhead in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from the San Francisco and San Pablo Bays and their tributaries. Designated critical habitat includes 2,308 miles of stream habitat

within the Central Valley as well as estuary habitat within the San Francisco-San Pablo-Suisun Bay complex (NMFS 2007).

Central Valley steelhead historically migrated upstream into the high gradient upper reaches of Central Valley streams and rivers for spawning and juvenile rearing. Construction of dams and impoundments on the majority of Central Valley rivers has created impassable barriers to upstream migration and substantially reduced the geographic distribution of steelhead. Although quantitative estimates of the number of adult steelhead returning to Central Valley streams to spawn are not available, anecdotal information and observations indicate that population abundance is low. Steelhead distribution is currently restricted to the mainstem Sacramento River downstream of Keswick Dam, the Feather River downstream of Oroville Dam, the American River downstream of Nimbus Dam, the Mokelumne River downstream of Comanche Dam, and a number of smaller tributaries to the Sacramento River system, Delta, and San Francisco Bay. Low numbers of steelhead have also been reported from the San Joaquin River tributaries. The Central Valley steelhead population is composed of both naturally spawning steelhead and steelhead produced in hatcheries. NMFS recently released the Central Valley Chinook Salmon and Steelhead Recovery Plan (NMFS 2014).

Central Valley steelhead have a similar life history as described for other Pacific salmonids (above). The steelhead life cycle is characterized by a high degree of flexibility (plasticity) in the duration of both their freshwater and marine rearing phases. The steelhead life cycle is adapted to respond to environmental variability in stream hydrology and other environmental conditions. Unlike Chinook salmon that die after spawning, adult steelhead may migrate downstream after spawning and return to spawn in subsequent years. Steelhead that do not migrate to the ocean, but spend their entire life in freshwater, are known as resident rainbow trout. Adult steelhead migrate upstream during the fall and winter (September through approximately February) with steelhead migration into the upper Sacramento River typically occurring during the fall and adults migrating into lower tributaries typically during the late fall and winter. Spawning typically occurs during the winter and spring (December - April) with the majority of spawning activity occurring during January and March. Downstream migration of steelhead smolts typically occurs during the late winter and early spring (January - May). The seasonal timing of downstream migration of steelhead smolts may vary in response to a variety of environmental and physiological factors including changes in water temperature, and in changes in stream flow and increased turbidity, resulting from stormwater runoff. Juvenile steelhead rear within the coastal marine waters for approximately two to three years before returning to their natal stream as spawning adults.

Central Valley steelhead are listed as a threatened species under the ESA. Steelhead are not listed for protection under the CESA but are identified as a species of concern.

L1.1.2 South-Central and Central California Coast Steelhead

The current range of Central California Coast (CCC) steelhead includes all naturally spawned populations of steelhead in coastal streams from the Russian River to Aptos Creek, and the drainages of San Francisco, San Pablo, and Suisun Bays eastward to Chipps Island at the confluence of the Sacramento and San Joaquin Rivers; and tributary streams to Suisun Marsh including Suisun Creek, Green Valley Creek, and an unnamed tributary to Cordelia Slough (commonly referred to as Red Top Creek), exclusive of the Sacramento-San Joaquin River Basin of the California Central Valley. The South-Central California coast steelhead includes winter steelhead found in three tributaries of Monterey Bay: the Pajaro, Salinas, and Carmel Rivers. Also included are small streams of the Big Sur Coast and small intermittent streams of San Luis Obispo County, south to Point Conception (Moyle 2002). Designated critical habitat for CCC steelhead includes 1,465 miles of stream habitat in central coastal California as well as estuarine habitat in San Pablo and San Francisco Bays. Designated critical habitat for South-Central California coast steelhead includes 1,250 miles of stream habitat within the 30 watersheds this DPS occupies as well as 3 square miles of estuarine habitat associated with these watersheds.

South-Central and CCC steelhead have a similar life history as described for other Pacific salmonids (above). The primary habitat requirements for coastal steelhead consists of shaded pools of small, cool, low-flow upstream reaches typical of the original steelhead habitat in the region. In addition, they can use warm water habitats below some dams or pipeline outfalls, where summer releases provide high summer flows and fast-water feeding habitat. Steelhead along the California coast enter coastal streams to spawn when winter storm events raise streamflows and breach the sandbars that form at the mouths of many streams during summer months. Increased streamflow during these large events also seems to provide cues that stimulate migration and allow better conditions for upstream fish passage (Moyle 2002). The complete season for potential upstream migration lasts from late October through the end of May, but the majority of the population (as observed in Waddell Creek) typically migrates between mid-December and mid-April (Shapovalov and Taft 1954). In Central California streams, steelhead typically rear for one or two years. Shapovalov and Taft (1954) observed that trout of all different ages migrated out of Waddell Creek throughout the year, but the majority migrated from April through June. This behavior is thought to be consistent for most coastal California populations native to other creek reaches as well.

Information on abundance and productivity trends for the naturally spawning component of the CCC steelhead DPS is extremely limited. Estimates of steelhead statewide show a reduction in numbers from 603,000 in the early 1960s to 240,000 to 275,000 in the 1980s (McEwan and Jackson 1996). It has been federally listed as Threatened since August 18, 1997 and was reaffirmed January 5, 2006.

Populations of South-Central California coast steelhead have declined from annual runs of approximately 25,000 spawning adults to fewer than 500 (NMFS 2013). It has been federally listed as Threatened since August 18, 1997, and following a five-year review issued by NMFS on December 7, 2011, it was concluded that this DPS should remain listed as Threatened. Critical habitat has been designated by NMFS for this species.

Steelhead habitat in Pacheco Creek is almost completely dependent upon releases from North Fork Pacheco Reservoir (Smith 2007). The stream is generally sparsely shaded and percolation rates are high, so stream flows decrease and temperatures increase rapidly downstream (Smith 2007). Even with good summer reservoir releases, conditions are rarely suitable for significant juvenile steelhead rearing (Smith 2007). Adult steelhead access through the lower portion of Pacheco Creek is also restricted in dry years (Smith 2007).

L1.1.3 Central Valley Fall-/Late Fall-Run Chinook Salmon

Fall-run Chinook salmon are the most abundant species of Pacific Salmon inhabiting the Sacramento and San Joaquin river systems. Fall-run Chinook salmon are not listed for protection under either CESA or ESA. In addition to fall-run Chinook salmon the group of Pacific Salmon is comprised of late fall-run Chinook salmon (which are not listed under either ESA or CESA), spring-run Chinook salmon and winter-run Chinook salmon, which are discussed below. Although fall-run and late fall-run Chinook salmon are not listed for protection under ESA they are included in this analysis since the area of analysis includes habitat identified as EFH for Pacific salmon.

Although fall-run and late fall-run Chinook salmon inhabit a number of watersheds within the Central Valley for spawning and juvenile rearing, the largest populations occur within the mainstem Sacramento, Feather, Yuba, American, Mokelumne, Merced, Tuolumne, and Stanislaus rivers. Fall-run Chinook salmon, in addition to spawning in these river systems, are also produced in fish hatcheries located on the Sacramento, Feather, American, Mokelumne, and Merced rivers. Hatchery operations are intended to mitigate for the loss of access to upstream spawning and juvenile rearing habitat resulting from construction of dams and reservoirs within the Central Valley in addition to producing fall-run Chinook salmon as part of the ocean salmon enhancement program to support commercial and recreational ocean salmon fisheries. Fall-run Chinook salmon also support an inland recreational fishery.

Fall-run and late fall-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult fall-run Chinook salmon migrate from the coastal marine waters upstream through San Francisco Bay, Suisun Bay, and the Delta during late summer and early fall (approximately late July to early December). Fall-run Chinook salmon spawning occurs between October and December with the greatest spawning activity occurring typically in November and early December. The success of fall-run Chinook salmon

spawning is dependent, in part, on seasonal water temperatures. After incubating and hatching, the young salmon emerge from the gravel redd as fry. A portion of the fry population migrate downstream soon after emergence, where they rear within the lower river channels, Delta, and estuary, during the spring months. The remaining portion of juvenile salmon continue to rear in the upstream stream systems through the spring months, until they are physiologically adapted to migration into saltwater (smolting), which typically takes place between April and early June. A small proportion of the fall-run Chinook salmon juveniles may, in some systems, rear through the summer and fall months migrating downstream during the fall, winter, or early spring as yearlings. Adult Chinook salmon spawn at ages ranging from approximately two to five-years-old with the majority of adult fall-run Chinook salmon returning at age three. Chinook salmon, unlike steelhead, die after spawning.

In 1998 NMFS proposed that Central Valley fall-run and late fall-run Chinook salmon be listed under ESA as a threatened species. Based upon further analysis, and public comment, NMFS decided that fall-run and late fall-run Chinook salmon did not warrant listing but rather remain as a candidate species for further analysis and evaluation.

L1.1.4 Central Valley Spring-Run Chinook Salmon

Spring-run Chinook salmon were historically widely distributed and abundant within the Sacramento and San Joaquin river systems (Yoshiyama et al. 1998). The Central Valley spring-run Chinook salmon evolutionary significant unit (ESU) has been reduced from an estimated 17 historical populations to only three extant natural populations with consistent spawning runs (on Mill, Deer, and Butte Creeks), which are tributaries to the Sacramento River. The ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries in California, including the Feather River, as well as the Feather River Hatchery spring-run Chinook program. Designated critical habitat includes 1,158 miles of stream habitat within the Sacramento River basin as well as estuary habitat within the San Francisco-San Pablo-Suisun Bay complex (NMFS 2007).

Spring-run Chinook salmon historically migrated upstream into the upper reaches of the mainstem rivers and tributaries for spawning and juvenile rearing. Construction of major dams and reservoirs on these river systems eliminated access to the upper reaches for spawning and juvenile rearing and completely eliminated the spring-run salmon population from the San Joaquin River system. Spring-run Chinook salmon abundance has declined substantially and the geographic distribution of the species within the Central Valley has also declined substantially. Spring-run spawning and juvenile rearing currently occurs on a consistent basis within only a small fraction of their previous geographic distribution, including populations inhabiting Deer, Mill, and Butte creeks, the mainstem Sacramento River, several other local tributaries on an intermittent basis, and the lower Feather River.

Spring-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult and juvenile spring-run Chinook salmon primarily migrate upstream and downstream within the mainstem Sacramento River. Adult spring-run Chinook salmon migrate upstream into the Sacramento River system during the spring months, but are sexually immature. Although the majority of adult spring-run Chinook salmon migrate upstream within the mainstem Sacramento River, there is a probability, although low, that adults may migrate into the Delta. Adult spring-run Chinook salmon hold in deep cold pools within the rivers and tributaries over the summer months prior to spawning. Spawning occurs during the late summer and early fall (late August through October) in areas characterized by suitable spawning gravels, water temperatures, and water velocities. Eggs incubate within the redds, emerging as fry during the late fall and winter. A portion of fry appear to migrate downstream soon after emerging where they rear within the lower river channels, and potentially within the Delta estuary, during winter and spring months. After emergence a portion of the spring-run Chinook salmon fry remain as residents in the creeks and rear for a period of approximately one year. The juvenile spring-run Chinook salmon that remain in the creeks migrate downstream as yearlings primarily during the late fall, winter and early spring with a peak yearling migration occurring in November (Hill and Weber 1999). Juvenile spring-run Chinook salmon may migrate from the Sacramento River into the interior Delta during their downstream migration and may occur within the central Delta, including the lower San Joaquin River, during the winter and early spring migration period. The downstream migration of both spring-run Chinook salmon fry and yearlings during the late fall and winter typically coincides with increased flow and turbidity associated with winter stormwater runoff.

A variety of environmental and biological factors have been identified that affect the abundance, mortality, and population dynamics of spring-run Chinook salmon. One of the primary factors that have affected population abundance of spring-run Chinook salmon has been the loss of access to historic spawning and juvenile rearing habitat within the upper reaches of the Sacramento River and its tributaries and San Joaquin River as a result of the migration barriers caused by construction of major dams and reservoirs. Operation of the Red Bluff Diversion Dam, which impedes adult upstream migration and vulnerability of juvenile spring-run Chinook salmon to predation mortality, has been identified as a factor affecting mortality within the river. Water temperatures within the rivers and creeks have also been identified as a factor affecting incubating eggs, holding adults, and growth and survival of juvenile spring-run Chinook salmon. Juvenile spring-run Chinook salmon are also vulnerable to entrainment at a large number of unscreened water diversions located along the Sacramento River and within the Delta in addition to entrainment and salvage mortality at the State Water Project (SWP) and Central Valley Project (CVP) export facilities. In recent years a number of changes have been made to improve the survival and habitat conditions for spring-run Chinook salmon. Several large previously unscreened water diversions have been equipped with positive

barrier fish screens. Changes to ocean salmon fishing regulations, and modifications to SWP and CVP export operations have also been made to improve the survival of both adult and juvenile spring-run Chinook salmon. Improvements in fish passage facilities have also been made to improve migration and access to Butte Creek. These changes and management actions, in combination with favorable hydrologic and oceanographic conditions in recent years, are thought to have contributed to the trend of increasing abundance of adult spring-run Chinook salmon returning to spawn in Butte Creek and other habitats within the upper Sacramento River system in recent years.

Spring-run Chinook salmon are listed as a threatened species under both CESA and ESA. Recent genetics studies have shown that spring-run like Chinook salmon returning to lower Feather River are genetically similar to fall-run Chinook salmon. Hybridization between spring-run and fall-run Chinook salmon, particularly on the Feather River where both stocks are produced within the Feather River hatchery, is a factor affecting the status of the spring-run salmon population. NMFS is in the process of developing a recovery plan for Central Valley spring-run Chinook salmon.

L1.1.5 Sacramento River Winter-Run Chinook Salmon

The Sacramento River winter-run Chinook Salmon ESU includes all naturally spawned populations in the Sacramento River and its tributaries as well as two artificial propagation programs; winter-run Chinook salmon from the Livingston Stone National Fish Hatchery winter-run Chinook salmon in a captive broodstock program maintained at the same hatchery (NMFS 2007). Designated critical habitat includes the Sacramento River from Keswick Dam to Chipps Island in the Delta as well as portions of San Francisco Bay.

Winter-run Chinook salmon historically migrated into the upper tributaries of the Sacramento River for spawning and juvenile rearing. With the construction of Shasta and Keswick dams, winter-run salmon no longer had access to historic spawning habitat within the upper watersheds. As a result of migration blockage, spawning and juvenile rearing habitat for winter-run Chinook is limited to the mainstem Sacramento River downstream of Keswick Dam. During the mid-1960s, adult winter-run Chinook salmon returns to the Sacramento River were relatively high (approximately 80,000 returning adults). However, the population declined substantially during the 1970s and 1980s. The population decline continued until 1991 when the adult winter-run Chinook salmon population returning to the Sacramento River was estimated to be less than 200 fish. As a result of the substantial decline in abundance, the species was listed as endangered under both the CESA and ESA. During the mid- and late- 1990s the numbers of adult winter-run salmon returning to the Sacramento River gradually increased and the trend of increasing abundance continues to be present.

Winter-run Chinook salmon have a similar life history as described for other Pacific salmon (above). Adult winter-run salmon migrate upstream through San

Francisco Bay, Suisun Bay, and the Delta during the winter and early spring months with peak migration occurring during March (Moyle 2002). Adult winter-run Chinook salmon migrate upstream within the Sacramento River with the majority of adults spawning in the reach upstream of Red Bluff. Winter-run Chinook salmon spawn within the mainstem of the Sacramento River in areas where gravel substrate, water temperatures, and water velocities are suitable. Spawning occurs during the spring and summer (mid-April through August; Moyle 2002). Egg incubation continues through the fall months. Juvenile winter-run Chinook salmon rear within the Sacramento River throughout the year. Juvenile winter-run salmon (smolts) migrate downstream through the lower reaches of the Sacramento River, Delta, Suisun Bay, and San Francisco Bay during the winter and early spring as they migrate from the freshwater spawning and juvenile rearing areas into the coastal marine waters of the Pacific Ocean. The Sacramento River mainstem is the primary upstream and downstream migration corridor for winter-run Chinook salmon. Juvenile winter-run Chinook salmon may migrate from the Sacramento River into the lower reaches of channels within Suisun Marsh during their downstream migration. The migration timing of juvenile winter-run Chinook salmon varies within and among years in response to a variety of factors including increases in river flow and turbidity resulting from winter storms, but generally occurs between early-winter through late-spring months. Environmental and biological factors that affect the abundance, mortality, and population dynamics of winter-run Chinook salmon are similar for those described for spring-run Chinook salmon (above).

Winter-run Chinook salmon are listed as an endangered species under both the CESA and ESA. As with other Chinook salmon stocks, NMFS is continuing to evaluate the status of the winter-run Chinook salmon population and the effectiveness of various management actions implemented within the Sacramento River, Delta, and ocean to provide improved protection and reduced mortality for winter-run salmon, in addition to providing enhanced habitat quality and availability for spawning and juvenile rearing. NMFS has prepared a draft recovery plan for winter-run Chinook salmon.

L1.1.6 North American Green Sturgeon

North American green sturgeon are large, bottom-dwelling, anadromous fish that are widely distributed along the Pacific coast of North America. These sturgeon are the most broadly distributed, wide ranging, and marine-oriented species of the sturgeon family; however, they are not very abundant in comparison to white sturgeon. San Francisco Bay, San Pablo Bay, Suisun Bay, the Delta, and the Sacramento River support the southernmost reproducing population of green sturgeon. Critical habitat for green sturgeon has not been designated.

Habitat requirements of green sturgeon are poorly understood, but spawning and larval ecologies are probably similar to those of white sturgeon. Indirect evidence indicates that green sturgeon spawn mainly in the upper reaches of

Sacramento River (e.g., Colusa to Keswick Dam). They are slow growing and late maturing, spawning every three to five years between March and July. Adult fish spawn in fresh water and then return to estuarine or marine environments. Preferred spawning habitat occurs in large rivers that contain large cobble in deep and cool pools with turbulent water (Moyle 2002; Adams et al. 2002). Larval and juvenile green sturgeon may rear for up to 2 years in fresh water and then migrate to an estuarine environment, primarily during summer and fall. They remain near estuaries at first, but may migrate considerable distances as they grow larger (Moyle 2002).

Both adult and juvenile North American green sturgeon are known to occur in the lower reaches of the San Joaquin River and in the south Delta. Juveniles have been captured in the vicinity of Santa Clara Shoals and Brannan Island State Recreation Area, and in the channels of the south Delta (NMFS 2006). The occurrence of green sturgeon in fishery sampling and CVP/SWP fish salvage is extremely low. As a result, very little information is available on the habitat requirements, geographic distribution, or seasonal distribution of various life history stages of green sturgeon within the estuary. However, adults and juveniles have the potential to occur within the project area throughout the year.

The southern DPS of North American green sturgeon is listed as threatened under ESA and is a California species of special concern.

L1.1.7 Delta Smelt

Delta smelt are endemic to the Delta estuary and inhabit the freshwater portions of the Delta, lower reaches of the Sacramento and San Joaquin rivers, and the low-salinity portions of Suisun Bay. Critical habitat for delta smelt has been designated by United States Fish and Wildlife Service (USFWS) within the Sacramento–San Joaquin River system.

Delta smelt are a relatively small species (two to four inches long) with an annual life cycle, although some individuals may live two years. Adult delta smelt migrate upstream into channels and sloughs of the Delta (e.g., lower Sacramento River in the vicinity of Decker Island and Rio Vista) during winter to prepare for spawning. Delta smelt live their entire life cycle within the Delta estuary. Juveniles and adults typically inhabit open waters of the Delta. Spawning occurs between February and July; peak spawning occurs during April through mid-May (Moyle 2002). Females deposit adhesive eggs on substrates such as gravel and sand. Eggs hatch, releasing planktonic larvae that are passively dispersed downstream by river flow. Larval and juvenile delta smelt rear within the estuary for a period of about six to nine months before beginning their upstream spawning movement into freshwater areas of the lower Sacramento and San Joaquin rivers. They also have been known to move downstream into Napa River during high flows; sometimes they do not move at all if the western end of Suisun Bay freshens; they have also been known inhabit Suisun Marsh.

Delta smelt experienced a general decline in population abundance over the past several decades leading to their listing as a threatened species under both ESA and CESA. In March 2006, a petition seeking to relist delta smelt as an endangered species was submitted to the USFWS. The proposal to elevate the listing status remains under review and USFWS has, as yet, not acted on the petition. In June 2007, the California Fish and Game Commission accepted a petition to uplist delta smelt from threatened to endangered status under CESA. This action is currently under review.

L1.1.8 Longfin Smelt

Longfin smelt are small, planktivorous fish species found in several Pacific coast estuaries from San Francisco Bay to Prince William Sound, Alaska. Longfin smelt can tolerate a broad range of salinity concentrations, ranging from fresh water to seawater (The Bay Institute [TBI] 2007). Spawning is believed to occur in the lower reaches of the Sacramento River (downstream of Rio Vista). Spawning is also thought to occur in the eastern portion of Suisun Bay and larger sloughs within Suisun Marsh. Historically, spawning probably occurred in the lower San Joaquin Rivers (TBI 2007). Spawning may take place as early as November and may extend into June. The majority of spawning occurs between January and March (TBI 2007). Adult longfin smelt are found mainly in Suisun, San Pablo, and San Francisco Bays, although their distribution is shifted upstream into the western Delta in years of low outflow (Baxter 1999; Moyle 2002).

Like delta smelt, longfin smelt spawn adhesive eggs in river channels of the eastern estuary, and after hatching their larvae are carried downstream (planktonic drift) to nursery areas by freshwater outflow. In contrast to delta smelt, longfin smelt juveniles and adults are broadly distributed and inhabit the more saline regions of the Delta estuary and nearshore coastal waters. During non-spawning periods longfin smelt are most often concentrated in Suisun, San Pablo, and North San Francisco Bay (Baxter 1999; Moyle 2002). The easternmost catch of longfin smelt in Fall Midwater Trawl Survey (FMWT) samples has been at Medford Island in the central Delta. A measurable portion of the longfin smelt population consistently survives into a second year. During the second year of life, the adult longfin smelt inhabit San Francisco Bay and occasionally have been found in nearshore ocean surveys (Rosenfield and Baxter 2007). Therefore, longfin smelt are often considered anadromous (SWRCB 1999).

Longfin smelt is an ESA candidate species for listing and a CESA threatened species.

L1.1.9 California/San Joaquin Roach

California roach are small, thick-bodied fish found throughout the Sacramento-San Joaquin river drainage, including the Pit River and tributaries to Goose Lake in Oregon. In coastal drainages, they are native to the Navarro, Gualala, and Russian rivers; streams tributary to Tomales Bay, Pescadero Creek and, in

the Monterey Bay drainage, San Lorenzo, Pajaro, and Salinas rivers (Moyle 2002). The Sacramento-San Joaquin roach, a distinct population within the California roach "complex" (Moyle 2002), is found within the Sacramento and San-Joaquin River drainages, except Pit River, as well as tributaries to San Francisco Bay. They are commonly found in small to medium sized foothill rivers and their present distribution is confined to rivers upstream of large Central Valley reservoirs or tributaries that are not affected by the CVP or SWP operations. Consequently, California roach are not included in the analysis of effects.

L1.1.10 Sacramento Perch

Sacramento perch are a California Department of Fish and Wildlife (CDFW) Species of Special Concern and were historically abundant predators throughout the Central Valley of California, where they occupied sloughs, lakes, and slow moving rivers. Today they are rare in their native waters, but may still exist in Clear Lake, as well as in some farm ponds and reservoirs (Crain and Moyle 2011). They have been widely introduced throughout California including in Owens Lake, the upper Klamath basin, upper Pit River watershed and Walker River watershed, (Moyle 2002). The only two native populations that were present in the area of analysis were in the Alameda Creek drainage, and are currently thought to be extirpated (Crain and Moyle 2011). These habitats would not be affected by the SLLPIP alternatives. Consequently, Sacramento perch are not included in the analysis of effects.

L1.1.11 Pacific Lamprey

The Pacific lamprey are anadromous, beginning their migration into freshwater towards upstream spawning areas primarily between early March and late June (Moyle 2002). Most upstream migration occurs at night and occurs in pulses. Spawning habitat requirements are thought to be similar to those of salmonids. There is some evidence that lamprey in larger river systems, such as the Klamath and Eel Rivers, have distinct runs similar to Chinook salmon (Moyle 2002). Both sexes contribute to nest construction by removing larger stones from a gravelly substrate, creating a shallow depression. These simple nests occur in gravelly substrata with moderately swift current, water temperatures typically of 12-18 degrees Celsius, and at a depth of 30-150 centimeters (Moyle 2002). External fertilization of eggs occurs just in front of the nest and are then washed into the nest. Fecundity is unknown. Spawning is repeated until both individuals are spent. Adults typically die after spawning. The eggs hatch into ammocoetes after approximately 19 days at 15 degrees Celsius, spend a short time in the nest, and then drift downstream to suitable area in sand or mud (Moyle 2002).

Ammocoetes remain in freshwater for approximately 5 to 7 years, where they bury into silt and mud and feedon algae, organic material, and microorganisms. Ammocoetes change locations during this stage. Ammocoetes begin metamorphosis into macropthalmia (juveniles) when they reach 14-16 centimeters TL. Downstream migration begins upon completion of this

metamorphosis, generally coinciding with high flow events in winter and spring (Moyle 2002).

Adults spend 3-4 years in the ocean in British Columbia, but this length is thought to be shorter in more southern areas (Moyle 2002). Adult remain close to the mouths of the rivers from which they came, likely because their prey is most abundant in estuaries and other coastal areas (Moyle 2002). Pacific lamprey are thought to be preyed upon in the ocean by sharks, other fish, otters, seals, and sea lions (Moyle 2002).

L1.1.12 Monterey Roach

Monterey roach, a subspecies of California roach and a California species of special concern, have similar habitat requirements to California roach in other areas where they are generally found in small streams and are adapted to life in intermittent watercourses where dense populations are frequently observed in isolated pools. Roach can tolerate a relatively wide range of temperatures and dissolved oxygen levels and are found in habitats ranging from cold, clear, well-aerated salmonid streams to intermittent streams where they can survive extremely high temperatures (30-35℃) and low dissolved oxygen levels (1-2 ppm) (Moyle et al. 2015).

L1.1.13 Monterey Hitch

Monterey hitch, a subspecies of hitch and a California species of special concern, can occupy a wide variety of habitats, but are most abundant in lowland areas with large pools or in small reservoirs. Monterey hitch were found to be most abundant in low-gradient sites in the Pajaro River basin that had permanent water and large pools in summer (Moyle et al. 2015. The water at these sites tended to be clear, warm in late summer, and moderately deep. Bottom substrates were mostly a mixture of sand and gravel and the presence of cover (e.g., fallen trees, overhanging bushes) was an important factor.

L1.2 References

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