Enclosure 1

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
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BIOLOGICAL OPINION

Agency: Bureau of Reclamation

Activity: Fish Habitat Restoration and Management

Consultation Conducted By: West Coast Region, National Marine Fisheries Service

File Number: 151422WCR2014SA00117

Date Issued:

I. BACKGROUND AND CONSULTATION HISTORY

The proposed activities are a continuation of ongoing anadromous fish restoration efforts in Clear Creek authorized under the Central Valley Project Improvement Act (CVPIA) of 1992 Section 3604(b)(12). The proposed activities build on prior Federal projects in Clear Creek that were directed and funded by the CVPIA-Anadromous Fish Restoration Program (AFRP) and the CALFED Bay-Delta Ecosystem Restoration Program. Clear Creek activities are coordinated through the Lower Clear Creek Restoration Team/Technical Advisory Committee (LCC TAC), comprised of U.S. Bureau of Reclamation (Reclamation), California Department of Fish and Wildlife (CDFW), California Department of Water Resources (DWR), Central Valley Regional Water Quality Control Board, U.S. Fish and Wildlife (USFWS), U.S. Bureau of Land Management (BLM), Western Shasta Resource Conservation District (WSRCD), NOAA's National Marine Fisheries Service (NMFS), and other stakeholders. Since 1995, projects implemented under these auspices have contributed to increases in the numbers of anadromous fish spawning and rearing within Clear Creek.

On June 17, 2011, the Reclamation sent a letter to NMFS to request a long-term formal consultation on the Lower Clear Creek Anadromous Fish Habitat Restoration and Management Project (LCC Habitat Restoration project). The letter stated that Reclamation has determined that the proposed project may affect and is likely to adversely affect Central Valley (CV) spring-run Chinook salmon and California CV steelhead. Discussions between USFWS, Reclamation and NMFS occurred between June and early November of 2011. On November 10, 2011, we received a final determination from Reclamation confirming the request for formal consultation on the long-term Project. On June 10, 2012 Reclamation requested the long-term Project be put on hold, and requested informal consultation for the 2012 season. Between September 13, 2012, and October 21, 2013, USFWS, Reclamation, and NMFS held discussions on the effects of the

Project. During the month of April 2014, discussions were held between Reclamation and NMFS updating details of area of temporary disturbance as a result of the project. April 30, 2014, we received the final information to initiate formal consultation.

Reclamation has been designated as the lead action agency for this project by both BLM and the U.S. Army Corps of Engineers (Corps). BLM will occasionally fund some of the project augmentation (DOI-BLM-CA-N060-2008-016-EA) described below in the project description, and the Corps will be issuing Reclamation a permit for this project (SPK-2010-01231). This biological opinion will therefore satisfy the requirements for the Corps and BLM to consult with NMFS under section 7 of the ESA of 1973, as amended (16 U.S.C 1531 et seq.) for this project.

II. DESCRIPTION OF THE PROPOSED ACTION

A. Project Activities

Reclamation proposes to implement the LCC Habitat Restoration project, through December 31, 2030 in Clear Creek between Whiskeytown Dam and its confluence with the Sacramento River, Shasta County, California (lower Clear Creek). Restoration activities include spawning gravel augmentation and placement of instream habitat structures (e.g., boulder clusters, digger logs, spider logs, and rootwads). The proposed action is a continuation of ongoing anadromous fish restoration efforts in Clear Creek authorized under the CVPIA, and will be carried out in partnership with the LCC TAC.

The goals of the proposed action are to: restore fluvial sediment processes, including coarse bedload transport continuity and fine sediment deposition on floodplain surfaces; and improve habitat conditions for anadromous salmonid species, including CV fall-/late-fall run Chinook salmon, CV spring-run Chinook salmon, and California CV steelhead/Sacramento River rainbow trout. Reclamation proposes to accomplish the project goals with the following activities: spawning gravel augmentation, and placement of instream habitat structures (e.g., boulder clusters, digger logs, spider logs, and rootwads).

1. <u>Project Description</u>

a. *Gravel Augmentation*

A severe limitation of suitable spawning substrate was identified as a limiting factor for anadromous fishes in Clear Creek (U.S. Fish and Wildlife Service 1995). Gravel restoration would occur in several locations in or along Clear Creek between Whiskeytown Dam and the Sacramento River.

There are 12 gravel augmentation sites included under the proposed action located between Whiskeytown Dam and the Clear Creek/Sacramento River confluence (Table 1; Figure 1). All but one of the sites is located on Federal land, with the exception being located on a privately owned property near the Placer Road Bridge. In past years, gravel augmentation projects have occurred at several of these sites. In addition to the 12 gravel augmentation sites, the proposed action includes gravel augmentation at currently unspecified locations within the Lower Reach (between Clear Creek Road Bridge and the Clear Creek/Sacramento River confluence). Gravel augmentation would not necessarily occur at all sites every year and some sites may not be implemented at all, depending on evaluation of monitoring data and the judgment of the LCC TAC. Some sites may be used every year, such as for recurring gravel injection, while others may only be used intermittently, such as gravel bar restoration. Up to a total of 25,000 tons of gravel would be placed annually within lower Clear Creek at these sites. The LCC TAC would utilize the sites, as needed, following an adaptive management approach based on the results of ongoing monitoring of gravel routing within the Clear Creek system.

Construction Criteria and Methods

Three different gravel augmentation methods (modified from McBain and Trush 2001) are proposed and include:

- Lateral Berm: A recruitment-pile of gravel is placed as a steeply sloping bar parallel to the channel to provide a long-term supply of spawning gravel and is mobilized into the stream channel during high flows.

- Riffle Supplementation: Gravel is placed and contoured across the entire channel width and graded to a uniform depth to provide immediate spawning habitat.

- End Dump Talus Cone: A large pile of gravel is placed on the bank for recruitment into the stream during high flows.

Up to 25,000 tons of cleaned and sorted river-run gravel would be placed into the proposed action area annually through December 31, 2030. The gravel would be washed at least once and the mixture would be sized between 3/8 inches and 5 inches following the guidance provided by the AFRP. The gravel would be transported to the augmentation sites or staging areas using dump trucks, and then either placed directly from the truck; or by an excavator, sluice, or helicopter. Where additional instream grading of gravel is required, an excavator or bulldozer would be used. Existing access routes would be used whenever possible, but some additional clearing or grading may be necessary to provide equipment access to the gravel augmentation sites. Instream work would be conducted during seasons of the year that are least likely to result in the take of CV spring-run Chinook salmon and California CV steelhead.

Table 1. Proposed Gravel Augmentation Sites On Clear Creek

Site	Zone	Method	Length	Quantity	Duration of activity
Whiskeytown Dam (existing)	1	EDTC[a]	Approx. 90’	3,000 tons	Over several days to a week
Below Dog Gulch Pool (existing)	2	RS[b]/LB[c]	300'	Up to 4,500 tons	Over several days to a week
Above Peltier Bridge (existing)	2	RS (sluice or helicopter)	160'	Up to 3,750 tons	Over several days to a week
Paige Bar (proposed)	2	RS/LB	180'	Up to 7,050 tons	Over several days to a week
Above NEED Camp Bridge (2 existing locations)	2	RS	Approx. 90’	Up to 2,250 tons	Over several days to a week
Below NEED Camp Bridge/Guardian Rock (existing)	2	LB	Un-specified	Up to 4,500 tons	Over several days to a week
Placer Road Bridge (existing)	2	EDTC	Approx. 90’	Up to 6,000 tons	Over several days to a week
Clear Cr. Rd. Bridge (existing)	2	EDTC	Approx. 90’	1,125 tons	Over several days to a week
Reading Bar (existing)	2 or 3	RS	Un-specified	Up to 1,500 tons	Over several days to a week
Saeltzer Gorge (2 existing locations)	3	EDTC; requires stream crossing	Approx. 90’	Up to 7,500 tons	Over several days to a week
Above Phase 3A (3 existing locations)	3	LB	Un-specified	Up to 2,250 tons	Over several days to a week
Phase 2A (existing)	3	RS/LB	Un-specified	Up to 5,000 tons	Over several days to a week
Lower Reach (proposed, unspecified locations)	3	RS, LB, EDTC	Un-specified	Up to 2,250 tons	Over several days to a week

[a] End Dump Talus Cone (EDTC); [b] Riffle Supplementation (RS); [c] Lateral Berm (LB)

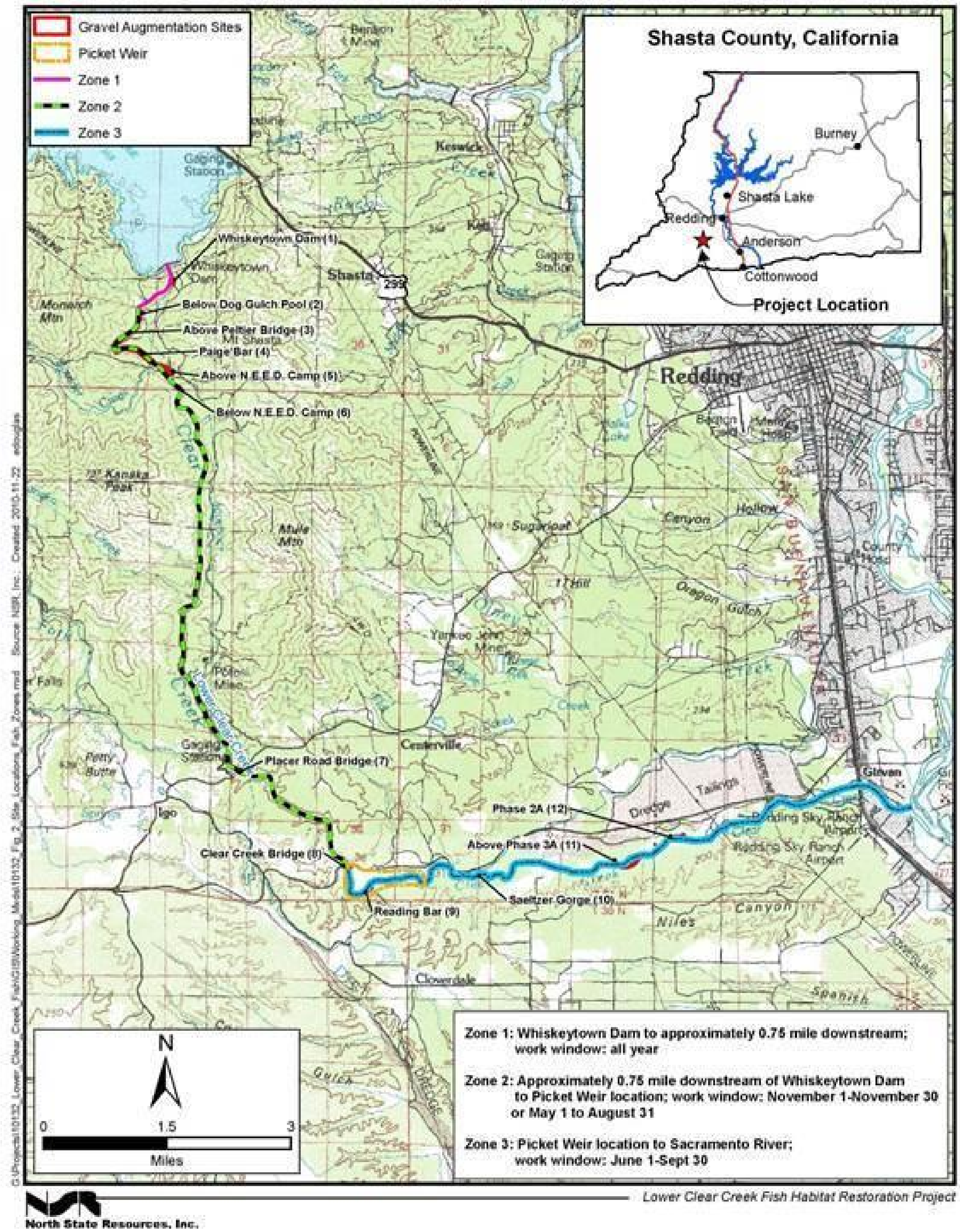

Figure 1. Locations of the Gravel Augmentation Sites and Zones.

b. *Instream Habitat Structures*

Instream habitat structures consisting of logs, rootwads, and boulders would be placed into the active channel of Clear Creek using construction equipment. The habitat structures would be placed, as needed, within the gravel augmentation sites and at various, but currently unidentified, locations within Clear Creek. The placement sites will be located on public and/or private lands. The LCC TAC would identify and implement placement sites, as needed, using an adaptive management approach based on the results of ongoing anadromous fisheries monitoring conducted by the USFWS. Access to augmentation sites would use existing roads, when feasible, to minimize impacts on vegetation or other sensitive biological or cultural resources. Up to 20 boulder clusters and 20 log structures would be placed within Clear Creek. The designs for in-stream habitat structures would be consistent with guidance provided in the California Salmonid Stream Habitat Restoration Manual, 3rd Edition (CDFG 1998).

Instream Habitat Structures

Three potential habitat structure designs have been identified:

- Boulder Clusters: structures placed in the active channel and along stream banks.
- Digger Logs: logs placed with one end anchored on the bank and the other extending into a pool.
- Spider Logs: several logs placed together, at angles, to mimic a log jam.

Boulder Clusters

Boulder structures are placed in the active channel and along stream banks to diversify stream flows in a particular stream reach, to provide in-stream cover for juvenile salmonids and spawning adults, or to retain spawning gravel. It is desirable to create a variety of stream flow velocities, because juvenile salmonids will select different velocities depending on whether they are feeding or resting. Different water velocities will also sort gravel and create diversity in the substrate. Boulders are well-suited for diversifying flows because they are resistant to being displaced by high flows. Because of this, they can be placed mid-channel without constructing a full-channel spanning structure. The interstices within boulder clusters and between large boulders can provide escape cover for juvenile and adult salmonids.

The range of flows to which a particular structure, or series of structures, may be subjected will dictate the size of boulders to be used. Generally, clusters are located in straight, stable, moderately to well-confined, low gradient riffles (0.5 to 1 percent slope) for spawning gravel enhancement. They are also placed in higher gradient riffles (1 to 4 percent slope) to improve rearing habitat and provide cover. At least three- to five-foot diameter boulders are recommended, except in very small streams. To be effective in creating scour pockets and habitat niches around individual boulders, the correct distance between adjacent boulders and the configuration of the boulder clusters must be determined. In general, adjacent boulders would be 0.5- to 1-foot apart.

The proposed design includes a triangle cluster of three boulders. The boulders would not be cabled together. Several of these clusters may be aggregated to increase scour area and create greater habitat complexity. Heavy equipment is usually required for transporting and positioning boulders including dump trucks, loaders, and bulldozers. Under some circumstances, it may be most cost-effective to transport and place boulders by helicopter.

Digger Logs

Digger logs are placed with one end anchored securely on the bank and the other end plunging into the bottom of a pool. They are also used to scour the channel, creating or expanding pool habitat. Logs with rootwads intact are positioned with the rootwad end extending down into the pool to create complexity for increasing rearing habitat and maximizing scour.

Digger logs are usually secured to bedrock and held in place using cable and polyester resin adhesive, or secured to live trees or downed wood with threaded rebar. The log is anchored in at least two places, with anchors spaced as far apart on the log as possible to keep it secure during high flows. Digger logs can also be set in a trench dug into the stream bank. At least one-third of the length of the log is placed in the bank. This buried portion of the log is covered with boulders to anchor the structure. Digger logs would usually be positioned to point downstream, although there may be some situations where pointing them upstream would be appropriate (where the intention of the log placement is to create scour). The vertical angle of the log is usually 30 to 45 degrees to the bank.

Spider Logs

Spider logs are several logs placed at angles to mimic a log or debris jam. Their use is restricted to areas where there is no danger of causing bank failure or channel migration. Pools and backwater eddy areas on the stream channel margins are the best locations for these structures.

The structures are constructed of several logs placed across each other, in the shape of a triangle, to imitate natural woody material or log jam. Each of the logs is secured to bedrock or large boulders in the channel with cable and polyester resin adhesive, or to live trees with threaded rebar. The logs are secured together with threaded rebar. Several other logs with branches and rootwads attached are then fastened to these structure logs with cable or threaded rebar. Before placing spider logs, it is necessary to determine channel capacity and bankfull discharge that could be expected. Log structures should not reduce channel capacity below flood stage needs or a massive log jam and sediment trap could develop.

B. Proposed Conservation and Avoidance Measures

1. <u>Measures to Minimize Injury and Mortality of Rearing Juvenile and Spawning Adult Anadromous Salmonids During Construction</u>

Due to the nearly year-round presence of at least one freshwater life stage of a listed fish species in the action area, the use of seasonal work windows to entirely avoid and prevent injury or mortality to the listed anadromous salmonids is not possible. However, the least mobile life stages (*i.e.* incubating eggs and pre-emergent fry), are the life stages most likely to experience direct injury and mortality from construction activities. Therefore, instream work would be restricted to specific windows in specific locations, developed with consideration of the spatial and temporal distribution of spawning CV spring-run Chinook salmon and California CV steelhead.

These seasonal work windows are designed to avoid harm to incubating CV spring-run Chinook salmon and California CV steelhead eggs and pre-emergent fry. Additionally, the following measure would be employed:

> Surveys for salmonids and redds will be conducted by a USFWS biologist prior to construction activities that occur near spawning habitat during spawning and incubation periods. Work would be conducted only after surveys were completed to ensure that no salmonids or redds are present in the work area.

Work areas have been broken up into three work zones (Figure 1; Table 2). Zone 1 extends from Whiskeytown Dam to approximately ¾ mile downstream and the work window is year-round. Until recent gravel augmentations, this zone contained little suitable salmonid spawning gravel and spawning was not considered likely to occur. After the establishment of the Whiskeytown Dam end-dump talus cone gravel augmentation site, steelhead began to spawn in this zone (Giovannetti and Brown 2007) and a few CV spring-run Chinook salmon redds have been documented in this reach as well (Giovannetti and Brown 2009).

The only proposed action in Zone 1 is the Whiskeytown Dam gravel augmentation site near the upper limit of the zone. Very little spawning has been documented near the site and the nearest redds have been constructed farther than 200 meters away. In order to maintain and increase the amount of suitable spawning habitat in this zone, the Whiskeytown Dam gravel augmentation site may need to be maintained year-round. When the cone is augmented, approximately 80 percent of the gravel is retained on the cliff until mobilized by high flows, and approximately 20 percent of the gravel falls into the stream. Therefore, any work planned in suitable spawning habitat while CV spring-run Chinook salmon or California CV steelhead are likely to be spawning or incubating (September 1 through April 30) would be conducted only after surveys were completed to ensure that no redds would be crushed by gravel.

Zone 2 extends from approximately ¾ mile downstream of Whiskeytown Dam to the USFWS picket weir location. The picket weir location can change annually, but is typically placed between river mile (RM) 7.4-8.2. The work window in Zone 2 is November 1 to November 30 and May 1 to August 31. The majority of spring-run Chinook salmon spawn in this zone, and many steelhead also spawn in this zone (Giovannetti and Brown 2007, 2008). The May 1 to August 31 portion of the work window is a time period when spring-run Chinook salmon and steelhead are not spawning or incubating, and well outside the peak period of juvenile spring-run Chinook emigration. Juvenile steelhead are expected to occur in this zone year-round; other conservation measures would be implemented to reduce the potential for adverse effects on juvenile steelhead. There may be some late spring-run Chinook salmon spawning or incubating activity during the month of November. To ensure that spring-run Chinook salmon redds are not disturbed during work, surveys would be completed prior to conducting any in-stream work during the month of November.

Gravel augmentation activities are planned at seven sites within Zone 2. All three gravel augmentation methods may be used at these sites. Instream habitat structures may be placed as needed where juvenile rearing habitat is identified as limited.

Zone 3 is located from the USFWS picket weir location to the Sacramento River confluence. The work window is June 1 to September 30. Few spring-run Chinook salmon spawn in this zone, because most fish pass through the picket weir and are confined upstream before spawning commences in early September. Steelhead are not likely to spawn during this time period. This work window is also well outside the peak out-emigration period for spring-run Chinook salmon and the migration period for steelhead. Some juvenile steelhead may be present in the zone during this work window; other conservation measures would be implemented to reduce the potential for adverse effects on juvenile steelhead.

Gravel augmentation activities are planned at four specific sites within this zone. Gravel augmentation is also planned at currently unspecified locations within this zone. All three gravel augmentation methods may be used at these sites. Instream habitat structures may be placed as needed where juvenile rearing habitat is identified as limited.

Table 2. **Zone Locations and Work Windows**

Zone	Location	Work Window
Zone 1	Whiskeytown Dam to approximately ¾ mile downstream	All year (pre-construction surveys conducted if work is planned in spawning habitat between September 1 and April 30)
Zone 2	Approximately ¾ mile downstream of Whiskeytown Dam to picket weir	November 1 to November 30 (pre-construction surveys conducted) or May 1 to August 31
Zone 3	USFWS picket weir to Sacramento River confluence	June 1 to September 30

2. <u>Measures to Control Turbidity and Suspended Sediment During Construction</u>

Measures to avoid and minimize the potential for adverse effects of turbidity or resuspension of sediment during instream work on the listed anadromous species would include the following:

- Best management practices (BMPs) to control erosion and storm water sediment runoff would be implemented. This may include, but is not limited, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from proposed project areas.

- Equipment would not operate in an active stream channel except as may be necessary to construct temporary stream crossings and/or place in-stream habitat structures and spawning gravel. When in-channel work is unavoidable, clean spawning gravel would be used to create a pad in the channel from which equipment will operate. Clean spawning gravel would also be used to construct required in-stream crossings. In-stream construction would proceed in a manner that minimizes sediment discharge. Following completion of restoration activities, the spawning gravel will be removed from the stream channel or spread evenly across the bottom of the channel, consistent with existing gravels.

- Spawning gravel used in restoration would be clean and washed with a cleanness value consistent with California Department of Transportation's Test #227 (California Department of Transportation 1999).

- All stream crossings would be designed to ensure that conditions are maintained for effective upstream and downstream fish passage, at all times and under all flow conditions.

- Stream crossings or instream work that may cause turbidity within 200 ft upstream of active redds would be avoided.

3. Measures to Avoid Adverse Effects on Riparian Vegetation

The following measures would be taken to minimize the loss and disturbance of riparian vegetation:

- Impacts to existing vegetation would be avoided to the extent practicable.

- Disturbed areas, not intended for future road access or gravel placement, would be revegetated with native plant species and/or mulched with certified weed-free hay following the completion of construction activities.

- All equipment used for the proposed project would be thoroughly washed off-site to remove invasive plant seed, stems, etc. and inspected to prevent transfer of aquatic invasive species, such as quagga mussel (*Dreissena bugensis*) and New Zealand mud snail (*Potamopyrgus antipodarum*), prior to arriving at the construction area. If construction involves work at two or more separate locations along the creek and proposed project area, when possible, equipment would be thoroughly cleaned after completing work at one location, before proceeding to the next location. This will minimize the dissemination of noxious or invasive plant species within the project areas.

- Project activities would avoid impacts to wetlands to the extent practicable. Wetlands located near construction areas, and at risk of inadvertent disturbance, would be protected with high-visibility fencing.

4. Measures to Prevent and Manage Potential Spills of Hazardous Materials

Contractor will be required to develop and implement a Spill Prevention, Control and Countermeasures Plan (SPCCP) prior to the onset of construction. The SPCCP will include measures to be implemented onsite that will keep construction and hazardous materials out of waterways and drainages. The SPCCP will include provisions for daily leak checks; hand-removal of external oil, grease, and mud; and the use of spill containment booms for refueling. Construction equipment refueling and maintenance would be restricted to designated staging areas located away from streams and sensitive habitats.

C. Description of Action Area

The project 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. The area subject to the proposed Federal action encompasses Clear Creek and adjacent riparian zone between Whiskeytown Dam and Clear Creek's confluence with the Sacramento River.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

The following federally listed species (evolutionarily significant units (ESU) or distinct population segments (DPS)) and designated critical habitat occur in the action area and may be affected by the proposed LCC Anadromous Fish Habitat Restoration and Management Project:

Central Valley spring-run Chinook salmon ESU
(*Oncorhynchus tshawytscha*) threatened (September 16, 1999, 64 FR 50394)
Central Valley spring-run Chinook salmon designated critical habitat
(September 2, 2005, 70 FR 52488)
California Central Valley steelhead DPS (referred to as Central Valley steelhead throughout this biological opinion)
(*Oncorhynchus mykiss*) threatened (signed December 22, 2005)
California Central Valley steelhead designated critical habitat
(September 2, 2005, 70 FR 52488)

A. Species and Critical Habitat Listing Status

NMFS has recently (August 2011) completed an updated status review of five Pacific Salmon ESUs and one steelhead DPS, including both CV spring-run Chinook salmon and CV steelhead, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Review (NMFS 2011b, 2011c) additionally stated that although the listings will remain unchanged since the 2005/2006 reviews, the status of these populations have worsened over the past five years and recommended that status be reassessed in two to three years as opposed to waiting another five years. The status reviews in 2005 and 2006 had also concluded that the species' status should remain as previously listed (70 FR 37160 and 71 FR 834).

CV spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of CV spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Hatchery (FRH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status (70 FR 37160, June 28, 2005). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488), and includes the action area for the proposed project.

CV steelhead were listed as threatened under the Endangered Species Act (ESA) on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin river (inclusive of and downstream of the Merced River) basins in California's Central Valley. The Coleman National Fish Hatchery and FRH steelhead populations have been included as part of the Central Valley steelhead DPS in the most recent modification of the Central Valley steelhead listing status (71 FR 834, January 5, 2006). These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for steelhead in the Central Valley on September 2, 2005 (70 FR 52488). Critical habitat includes the stream channels to the ordinary high water line within designated stream reaches such as those of the American, Feather, and Yuba rivers, and Deer, Mill, Battle, Antelope, and Clear creeks in the Sacramento River basin; the Calaveras, Mokelumne, Stanislaus, and Tuolumne rivers in the San Joaquin River basin; and, the Sacramento and San Joaquin rivers and the Sacramento-San Joaquin River Delta (Delta). Designated critical habitat for Central Valley steelhead is found within the action area.

B. Species Life History, Population Dynamics, and Likelihood of Survival

1. Chinook Salmon

a. *General Life History*

Chinook salmon exhibit two generalized freshwater life history types (Healey 1991). "Stream-type" Chinook salmon, enter freshwater months before spawning and reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon spawn soon after entering freshwater and migrate to the ocean as fry or parr within their first year. Spring-run Chinook salmon exhibit a stream-type life history. Adults enter freshwater in the spring, hold over summer, spawn in fall, and the juveniles typically spend a year or more in freshwater before emigrating. Winter-run Chinook salmon are somewhat anomalous in that they have characteristics of both stream- and ocean-type races (Healey 1991). Adults enter freshwater in winter or early spring, and delay spawning until spring or early summer (stream-type). However, juvenile winter-run Chinook salmon migrate to sea after only 4 to 7 months of river life (ocean-type). Adequate instream flows and cool water temperatures are more critical for the survival of Chinook salmon exhibiting a stream-type life history due to over summering by adults and juveniles.

Chinook salmon typically mature between two and six years of age (Myers *et al.* 1998). Freshwater entry and spawning timing generally are thought to be related to local water temperature and flow regimes. Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and the actual time of spawning (Myers *et al.* 1998). Both spring-run and winter-run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and delay spawning for weeks or months. For comparison, fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the main stem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

During their upstream migration, adult Chinook salmon require stream flows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate stream flows are necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38 degrees Fahrenheit (^{o}F) to 56 ^{o}F (Bell 1991, CDFG 1998). Boles (1988) recommends water temperatures below 65 ^{o}F for adult Chinook salmon migration, and Lindley *et al.* (2004) report that adult migration is blocked when temperatures reach 70 ^{o}F, and that fish can become stressed as temperatures approach 70 ^{o}F. Spring-run Chinook salmon holding in upper watershed locations prefer water temperatures below 60 ^{o}F; although salmon can tolerate temperatures up to 65 ^{o}F before they experience an increased susceptibility to disease (Williams 2006).

Information on the migration rates of Chinook salmon in freshwater is scant and primarily comes from the Columbia River basin where information regarding migration behavior is needed to assess the effects of dams on travel times and passage (Matter *et al*. 2003). Keefer *et al.* (2004) found migration rates of Chinook salmon ranging from approximately 10 kilometers (km) per day to greater than 35 km per day and to be primarily correlated with date, and secondarily with discharge, year, and reach, in the Columbia River basin. Matter *et al*. (2003) documented migration rates of adult Chinook salmon ranging from 29 to 32 km per day in the Snake River. Adult Chinook salmon inserted with sonic tags and tracked throughout the Delta and lower Sacramento and San Joaquin rivers were observed exhibiting substantial upstream and downstream movement in a random fashion while migrating upstream over the course of several days at a time (CALFED 2001). Adult salmonids migrating upstream are assumed to make greater use of pool and mid-channel habitat than channel margins (Stillwater Sciences 2004), particularly larger salmon such as Chinook salmon, as described by Hughes (2004). Adults are thought to exhibit crepuscular behavior during their upstream migrations; meaning that they primarily are active during twilight hours. Recent hydroacoustic monitoring showed peak upstream movement of adult CV spring-run Chinook salmon in lower Mill Creek, a tributary to the Sacramento River, occurring in the four-hour period before sunrise and again after sunset.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995a). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55 ^{o}F to 57 ^{o}F (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001). Exposure to high temperatures prior to spawning can result in lower egg viability even if the eggs are incubated under optimum conditions (Berman 1990).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. The optimal water temperature for egg incubation ranges from 41 ^{o}F to 56 ^{o}F (44 ^{o}F to 54 ^{o}F [Rich 1997], 46 ^{o}F to 56 ^{o}F [NMFS 1997 Winter Run Chinook salmon Recovery Plan], and 41 ^{o}F to 55.4 ^{o}F [Moyle 2002]). A significant reduction in egg viability occurs at water temperatures above 57.5 ^{o}F and total embryo mortality can occur at temperatures above 62 ^{o}F (NMFS 1997). Alderdice and Velsen (1978) found that the upper and lower temperatures resulting in 50 percent pre-hatch mortality were 61 ^{o}F and 37 ^{o}F, respectively, when the incubation temperature was held constant. As water temperatures increase, the rate of embryo malformations also increases, as well as the susceptibility to fungus and bacterial infestations. The length of development for Chinook salmon embryos is dependent on the ambient water temperature surrounding the egg pocket in the redd. Colder water necessitates longer development times as metabolic processes are slowed. Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel.

During the four to six week period when alevins remain in the gravel, they utilize their yolk-sac to nourish their bodies. As their yolk-sac is depleted, fry begin to emerge from the gravel to begin exogenous feeding in their natal stream. The post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody material, and begin feeding on zooplankton, small insects, and other micro-crustaceans. As they switch from endogenous nourishment to exogenous feeding, the fry’s yolk-sac is reabsorbed, and the belly suture closes over the former location of the yolk-sac (button-up fry). Fry typically range from 25 mm to 40 mm during this stage. Some fry may take up residence in their natal stream for several weeks to a year or more, while others are displaced downstream by the stream’s current. Once started downstream, fry may continue downstream to the estuary and rear, or may take up residence in river reaches farther downstream for a period of time ranging from weeks to a year (Healey 1991).

Fry then seek nearshore habitats containing beneficial aspects such as riparian vegetation and associated substrates important for providing aquatic and terrestrial invertebrates, predator avoidance, and slower velocities for resting (NMFS 1996a). The benefits of shallow water habitats for salmonid rearing also have recently been realized as shallow water habitat has been found to be more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001).

When juvenile Chinook salmon reach a length of 50 to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the margins and avoid the elevated water velocities found in the thalweg of the channel. When the channel of the river is greater than 9 to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams may spur outmigration of juveniles when they have reached the appropriate stage of maturation (Kjelson *et al.* 1982, Brandes and McLain 2001).

As fish begin their emigration, they are displaced by the river's current downstream of their natal reaches. Similar to adult movement, juvenile salmonid downstream movement is crepuscular. Documents and data provided to NMFS in support of ESA section 10 research permit applications depicts that the daily migration of juveniles passing Red Bluff Diversion Dam (RBDD) is highest in the four hour period prior to sunrise (Martin *et al.* 2001). Juvenile Chinook salmon migration rates vary considerably presumably depending on the physiological stage of the juvenile and hydrologic conditions. Kjelson *et al*. (1982) found fry Chinook salmon to travel as fast as 30 km per day in the Sacramento River and Sommer *et al.* (2001) found rates ranging from approximately 0.5 miles up to more than 6 miles per day in the Yolo Bypass. As Chinook salmon begin the smoltification stage, they prefer to rear further downstream where ambient salinity is up to 1.5 to 2.5 parts per thousand (Healey 1980, Levy and Northcote 1981).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. In addition, CV spring-run Chinook salmon juveniles have been observed rearing in the lower reaches of non-natal tributaries and intermittent streams in the Sacramento Valley during the winter months (Maslin *et al.* 1997, Snider 2001). Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Shallow water habitats are more productive than the main river channels, supporting higher growth rates, partially due to higher prey consumption rates, as well as favorable environmental temperatures (Sommer *et al.* 2001). Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54 ^{o}F to 57 ^{o}F (Brett 1952). In Suisun and San Pablo bays water temperatures reach 54 ^{o}F by February in a typical year. Other portions of the Delta (*i.e*., South Delta and Central Delta) can reach 70 ^{o}F by February in a dry year. However, cooler temperatures are usually the norm until after the spring runoff has ended.

Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982, Levings 1982, Levings *et al.* 1986, Healey 1991). As juvenile Chinook salmon increase in length, they tend to school in the surface waters of the main and secondary channels and sloughs, following the tides into shallow water habitats to feed (Allen and Hassler 1986). In Suisun Marsh, Moyle *et al.* (1989) reported that Chinook salmon fry tend to remain close to the banks and vegetation, near protective cover, and in dead-end tidal channels. Kjelson *et al.* (1982) reported that juvenile Chinook salmon demonstrated a diel migration pattern, orienting themselves to nearshore cover and structure during the day, but moving into more open, offshore waters at night. The fish also distributed themselves vertically in relation to ambient light. During the night, juveniles were distributed randomly in the water column, but would school up during the day into the upper three meters of the water column. Available data indicates that juvenile Chinook salmon use Suisun Marsh extensively both as a migratory pathway and rearing area as they move downstream to the Pacific Ocean. Juvenile Chinook salmon were found to spend about 40 days migrating through the Delta to the mouth of San Francisco Bay and grew little in length or weight until they reached the Gulf of the Farallones (MacFarlane and Norton 2002). Based on the mainly ocean-type life history observed (*i.e.*, fall-run Chinook salmon) MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show little estuarine dependence and may benefit from expedited ocean entry.

b. *Central Valley Spring-Run Chinook salmon*

Historically the CV spring-run Chinook salmon were the second most abundant salmon run in the Central Valley (CDFG 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other low elevation dams in the Sierra Nevada foothills on the American, Mokelumne, Stanislaus, Tuolumne, and Merced rivers extirpated CV spring-run Chinook salmon from these watersheds. Naturally-spawning populations of CV spring-run Chinook salmon currently are restricted to accessible reaches of the upper Sacramento River, Antelope, Battle, Beegum, Big Chico, Butte, Clear, Deer, and Mill creeks, and Feather and Yuba rivers (CDFG 1998).

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River between March and September, primarily in May and June (Table 3; Yoshiyama *et al*. 1998, Moyle 2002). Lindley *et al*. (2004) indicates adult CV spring-run Chinook salmon enter native tributaries from the Sacramento River primarily between mid-April and mid-June. Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama *et al*. 1998).

Spring-run Chinook salmon spawning occurs between September and October depending on water temperatures. Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins *et al.* 1940, Fisher 1994).

Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the-year or as juveniles or yearlings. The modal size of fry migrants at approximately 40 mm between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley *et al*. 2004). Studies in Butte Creek (Ward *et al*. 2002, 2003, McReynolds *et al*. 2005) found the majority of CV spring-run Chinook salmon migrants to be fry occurring primarily during December, January, and February; and that these movements appeared to be influenced by flow. Small numbers of CV spring-run Chinook salmon remained in Butte Creek to rear and migrated as yearlings later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley *et al*. 2004).

Once juveniles emerge from the gravel they initially seek areas of shallow water and low velocities while they finish absorbing the yolk sac and transition to exogenous feeding (Moyle 2002). Many also will disperse downstream during high-flow events. As is the case in other salmonids, there is a shift in microhabitat use by juveniles to deeper faster water as they grow larger. Microhabitat use can be influenced by the presence of predators which can force fish to select areas of heavy cover and suppress foraging in open areas (Moyle 2002). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period (CDFG 1998). Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000). Based on the available information, the emigration timing of CV spring-Chinook salmon appears highly variable (CDFG 1998). Some fish may begin emigrating soon after emergence from the gravel, whereas others over summer and emigrate as yearlings with the onset of fall storms (CDFG 1998).

On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRH. In 2002, the FRH reported 4,189 returning spring-run Chinook salmon, which is 22 percent below the 10-year average of 4,727 fish. However, coded-wire tag (CWT) information from these hatchery returns indicates substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to hatchery practices. Because Chinook salmon have not always been temporally separated in the hatchery, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock. The number of naturally spawning spring-run Chinook salmon in the Feather River has been estimated only periodically since the 1960s, with estimates ranging from 2 fish in 1978 to 2,908 in 1964. However, the genetic integrity of this population is questionable because of the significant temporal and spatial overlap between spawning populations of spring-run and fall-run Chinook salmon (Good *et al*. 2005). For the reasons discussed above, the Feather River spring-run Chinook population numbers are not included in the following discussion of ESU abundance trends.

Table 3. The temporal occurrence of adult (a) and juvenile (d) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest abundance.

(a) Adult migration																								
Location	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		**Nov**		**Dec**	
Sac.River basin[a,b]					Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low				
Sac. River mainstem[c]		Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low								
Mill Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium	Low	Low									
Deer Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium											
Butte Creek[d]			Medium	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Low											
(b) Adult Holding			Medium	Medium	Medium	Medium	Medium	High	High	High	High	High	High	High	High	High	High	Medium	Medium	Low				
(c) Adult Spawning															Low	Medium	High	High	Medium	Low				
(d) Juvenile migration																								
Location	**Jan**		**Feb**		**Mar**		**Apr**		**May**		**Jun**		**Jul**		**Aug**		**Sep**		**Oct**		**Nov**		**Dec**	
Sac. River Tribs[e]	Medium	Medium	Medium	Medium	Medium	Medium													Medium	Medium	High	High	High	High
Upper Butte Creek[f]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	High	High
Mill, Deer, Butte Creeks[d]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	Low	Low
Sac. River at RBDD[c]	High	High	Low	Low	Low	Low	Low	Low	Low												High	High	High	High
Sac. River at KL[g]	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium											Medium	Medium	High	High
Relative Abundance:	High	= High							Medium	= Medium							Low	= Low						

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Young of the year spring-run Chinook salmon emigrate during the first spring after they hatch.
Sources: [a]Yoshiyama *et al*. (1998); [b]Moyle (2002); [c]Myers *et al*. (1998); [d]Lindley *et al*. (2004); CDFG (1998); [f]McReynolds *et al*. (2007); Ward *et al*. (2003); [g]Snider and Titus (2000)

In addition, monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the potential to physically separate spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon has made identification of spring-run Chinook salmon in the mainstem very difficult to determine, and there is speculation as to whether a true spring-run Chinook salmon population still exists downstream of Keswick Dam. Although the physical habitat conditions downstream of Keswick Dam is capable of supporting spring-run Chinook salmon, some years have had high water temperatures resulting in substantial levels of egg mortality. Less than 15 redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the RBDD, ranging from three to 105 redds (CDFG, unpublished data, 2011). This is typically when spring-run spawn, however, these redds also could be early spawning fall-run. Therefore, even though physical habitat conditions may be suitable, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

The CV spring-run Chinook salmon tributary populations have displayed broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998 (Table 4). Sacramento River tributary populations in Mill, Deer, and Butte creeks are probably the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the primary independent populations within the ESU. Until recently, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged around 7,000 fish from 1995 to 2005, but then declined in years 2006 to 2011 with an average of just over 3,000. During this same period, adult returns on Mill and Deer creeks combined have averaged 2,000 fish, and just over 1,000 fish, respectively. Although trends were generally positive during this time, annual abundance estimates displayed a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remained well below estimates of historic abundance. Fluctuations may be attributable to poor ocean conditions that exist when the returning adults enter the ocean as smolts, leading to poor ocean survival in the critical ocean entry phase of their life history. Additional factors that have limited adult spawning populations are in-river water quality conditions. In 2002 and 2003, mean water temperatures in Butte Creek exceeded 21°C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris Disease (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) in the adult spring-run Chinook salmon holding in Butte Creek. In 2002, this contributed to the pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek. From 2007 to 2011 most spring-run Chinook salmon population numbers have shown a steady decrease, resulting in the combined tributary population's 5-year average 3,961, the lowest since before 1998. Most populations observed an increase in 2012, with the combined tributary population reaching 10,810.

Table 4. CV Spring-run Chinook salmon population estimates from CDFW Grand Tab (April 2013) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average Tributary Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1658	5.24		4948	2.30	
1991	5,101	4,303	798	1376	0.36		5240	0.56	
1992	2,673	1,497	1,176	1551	0.60		5471	0.38	
1993	5,685	4,672	1,013	1307	0.64	1.54	4795	1.63	1.36
1994	5,325	3,641	1,684	1253	2.11	1.79	4454	1.04	1.18
1995	14,812	5,414	9,398	2814	7.99	2.34	6719	5.54	1.83
1996	8,705	6,381	2,324	3119	2.29	2.73	7440	1.53	2.03
1997	5,065	3,653	1,412	3166	0.84	2.77	7918	0.95	2.14
1998	30,534	6,746	23,788	7721	2.53	3.15	12888	2.06	2.23
1999	9,838	3,731	6,107	8606	2.63	3.26	13791	1.13	2.24
2000	9,201	3,657	5,544	7835	3.93	2.44	12669	1.82	1.50
2001	16,869	4,135	12,734	9917	0.54	2.09	14301	0.55	1.30
2002	17,224	4,189	13,035	12242	2.13	2.35	16733	1.75	1.46
2003	17,691	8,662	9,029	9290	1.63	2.17	14165	1.92	1.43
2004	13,612	4,212	9,400	9948	0.74	1.79	14919	0.81	1.37
2005	16,096	1,774	14,322	11704	1.10	1.23	16298	0.93	1.19
2006	10,948	2,181	8,767	10911	0.97	1.31	15114	0.62	1.21
2007	9,726	2,674	7,052	9714	0.75	1.04	13615	0.71	1.00
2008	6,368	1,624	4,744	8857	0.33	0.78	11350	0.40	0.69
2009	3,801	989	2,812	7539	0.32	0.69	9388	0.35	0.60
2010	3,792	1,661	2,131	5101	0.30	0.54	6927	0.39	0.49
2011	4,967	1,969	3,067	3961	0.65	0.47	5731	0.78	0.53
2012	18,275	7,465	10,810	4713	3.84	1.09	7441	0.79	0.54
Median	9,900	3,856	6,047	6,274	0.89	1.79	10,369	0.95	1.36

[a] NMFS is only including the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries.
[b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

At the ESU level, the reestablishment of spring-run Chinook salmon into Battle Creek (persisting since around 1995), through a large restoration project that has increased flows, and removed barriers to habitat; and the increasing abundance of spring-run Chinook salmon holding in Clear Creek due to efforts to enhance summer flows in the upper reaches downstream of Whiskeytown Dam, maintain suitable water temperatures in those reaches, enhance spawning habitat through gravel augmentation, and prevent genetic introgression with fall-run which utilize the same watershed, are improving the status of CV spring-run Chinook salmon. Further efforts will need to involve more than restoration of currently accessible watersheds. The draft Central Valley Salmon and Steelhead Recovery Plan (NMFS 2009b) calls for reestablishing populations into historical habitats currently blocked by large dams, such as those underway to establish spring-run Chinook salmon production in the San Joaquin River downstream of Friant Dam, a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River which will be needed to make the ESU viable (NMFS 2009b).

Summary of Viable Salmonid Population (VSP) Parameters for Central Valley Spring-run Chinook Salmon

The following provides the evaluation of the likelihood of viability of the CV spring-run Chinook salmon ESU based on the viable salmonid population parameters of population size, population growth rate, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000).

Population Size (Abundance). The CV spring-run Chinook salmon declined drastically in the mid to late 1980s before stabilizing at very low levels in the early to mid-1990s. From 1995 through 2005 the tributary populations showed a positive escapement trend, with a high 5-year moving average of over 12,000. Abundance has generally been dominated by the Butte Creek population. Other independent and dependent populations are smaller. In the most recent years (2007 through 2011) we have seen another decline, with the 5-year moving average of the tributary populations reaching a low of 3,961 (the lowest since 1997). Year 2012 appears to have been a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799).

Population Growth Rate (Productivity). The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used. Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation.

1993 to 2007 the 5-year moving average of the tributary population CRR remainded over 1.0, but then declined to a low of 0.47 for the years 2007 through 2011. The productivity of the

Feather River and Yuba River populations and contribution to the CV spring-run ESU currently is unknown. The CRR for the 2012 combined tributary population was 3.84, due to increases in abundance for most populations.

Spatial Structure. In general, there is less information available on how spatial processes relate to salmonid viability than there is for the other VSP parameters (McElhany *et al.* 2000). Understanding the spatial structure of a population is important because the population structure can affect evolutionary processes and, therefore, alter the ability of a population to adapt to spatial or temporal changes in the species' environment (McElhany *et al*. 2000).

Lindley *et al*. (2007) indicated that of the 19 independent populations of spring-run that occurred historically, only three (Butte, Mill, and Deer creeks) remain, and their current distribution makes the spring-run ESU vulnerable to catastrophic disturbance. Butte, Mill, and Deer creeks all occur in the same biogeographic region (diversity group), whereas historically, independent spring-run populations were distributed throughout the CV among at least three diversity groups (*i.e*., basalt and porous lava, northern Sierra Nevada, and southern Sierra Nevada). In addition, dependent spring-run populations historically persisted in the Northwestern California diversity group (Lindley *et al*. 2004). Currently, there are dependent populations of spring-run in Big Chico, Antelope, Clear, Battle, and Beegum creeks, and in the Sacramento, Feather, and Yuba rivers (Lindley *et al*. 2007).

Recovery criteria for each diversity group have been specifically laid out in the draft Central Valley Salmon and Steelhead Recovery Plan (NMFS 2009b). One viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group. It is clear that further efforts will need to involve more than restoration of currently accessible watersheds to make the ESU viable. The draft Central Valley Salmon and Steelhead Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as the reintroduction of a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River (NMFS 2009b).

Diversity. Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The CV spring-run Chinook salmon are comprised of two genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the Central Valley indicates that the southern Cascades spring-run Chinook salmon population complex (Mill, Deer, and Butte creeks) retains genetic integrity. The genetic integrity of the Sierra Nevada spring-run Chinook salmon population complex has been somewhat compromised with the loss of the San Joaquin River basin spring-run Chinook salmon populations. In addition, the Feather River spring-run Chinook salmon have introgressed with the fall-run Chinook salmon, and it appears that the Yuba River population may have been impacted by FRH fish straying into the Yuba River. Spring-run Chinook salmon do however reserve some genetic and behavioral variation in that in any given year, at least two cohorts are in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

The CV spring-run ESU fails to meet the "representation and redundancy rule," since the northern Sierra Nevada is the only diversity group in the CV spring-run Chinook salmon ESU that contains demonstrably viable populations out of at least three diversity groups that historically contained them. The Northwestern California diversity group contains a few smaller populations of CV spring-run Chinook salmon that are likely currently dependent on the northern Sierra Nevada populations for their continued existence. The CV spring-run Chinook salmon populations that historically occurred in the basalt and porous lava, and southern Sierra Nevada diversity groups have been extirpated, although small populations in Battle Creek has been reestablished and persisting over the last 15 years.

Summary. Lindley *et al*. (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their PVA model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon population failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them. Over the long term, these remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

The status of CV spring-run Chinook salmon ESU has probably deteriorated on balance since the 2005 status review and Lindley et al.'s (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Butte Creek remains at low risk, although it is on the verge of moving towards high risk, due to rate of population decline. In contrast, spring-run Chinook salmon in Battle and Clear creeks have increased in abundance over the last decade, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have increased at least in part due to extensive habitat restoration. Overall, the SWFSC concluded in their viability report that the status of CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased (Williams et al. 2011). The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

2. Central Valley Steelhead

CV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). This DPS consists of steelhead populations in the Sacramento and San Joaquin river basins in California's Central Valley. In June 2004, after a complete status review of the 26 west coast salmon, NMFS proposed that CV spring-run Chinook salmon remain listed as threatened (69 FR 33102), while the other Chinook salmon and steelhead were further reviewed. On June 28, 2005, after reviewing the best available scientific and commercial information, NMFS issued its final decision to retain the status of CV steelhead as threatened (70 FR 37160). This decision also included the Coleman National Fish Hatchery and FRH steelhead populations. These populations were previously included in the DPS but were not deemed essential for conservation and thus not part of the listed steelhead population. Critical habitat was designated for Central Valley steelhead on September 2, 2005 (70 FR 52488).

Steelhead can be divided into two life history types, summer-run steelhead and winter-run steelhead, based on their state of sexual maturity at the time of river entry and the duration of their spawning migration, stream-maturing and ocean-maturing. Only winter steelhead are currently found in Central Valley rivers and streams (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento river system prior to the commencement of large-scale dam construction in the 1940s [Interagency Ecological Program (IEP) Steelhead Project Work Team 1999]. At present, summer steelhead are found only in northern California coast drainages, mostly in tributaries of the Eel, Klamath, and Trinity river systems (McEwan and Jackson 1996).

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April, with peaks from January through March, in small streams and tributaries where cool, well oxygenated water is available year-round (Table 5, Hallock *et al.* 1961, McEwan and Jackson 1996). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapolov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams.

Spawning occurs during winter and spring months. The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly-emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Table 5. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1]Sacramento River near Fremont Weir	L / L	L / L	L / –	– / –	– / –	– / L	L / L	L / M	H / H	H / M	L / L	L / L
[2]Sacramento R. at Red Bluff	L / L	L / L	L / L	L / L	L / L	L / L	L / L	L / L	M / M	H / M	L / L	L / L
[3]Mill and Deer Creeks	M / M	H / M	M / L	L / L	L / L	L / L	– / –	– / –	– / –	M / H	H / L	L / L
[4]Mill Creek at Clough Dam	L / L	M / H	M / M	L / L	– / –	– / –	– / –	– / –	– / L	M / H	H / H	M / M
[5]San Joaquin River	H / H	M / M	L / L	– / –	– / –	– / –	L / L	L / L	M / M	M / M	M / M	H / H

(b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento River near Fremont Weir	L / L	L / L	M / M	M / M	M / M	M / M	L / L	L / L	L / L	M / M	M / M	L / L
[6]Sacramento River at Knights Landing	H / H	H / H	M / M	M / M	L / L	L / L	– / –	– / –	– / –	– / –	L / L	L / L
[7]Mill and Deer Creeks (silvery parr/smolts)	L / L	L / L	M / H	H / H	H / H	L / L	– / –	– / –	– / –	L / L	L / L	L / L
[7]Mill and Deer Creeks (fry/parr)	L / L	L / L	L / L	M / M	H / H	H / H	– / –	– / –	– / –	M / M	M / M	M / M
[8]Chipps Island (clipped)	M / M	H / H	M / M	L / L	L / L	– / –	– / –	– / –	– / –	– / –	– / –	L / L
[8]Chipps Island (unclipped)	M / M	M / M	H / H	H / H	H / H	M / M	L / L	– / –	– / –	– / –	– / –	L / L
[9]Mossdale on San Joaquin River	– / –	L / L	M / M	H / H	H / H	L / L	– / –	– / –	– / –	L / L	– / –	– / –
[10]Mokelumne R. (silvery parr/smolts)	L / L	M / M	M / M	H / H	H / H	M / M	M / M	– / –	– / –	– / –	– / –	– / –
[10]Mokelumne R. (fry/parr)	– / –	L / L	L / L	L / L	M / M	H / H	M / M	– / –	– / –	– / –	– / –	– / –
[11]Stanislaus R. at Caswell	L / L	M / M	H / H	M / M	M / M	L / L	– / –	– / –	– / –	– / –	– / –	– / –
[12]Sacramento R. at Hood	L / L	H / H	H / H	H / H	H / H	H / –	– / –	– / –	– / –	– / –	L / L	L / L

Relative Abundance: ■ = High ■ = Medium ■ = Low

Sources: 1(Hallock 1957); 2(McEwan 2001); 3(Harvey 1995); 4CDFW unpublished data; 5CDFG Steelhead Report Card Data 2007; 6NMFS analysis of 1998-2011 CDFW data; 7(Johnson and Merrick 2012); 8NMFS analysis of 1998-2011 USFWS data; 9NMFS analysis of 2003-2011 USFWS data; 10unpublished EBMUD RST data for 2008-2013; 11Oakdale RST data (collected by Fishbio) summarized by John Hannon (Reclamation) ; 12(Schaffter 1980).

Steelhead rearing during the summer takes place primarily in higher velocity areas in pools, although young-of-the-year also are abundant in glides and riffles. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small woody material. Cover is an important habitat component for juvenile steelhead both as velocity refugia and as a means of avoiding predation (Meehan and Bjornn 1991).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Some juvenile steelhead may utilize tidal marsh areas, non-tidal freshwater marshes, and other shallow water areas in the Delta as rearing areas for short periods prior to their final emigration to the sea. Hallock *et al.* (1961) found that juvenile steelhead in the Sacramento River basin migrate downstream during most months of the year, but the peak period of emigration occurred in the spring, with a much smaller peak in the fall. Nobriga and Cadrett (2003) have also verified these temporal findings based on analysis of captures at Chipps Island, Suisun Bay.

Historic Central Valley steelhead run sizes are difficult to estimate given the paucity of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally-spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River. Steelhead counts at RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations.

Recent estimates from trawling data in the Delta indicate that approximately 100,000 to 300,000 (mean 200,000) smolts emigrate to the ocean per year, representing approximately 3,600 female Central Valley steelhead spawners in the Central Valley basin (Good *et al.* 2005). This can be compared with McEwan's (2001) estimate of 1 to 2 million spawners before 1850, and 40,000 spawners in the 1960s.

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks, and a few wild steelhead are produced in the American and Feather rivers (McEwan and Jackson 1996). Recent snorkel surveys (1999 to 2008) indicate that steelhead are present in Clear Creek (Giovannetti *et al.* 2008, Good *et al.* 2005) as well as monitoring from 2005 through 2009 in Battle Creek (Newton and Stafford 2011). Because of the large resident *O. mykiss* population in Clear Creek, steelhead spawner abundance has not been estimated.

Until recently, Central Valley steelhead were thought to be extirpated from the San Joaquin River system. However, monitoring has detected small, self-sustaining populations of steelhead in the Stanislaus, Mokelumne, and Calaveras rivers, and other streams previously thought to be devoid of steelhead (McEwan 2001). On the Stanislaus River, steelhead smolts have been captured in rotary screw traps at Caswell State Park and Oakdale each year since 1995 (S.P. Cramer and Associates Inc. 2000).

It is possible that naturally-spawning populations exist in other streams but are undetected due to lack of monitoring programs (IEP Steelhead Project Work Team 1999). Incidental catches and observations of steelhead juveniles have also occurred on the Tuolumne and Merced rivers during fall-run Chinook salmon monitoring activities, indicating that steelhead are widespread throughout accessible streams and rivers in the Central Valley (Good *et al.* 2005). CDFW staff have prepared juvenile migrant Central Valley steelhead catch summaries on the San Joaquin River near Mossdale, representing migrants from the Stanislaus, Tuolumne, and Merced rivers. Based on trawl recoveries at Mossdale between 1988 and 2002, as well as rotary screw trap efforts in all three tributaries, CDFG (2003) stated that it is "clear from this data that rainbow trout do occur in all the tributaries as migrants and that the vast majority of them occur on the Stanislaus River." The documented returns on the order of single fish in these tributaries suggest that existing populations of Central Valley steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed.

Good *et al.* (2005) indicated that population census estimates completed in the 1990s found that compared to most Chinook salmon populations in the Central Valley, Central Valley steelhead spawning population upstream of RBDD had a fairly strong negative population growth rate and small population size; in addition, that this decline was continuing, as evidenced by new information (Chipps Island trawl data). Central Valley steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. The future of Central Valley steelhead is uncertain due to limited data concerning their status. However, Lindley *et al.* (2007), concluded that there is sufficient evidence to suggest that the ESU is at moderate to high risk of extinction.

The most recent status review of the Central Valley steelhead DPS (NMFS 2011c) found that the status of the population appears to have worsened since the 2005 status review (Good *et al*. 2005), when it was considered to be in danger of extinction. Analysis of data from the Chipps Island monitoring program indicates that natural steelhead production has continued to decline and that hatchery origin fish represent an increasing fraction of the juvenile production in the Central Valley. Since 1998, all hatchery produced steelhead in the Central Valley have been adipose fin clipped (ad-clipped). Since that time, the trawl data indicates that the proportion of ad-clip steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. In recent years, the proportion of hatchery produced juvenile steelhead in the catch has exceeded 90 percent and in 2010 was 95 percent of the catch. Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the Central Valley.

In contrast to the data from Chipps Island, some populations of wild California Central Valley steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the Central Valley compared to hatchery produced fish (NMFS 2011c). Since 2003, fish returning to the Coleman National Fish Hatchery (adjacent to Battle Creek) have been identified as wild (adipose fin intact) or hatchery produced (ad-clipped). Returns of wild fish to Battle Creek have remained fairly steady, ranging from 225 to 593 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely; ranging from 624 to 2,968 fish per year. The returns of wild fish remained steady, even during the recent poor ocean conditions and the three-year drought in the Central Valley, while hatchery produced fish showed a decline in the numbers returning to the hatchery (NMFS 2011c). Furthermore, the continuing widespread distribution of wild steelhead throughout most of the watersheds in the Central Valley provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change.

Summary of Viable Salmonid Population Parameters for Central Valley Steelhead

Population Size (Abundance). All indications are that the naturally produced California Central Valley steelhead population has continued to decrease in abundance and in the proportion of naturally spawned fish to hatchery produced fish over the past 25 years (Good *et al.* 2005, NMFS 2011c); the long-term abundance trend remains negative. There has been little comprehensive steelhead population monitoring, despite 100 percent marking of hatchery steelhead since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being considered (NMFS 2011c). Hatchery production and returns are dominant over wild fish and include significant numbers of non-DPS-origin Eel River steelhead stock. Continued decline in the ratio between wild juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases have remained relatively constant over the past decade, yet the proportion of ad-clipped fish to wild, adipose fin bearing fish has steadily increased over the past several years.

Population Growth Rate (Productivity). An estimated 100,000 to 300,000 wild juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). Concurrently, one million in-DPS hatchery steelhead smolts and another half million out-of-DPS hatchery steelhead smolts are released annually in the Central Valley. The estimated ratio of nonclipped to clipped steelhead has decreased from 0.3 percent to less than 0.1 percent, with a net decrease to one-third of wild female spawners from 1998 to 2000 (Good *et al.* 2005). Recent data from the Chipps Island fish monitoring trawls indicates that in recent years over 90 percent of captured steelhead smolts have been of hatchery origin. In 2010, the data indicated hatchery fish made up 95 percent of the catch.

Spatial Structure. Lindley *et al*. (2006) identified 81 historical and independent populations within the Central Valley steelhead DPS. These populations form eight clusters, or diversity groups, based on the similarity of the habitats they occupied for spawning and rearing. About 80 percent of the habitat that was historically available to Central Valley steelhead is now behind impassable dams, and 38 percent of the populations have lost all of their habitats. Although much of the habitat has been blocked by impassable dams, or degraded, small populations of CV steelhead are still found throughout habitat available in the Sacramento River and many of the tributaries, and some of the tributaries to the San Joaquin River (Good *et al.* 2005, NMFS 2011c, Zimmerman *et al.* 2009). The efforts to provide passage of salmonids over impassable dams, as recommended in the draft Central Valley Recovery Plan would increase the spatial diversity of Central Valley Steelhead.

Diversity. Central Valey steelhead naturally experience the most diverse life history strategies of the listed Central Valley anadromous salmonid species. In addition to being iteroparous, they reside in freshwater for 2-4 years before emigrating to the ocean. However, as the species' abundance decreases, and spatial structure of the DPS is reduced, it has less flexibility to adapt to changes in the environment. Central Valley steelhead abundance and growth rate continue to decline, largely the result of a significant reduction in the diversity of habitats available to Central Valley steelhead (Lindley *et al*. 2006). Consistent with the life history strategy of spring-run, some genetic and behavioral variation is conserved in that in any given year, there are additional cohorts in the marine environment, and therefore, not exposed to the same environmental stressors as their freshwater cohorts.

Analysis of natural and hatchery steelhead stocks in the Central Valley reveal genetic structure remaining in the DPS (Nielsen *et al.* 2003). There appears to be a great amount of gene flow among upper Sacramento River basin stocks, due to the post-dam, lower basin distribution of steelhead and management of stocks. Recent reductions in natural population sizes have created genetic bottlenecks in several Central Valley steelhead stocks (Good *et al.* 2005; Nielsen *et al.* 2003). The out-of-basin steelhead stocks of the Nimbus and Mokelumne River hatcheries are currently not included in the Central Valley steelhead DPS. However, recent work (Garza and Pearse 2008) has identified introgression of stray domestic rainbow trout genes with steelhead, which may be occurring either during egg taking practices in hatcheries or in-river spawning between domesticated strains of rainbow trout and steelhead. Garza and Pearse (2008) also found that all below dam steelhead populations in the Central Valley were genetically closely related and that these populations had a high level of genetic similarity to populations of steelhead in the Klamath and Eel river basins. This genetic data suggests that the progeny of out-of basin steelhead reared in the Nimbus and Mokelumne River hatcheries have become widely introgressed with natural steelhead populations throughout the anadromous sections of rivers and streams in the Central Valley, including the tail-water sections below impassable dams. This suggests the potential for the loss of local genetic diversity and population structure over time in these waters. Their work also indicates that in contrast to the similarity of the steelhead genetics below dams in the Central Valley, the ancestral genetic structure is still relatively intact upstream of the impassable barriers. This would indicate that extra precautions should be included in restoration plans before upstream of dam access is provided to the steelhead from the downstream dam populations in order to maintain genetic heritage and structure in the upstream dam *O. mykiss* populations.

Summary. Historic CV steelhead run sizes are difficult to estimate given the limited extent of data, but may have approached 1 to 2 million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). The most recent status review of the CV steelhead DPS (NMFS 2011a) found that the status of the population appears to have worsened since the 2005 status review (Good *et al*. 2005), when it was considered to be in danger of extinction.

C. Critical Habitat and Primary Constituent Elements for Listed Salmonids

Critical habitat was designated for CV spring-run Chinook salmon and CV steelhead on September 2, 2005, (70 FR 52488). Critical habitat for CV spring-run Chinook salmon includes stream reaches such as those of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat for Central Valley 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. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488).

In designating critical habitat, NMFS considers those physical and biological features that are essential to the conservation of a species and that may require special management considerations or protection, including, but not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and, generally, (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of a species [see 50 CFR 424.12(b)]. In addition to these factors, NMFS focuses on the known principal biological or physical constituent elements within the designated area that are essential to the conservation of the species (primary constituent elements). These primary constituent elements may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

Within the areas of designated critical habitat for the CV spring-run Chinook salmon ESU, and the CV steelhead DPS, the primary constituent elements (PCEs) are those sites and habitat components that support one or more life stages, including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas with certain conditions that are more completely described below. The following discussion describes the current conditions of the freshwater PCEs for CV spring-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon and steelhead is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between RBDD and

Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks (however, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon), as well as the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. Spawning habitat for Central Valley steelhead is similar in nature to the requirements of Chinook salmon, primarily occurring in reaches directly downstream of dams (*i.e*., upstream of RBDD on the Sacramento River) on perennial watersheds throughout the Central Valley. These reaches can be subjected to variations in flows and temperatures, particularly over the summer months, which can have adverse effects upon salmonids spawning below them. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large woody material (LWM), log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g*., the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults, and the downstream emigration of outmigrant juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, but problems exist on many tributary streams.

For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PCE. However, since the primary migration corridors are used by numerous populations, and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging.

The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

D. Factors Affecting Listed Species and Critical Habitat

California's robust agricultural economy and rapidly increasing urban growth place high demand for water in the Sacramento and San Joaquin river basins. The demand for water in the Central Valley has significantly altered the natural morphology and hydrology of the Sacramento and San Joaquin rivers and their major tributaries. Agricultural lands and urban areas have flourished on historic floodplains. An extensive flood management system of dams, levees, and bypass channels restricts the river's natural sinuosity, volume, and reduces the lag time of water flowing through the system. An impressive network of water delivery systems have transformed the Central Valley drainage system into a series of lined conveyance channels and reservoirs that are operated by several pumping facilities. Flood management and water delivery systems, in addition to agricultural, grazing, and urban land uses, are the main anthropogenic factors affecting watersheds in the action area.

A number of documents have addressed the history of human activities, present environmental conditions, and factors contributing to the decline of salmon and steelhead species in the Central Valley (*e.g*., Busby *et al.* 1996, Myers *et al.* 1998, Good *et al.* 2005, CALFED 2000). NMFS has also assessed the factors contributing to Chinook salmon and steelhead decline in supplemental documents (NMFS 1996, 1998) and Federal Register notices (*e.g*., June 16, 1993, 58 FR 33212; January 4, 1994, 59 FR 440; May 6, 1997, 62 FR 24588; August 18, 1997, 62 FR 43937; March 19, 1998, 63 FR 13347; May 5, 1999, 64 FR 24049; September 16, 1999, 64 FR 50394; February 16, 2000, 65 FR 7764). The foremost reason for the decline in these anadromous salmonid populations is the degradation and destruction of habitat (*e.g.*, substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, and migration conditions). Additional factors contributing to the decline of these populations include: over-utilization, disease or predation, the inadequacy of existing regulatory mechanisms, and other natural and manmade factors including global climate change. All of these factors have contributed to the ESA-listing of these fish and deterioration of their critical habitats. However, it is widely recognized in numerous species accounts in the peer-reviewed literature that the modification and curtailment of habitat and range have had the most substantial impacts on the abundance, distribution, population growth, and diversity of salmonid ESUs and DPSs. Although habitat and ecosystem restoration has contributed to recent improvements in habitat conditions throughout the ESUs/DPSs, global climate change remains a looming threat. The following general description of the factors affecting the viability of CV spring-run Chinook salmon, and CV steelhead is based on a summarization of these documents.

1. Habitat Blockage

Hydropower, flood control, and water supply dams of the Central Valley Project (CVP), State Water Project (SWP), and other municipal and private entities have permanently blocked or hindered salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 linear miles of salmon habitat in the Central Valley system and that 80 percent of this habitat had been lost by 1928. Yoshiyama *et al.* (1996) calculated that roughly 2,000 linear miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today.

As a result of migrational barriers, spring-run Chinook salmon, and steelhead populations have been confined to lower elevation mainstems that historically only were used for migration. Population abundances have declined in these streams due to decreased quantity and quality of spawning and rearing habitat. Higher temperatures at these lower elevations during late-summer and fall are also a major stressor to adult and juvenile salmonids. According to Lindley *et al.* (2004), of the 18 independent populations of CVspring-run Chinook salmon that occurred historically, only three independent populations remain in Deer, Mill, and Butte creeks. Dependent populations of CV spring-run Chinook salmon continue to occur in Big Chico, Antelope, Battle, Clear, Thomes, Beegum, and Stony creeks, but rely on the three extant independent populations for their continued survival. Central Valley steelhead historically had at least 81 independent populations based on Lindley *et al.*'s (2006) analysis of potential habitat in the Central Valley. However, due to dam construction, access to 38 percent of all spawning habitat has been lost as well as access to 80 percent of the historically available habitat. Beginning this year (2012), the gates of the RBDD are required to remain open year round.

Further efforts will need to involve more than restoration of currently accessible watersheds. The draft Central Valley Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as those underway to establish spring-run Chinook salmon production in the San Joaquin River downstream Friant Dam, a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River will be needed to make the ESU viable.

2. Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley waterways have depleted stream flows and altered the natural cycles by which juvenile and adult salmonids base their migrations. As much as 60 percent of the natural historical inflow to

Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower dissolved oxygen (DO) levels, and decreased recruitment of gravel and LWM. More uniform flows year round have resulted in diminished natural channel formation, altered food web processes, and slower regeneration of riparian vegetation. These stable flow patterns have reduced bed load movement (Mount 1995, Ayers 2001), caused spawning gravels to become embedded, and decreased channel widths due to channel incision, all of which has decreased the available spawning and rearing habitat below dams. The storage of unimpeded runoff in these large reservoirs also has altered the normal hydrograph for the Sacramento and San Joaquin river watersheds. Rather than seeing peak flows in these river systems following winter rain events (Sacramento River) or spring snow melt (San Joaquin River), the current hydrology has truncated peaks with a prolonged period of elevated flows (compared to historical levels) continuing into the summer dry season.

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al*. 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run Chinook salmon survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al*. 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Most of the 370 water diversions operating in Suisun Marsh are unscreened (Herren and Kawasaki 2001).

Outmigrant juvenile salmonids in the Delta have been subjected to adverse environmental conditions created by water export operations at the CVP and SWP facilities. Specifically, juvenile salmonid survival has been reduced by the following: (1) water diversion from the mainstem Sacramento River into the Central Delta via the Delta Cross Channel (DCC); (2) upstream or reverse flows of water in the lower San Joaquin River and southern Delta waterways; (3) entrainment at the CVP and SWP export facilities and associated problems at Clifton Court Forebay; and (4) increased exposure to introduced, non-native predators such as striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and sunfishes (Centrarchidae). On June 4, 2009, NMFS issued a biological and conference opinion on the long-term operations of the CVP and SWP (NMFS 2009a). As a result of the jeopardy and adverse modification determinations, NMFS provided a reasonable and prudent alternative that reduces many of the adverse effects of the CVP and SWP resulting from the stressors described above.

3. <u>Water Conveyance and Flood Control</u>

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of channels and diversions to increase channel elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine habitat PCEs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watersheds supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of near shore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al*. 2002). Simple slopes protected with rock revetment generally create near shore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody material. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

Prior to the 1970s, there was so much woody material resulting from poor logging practices that many streams were completely clogged and were thought to have been total barriers to fish migration. As a result, in the 1960s and early 1970s it was common practice among fishery management agencies to remove woody material thought to be a barrier to fish migration (NMFS 1996b). However, it is now recognized that too much LWM was removed from the streams resulting in a loss of salmonid habitat and it is thought that the large scale removal of woody material prior to 1980 had major, long-term negative effects on rearing habitats for salmonids in northern California (NMFS 1996b). Areas that were subjected to this removal of LWM are still limited in the recovery of salmonid stocks; this limitation could be expected to persist for 50 to 100 years following removal of woody material.

Large quantities of downed trees are a functionally important component of many streams (NMFS 1996b). LWM influences stream morphology by affecting channel pattern, position, and geometry, as well as pool formation (Keller and Swanson 1979, Bilby 1984, Robison and Beschta 1990). Reduction of wood in the stream channel, either from past or present activities, generally reduces pool quantity and quality, alters stream shading which can affect water temperature regimes and nutrient input, and can eliminate critical stream habitat needed for both vertebrate and invertebrate populations. Removal of vegetation also can destabilize marginally stable slopes by increasing the subsurface water load, lowering root strength, and altering water flow patterns in the slope.

In addition, the armoring and revetment of stream banks tends to narrow rivers, reducing the amount of habitat per unit channel length (Sweeney *et al*. 2004). As a result of river narrowing, benthic habitat decreases and the number of macroinvertebrates, such as stoneflies and mayflies, per unit channel length decreases affecting salmonid food supply.

4. Land Use Activities

Land use activities continue to have large impacts on salmonid habitat in the Central Valley watershed. Until about 150 years ago, the Sacramento River was bordered by up to 500,000 acres of riparian forest, with bands of vegetation extending outward for 4 or 5 miles (California Resources Agency 1989). Starting with the gold rush, these vast riparian forests were cleared for building materials, fuel, and to clear land for farms on the raised natural levee banks. The degradation and fragmentation of riparian habitat continued with extensive flood control and bank protection projects, together with the conversion of the fertile riparian lands to agriculture outside of the natural levee belt. By 1979, riparian habitat along the Sacramento River diminished to 11,000 to 12,000 acres, or about 2 percent of historic levels (McGill 1987). The clearing of the riparian forests removed a vital source of snags and driftwood in the Sacramento and San Joaquin River basins. This has reduced the volume of LWM input needed to form and maintain stream habitat that salmon depend on in their various life stages. In addition to this loss of LWM sources, removal of snags and obstructions from the active river channel for navigational safety has further reduced the presence of LWM in the Sacramento and San Joaquin rivers, as well as the Delta.

Increased sedimentation resulting from agricultural and urban practices within the Central Valley is one of the primary causes of salmonid habitat degradation (NMFS 1996a). Sedimentation can adversely affect salmonids during all freshwater life stages by: clogging or abrading gill surfaces, adhering to eggs, hampering fry emergence (Phillips and Campbell 1961), burying eggs or alevins, scouring and filling in pools and riffles, reducing primary productivity and photosynthesis activity (Cordone and Kelley 1961), and affecting intergravel permeability and DO levels. Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995).

Land use activities associated with road construction, urban development, logging, mining, agriculture, and recreation have significantly altered fish habitat quantity and quality through the alteration of stream bank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWM; and removal of riparian vegetation, resulting in increased stream bank erosion (Meehan 1991). Urban stormwater and agricultural runoff may be contaminated with herbicides and pesticides, petroleum products, sediment, *etc.* Agricultural practices in the Central Valley have eliminated large trees and logs and other woody material that would otherwise be recruited into the stream channel (NMFS 1998).

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and

Phillips 1988, Monroe *et al.* 1992, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. In Suisun Marsh, saltwater intrusion and land subsidence gradually has led to the decline of agricultural production. Presently, Suisun Marsh consists largely of tidal sloughs and managed wetlands for duck clubs, which first were established in the 1870s in western Suisun Marsh (Goals Project 1999). Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin river basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the United States Army Corp of Engineers (Corps) and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and riffle segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bed load in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWM from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban storm water and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, polycyclic aromatic hydrocarbons (PAHs), and other organics and nutrients (California Regional Water Quality Control Board-Central Valley Region [Regional Board] 1998) that can potentially destroy aquatic life necessary for salmonid survival (NMFS 1996a,b). Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e.*, concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a,b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

Past mining activities routinely resulted in the removal of spawning gravels from streams, the straightening and channelization of the stream corridor from dredging activities, and the leaching of toxic effluents into streams from mining operations. Many of the effects of past mining operations continue to impact salmonid habitat today. Current mining practices include suction dredging (sand and gravel mining), placer mining, lode mining and gravel mining. Present day mining practices are typically less intrusive than historic operations (hydraulic mining); however, adverse impacts to salmonid habitat still occur as a result of present-day mining activities. Sand and gravel are used for a large variety of construction activities including base material and asphalt, road bedding, drain rock for leach fields, and aggregate mix for concrete to construct buildings and highways.

Most aggregate is derived principally from pits in active floodplains, pits in inactive river terrace deposits, or directly from the active channel. Other sources include hard rock quarries and mining from deposits within reservoirs. Extraction sites located along or in active floodplains present particular problems for anadromous salmonids. Physical alteration of the stream channel may result in the destruction of existing riparian vegetation and the reduction of available area for seedling establishment (Stillwater Sciences 2002). Loss of vegetation impacts riparian and aquatic habitat by causing a loss of the temperature moderating effects of shade and cover, and habitat diversity. Extensive degradation may induce a decline in the alluvial water table, as the banks are effectively drained to a lowered level, affecting riparian vegetation and water supply (NMFS 1996b). Altering the natural channel configuration will reduce salmonid habitat diversity by creating a wide, shallow channel lacking in the pools and cover necessary for all life stages of anadromous salmonids. In addition, waste products resulting from past and present mining activities, include cyanide (an agent used to extract gold from ore), copper, zinc, cadmium, mercury, asbestos, nickel, chromium, and lead.

Juvenile salmonids are exposed to increased water temperatures in the Delta during the late spring and summer due to the loss of riparian shading, and by thermal inputs from municipal, industrial, and agricultural discharges. Studies by California Department of Water Resources (DWR) on water quality in the Delta over the last 30 years show a steady decline in the food sources available for juvenile salmonids and sturgeon and an increase in the clarity of the water due to a reduction in phytoplankton and zooplankton. These conditions have contributed to increased mortality of juvenile Chinook salmon, steelhead, and sturgeon as they move through the Delta.

5. Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased dissolved oxygen (DO) levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes [including lindane], endosulfan and toxaphene), mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al*. 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids or the threatened green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized “hot spots” where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (Environmental Protection Agency 1994). However, the more likely route of exposure to salmonids or sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures.

Low DO levels frequently are observed in the portion of the Stockton deep water ship channel (DWSC) extending from Channel Point, downstream to Turner and Columbia cuts. For example, over the 5-year period, starting in August 2000, a DO meter recorded channel DO levels at Rough and Ready Island (Dock 20 of the West Complex). Over the course of this time period, there have been 297 days in which violations of the 5 mg/L DO criteria for the protection of aquatic life in the San Joaquin River between Channel Point and Turner and Columbia cuts have occurred during the September through May migratory period for salmonids in the San Joaquin River. The data derived from the California Data Exchange Center files indicate that DO depressions occur during all migratory months, with significant events occurring from November through March when listed Central Valley steelhead adults and smolts would be utilizing this portion of the San Joaquin River as a migratory corridor.

Potential factors that contribute to these DO depressions are reduced river flows through the ship channel, released ammonia from the City of Stockton Wastewater Treatment Plant, upstream contributions of organic materials (*e.g.*, algal loads, nutrients, agricultural discharges) and the increased volume of the dredged ship channel. During the winter and early spring emigration period, increased ammonia concentrations in the discharges from the City of Stockton Waste

Water Treatment Facility lowers the DO in the adjacent DWSC near the West Complex. In addition to the adverse effects of the lowered DO on salmonid physiology, ammonia is in itself toxic to salmonids at low concentrations. Likewise, adult fish migrating upstream will encounter lowered DO in the DWSC as they move upstream in the fall and early winter due to low flows and excessive algal and nutrient loads coming downstream from the upper San Joaquin River watershed. Levels of DO below 5 mg/L have been reported as delaying or blocking fall-run Chinook salmon in studies conducted by Hallock *et al.* (1970).

6. Hatchery Operations and Practices

Five hatcheries currently produce Chinook salmon in the Central Valley and four of these also produce steelhead. Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs in the Central Valley primarily are caused by straying of hatchery fish and the subsequent interbreeding of hatchery fish with wild fish. In the Central Valley, practices such as transferring eggs between hatcheries and trucking smolts to distant sites for release contribute to elevated straying levels [Department of the Interior (DOI) 1999]. For example, the original source of steelhead broodstock at Nimbus Hatchery on the American River originally came from the Eel River basin and was not from the Central Valley. Thus, the progeny from that initial broodstock served as the basis for the hatchery steelhead reared and released from the Nimbus Fish Hatchery. One of the recommendations in the Joint Hatchery Review Report (NMFS and CDFG 2001) was to identify and designate new sources of steelhead brood stock to replace the current Eel River origin brood stock.

Hatchery practices as well as spatial and temporal overlaps of habitat use and spawning activity between spring- and fall-run fish have led to the hybridization and homogenization of some subpopulations (CDFG 1998). As early as the 1960s, Slater (1963) observed that early fall- and spring-run Chinook salmon were competing for spawning sites in the Sacramento River downstream of Keswick Dam, and speculated that the two runs may have hybridized. The FRH spring-run Chinook salmon have been documented as straying throughout the Central Valley for many years (CDFG 1998), and in many cases have been recovered from the spawning grounds of fall-run Chinook salmon, an indication that FRH spring-run Chinook salmon may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish.

The management of hatcheries, such as Nimbus Hatchery and FRH, can directly impact spring-run Chinook salmon and steelhead populations by oversaturating the natural carrying capacity of the limited habitat available below dams. In the case of the Feather River, significant redd superimposition occurs in-river due to hatchery overproduction and the inability to physically separate spring- and fall-run Chinook salmon adults. This concurrent spawning has led to hybridization between the spring- and fall-run Chinook salmon in the Feather River. At Nimbus Hatchery, operating Folsom Dam to meet temperature requirements for returning hatchery fall-run Chinook salmon often limits the amount of water available for steelhead spawning and rearing the rest of the year within the American River downstream of Nimbus Dam.

The increase in Central Valley hatchery production has reversed the composition of the steelhead population, from 88 percent naturally-produced fish in the 1950s (McEwan 2001) to an estimated 23 percent to 37 percent naturally-produced fish by 2000 (Nobriga and Cadrett 2003), and less than 10 percent currently. The increase in hatchery steelhead production proportionate to the wild population has reduced the viability of the wild steelhead populations, increased the use of out-of-basin stocks for hatchery production, and increased straying (NMFS and CDFG 2001). Thus, the ability of natural populations to successfully reproduce and continue their genetic integrity likely has been diminished.

The relatively low number of spawners needed to sustain a hatchery population can result in high harvest-to-escapements ratios in waters where fishing regulations are set according to hatchery population. This can lead to over-exploitation and reduction in the size of wild populations existing in the same system as hatchery populations due to incidental bycatch (McEwan 2001). Currently, hatchery produced fall-run Chinook salmon comprise the majority of fall-run adults returning to Central Valley streams. Based on a 25 percent constant fractional marking of hatchery produced fall-run Chinook salmon juveniles, adult escapement of fin clipped fish greater than 25 percent in Central Valley tributaries would indicate that hatchery produced fish are the predominate source of fish in the spawning population.

Hatcheries also can have some positive effects on salmonid populations. Artificial propagation has been shown to be effective in bolstering the numbers of naturally spawning fish in the short term under specific scenarios. Artificial propagation programs can also aid in conserving genetic resources and guarding against catastrophic loss of naturally spawned populations at critically low abundance levels. However, relative abundance is only one component of a viable salmonid population.

7. Over Utilization

Extensive ocean recreational and commercial troll fisheries for Chinook salmon exist along the Northern and Central California coast, and an inland recreational fishery exists in the Central Valley for Chinook salmon and steelhead. Ocean harvest of Central Valley Chinook salmon is estimated using an abundance index, called the Central Valley Index (CVI). The CVI is the ratio of Chinook salmon harvested south of Point Arena (where 85 percent of Central Valley Chinook salmon are caught) to escapement (adult spawner populations that have "escaped" the ocean fisheries and made it into the rivers to spawn). CWT returns indicate that Sacramento River salmon congregate off the California coast between Point Arena and Morro Bay.

Ocean fisheries have affected the age structure of CV spring-run Chinook salmon through targeting large fish for many years and reducing the numbers of four- and five-year-old fish (CDFG 1998). As a result of very low returns of fall-run Chinook salmon to the Central Valley in 2007 and 2008, there was a complete closure of commercial and recreational ocean Chinook salmon fishery in 2008 and 2009, respectively. Salmon fisheries were again restricted in 2010 with a limited fishing season due to poor returns of fall-run Chinook salmon in 2009. However, contrary to expectations, even with the two years of ocean fishery closures, the CV spring-run Chinook salmon population continues to decline. Ocean harvest rates of CV spring-run Chinook salmon are thought to be a function of the CVI (Good *et al*. 2005). Harvest rates of CV spring-run Chinook salmon ranged from 0.55 to nearly 0.80 between 1970 and 1995 when harvest rates were adjusted for the protection of Sacramento River winter-run Chinook salmon. The drop in the CVI in 2001 as a result of high fall-run escapement to 0.27 also reduced harvest of CV spring-run Chinook salmon. There is essentially no ocean harvest of steelhead.

In-river recreational fisheries historically have taken CV spring-run Chinook salmon throughout the species' range. During the summer, holding adult CV spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate; however, the significance of poaching on the adult population is unknown. Specific regulations for the protection of CV spring-run Chinook salmon in Mill, Deer, Butte, and Big Chico vreeks and the Yuba River have been added to the existing CDFG regulations. The current regulations, including those developed for Sacramento River winter-run Chinook salmon provide some level of protection for spring-run fish (CDFG 1998).

There is little information on steelhead harvest rates in California. Hallock et al. (1961) estimated that harvest rates for Sacramento River steelhead from the 1953-1954 through 1958-1959 seasons ranged from 25.1 percent to 45.6 percent assuming a 20 percent non-return rate of tags. The average annual harvest rate of adult steelhead above RBDD for the 3-year period from 1991-1992 through 1993-1994 was 16 percent (McEwan and Jackson 1996). Since 1998, all hatchery steelhead have been marked with an adipose fin clip allowing anglers to distinguish hatchery and wild steelhead. Current regulations restrict anglers from keeping unmarked steelhead in Central Valley streams. Overall, this regulation has greatly increased protection of naturally produced adult steelhead; however, the total number of CV steelhead contacted might be a significant fraction of basin-wide escapement, and even low catch-and-release mortality may pose a problem for wild populations (Good et al. 2005).

8. Disease and Predation

Infectious disease is one of many factors that influence adult and juvenile salmonid survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment (NMFS 1996a, 1996b, 1998). Specific diseases such as bacterial kidney disease, C*eratomyxosis shasta* (C-shasta), columnaris, furunculosis, infectious hematopoietic necrosis, redmouth and black spot disease, whirling disease, and erythrocytic inclusion body syndrome are known, among others, to affect steelhead and Chinook salmon (NMFS 1996a, 1996b, 1998). Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases; however, studies have shown that wild fish tend to be less susceptible to pathogens than are hatchery-reared fish. Nevertheless, wild salmonids may contract diseases that are spread through the water column (*i.e.*, waterborne pathogens) as well as through interbreeding with infected hatchery fish. The stress of being released into the wild from a controlled hatchery environment frequently causes latent infections to convert into a more pathological state, and increases the potential of transmission from hatchery reared fish to wild stocks within the same waters.

Accelerated predation also may be a factor in the decline of CV spring-run Chinook salmon, and to a lesser degree Central Valley steelhead. Human-induced habitat changes such as alteration of natural flow regimes and installation of bank revetment and structures such as dams, bridges, water diversions, piers, and wharves often provide conditions that both disorient juvenile salmonids and attract predators (Stevens 1961, Decato 1978, Vogel *et al.* 1988, Garcia 1989).

On the mainstem Sacramento River, high rates of predation have been known to occur at the RBDD, Anderson-Cottonwood Irrigation District's (ACID) diversion dam, Glenn-Colusa Irrigation District's diversion facility, areas where rock revetment has replaced natural river bank vegetation, and at south Delta water diversion structures (*e*.g., Clifton Court Forebay; CDFG 1998). In passing a dam, juveniles are subject to conditions which greatly disorient them, making them highly susceptible to predation by fish or birds. Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate downstream of the dam and prey on juvenile salmon in the tail waters. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker *et al.* (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow. Striped bass showed a strong preference for juvenile salmonids as prey during this study. This research also indicated that the percent frequency of occurrence for juvenile salmonids nearly equaled other fish species in the stomach contents of the predatory fish. Tucker *et al.* (2003) showed the temporal distribution for these two predators in the RBDD area were directly related to RBDD operations (predators congregated when the dam gates were in, and dispersed when the gates were removed). With the interim RBDD operations proposed under the 2009 OCAP BiOp the gates of the RBDD remain open for a longer period of time. This should reduce the level of predation upon emigrating salmonids. Eventually the gates will remain open year round and predation should be even further reduced. Some predation is still likely to occur due to the physical structure of the dam remaining in the water way, even with the gates in the open position.

USFWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). From October 1976 to November 1993, CDFG conducted 10 mark and recapture studies at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69 percent to 99 percent. Predation by striped bass is thought to be the primary cause of the loss (Gingras 1997, DWR 2009).

Predation on juvenile salmonids has increased as a result of water development activities which have created ideal habitats for predators and non-native invasive species (NIS). Turbulent conditions near dam bypasses, turbine outfalls, water conveyances, and spillways disorient juvenile salmonid migrants and increase their predator avoidance response time, thus improving predator success. Increased exposure to predators has also resulted from reduced water flow through reservoirs; a condition which has increased juvenile travel time. Other locations in the Central Valley where predation is of concern include flood bypasses, post-release sites for salmonids salvaged at the CVP and SWP Fish Facilities, and the Suisun Marsh Salinity Control Gates (SMSCG). Predation on salmon by striped bass and Sacramento pikeminnow at salvage release sites in the Delta and lower Sacramento River has been documented (Orsi 1967, Pickard *et al.* 1982); however, accurate predation rates at these sites are difficult to determine. CDFG conducted predation studies from 1987 to 1993 at the SMSCG to determine if the structure attracts and concentrates predators. The dominant predator species at the SMSCG was striped bass, and the remains of juvenile Chinook salmon were identified in their stomach contents (Edwards *et al.* 1996, Tillman *et al.* 1996, NMFS 1997).

Avian predation on fish contributes to the loss of migrating juvenile salmonids by constraining natural and artificial production. Fish-eating birds that occur in the California Central Valley include great blue herons (*Ardea herodias*), gulls (*Larus* spp.), osprey (*Pandion haliaetus*), common mergansers (*Mergus merganser*), American white pelicans (*Pelecanus erythrorhynchos*), double-crested cormorants (*Phalacrocorax* spp.), Caspian terns (*Sterna caspia*), belted kingfishers (*Ceryle alcyon*), black-crowned night herons (*Nycticorax nycticorax*), Forster's terns (*Sterna forsteri*), hooded mergansers (*Lophodytes cucullatus*), and bald eagles (*Haliaeetus leucocephalus*) (Stephenson and Fast 2005). These birds have high metabolic rates and require large quantities of food relative to their body size.

Mammals can also be an important source of predation on salmonids within the California Central Valley. Predators such as river otters (*Lutra canadensis*), raccoons (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and western spotted skunk (*Spilogale gracilis*) are common. Other mammals that take salmonids include: badger (*Taxidea taxus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), long-tailed weasel (*Mustela frenata*), mink (*Mustela vison*), mountain lion (*Felis concolor*), red fox (*Vulpes vulpes*), and ringtail (*Bassariscus astutus*). These animals, especially river otters, are capable of removing large numbers of salmon and trout from the aquatic habitat (Dolloff 1993). Mammals have the potential to consume large numbers of salmonids, but generally scavenge post-spawned salmon. In the marine environment, pinnipeds, including harbor seals (*Phoca vitulina*), California sea lions (*Zalophus californianus*), and Steller's sea lions (*Eumetopia jubatus*) are the primary marine mammals preying on salmonids (Spence *et al*. 1996). Pacific striped dolphin (*Lagenorhynchus obliquidens*) and killer whale (*Orcinus orca*) can also prey on adult salmonids in the nearshore marine environment, and at times become locally important. Although harbor seal and sea lion predation primarily is confined to the marine and estuarine environments, they are known to travel well into freshwater after migrating fish and have frequently been encountered in the Delta and the lower portions of the Sacramento and San Joaquin rivers. All of these predators are opportunists, searching out locations where juveniles and adults are most vulnerable, such as the large water diversions in the south Delta.

9. Environmental Variation

Natural changes in the freshwater and marine environments play a major role in salmonid abundance. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare *et al*. 1999, Mantua and Hare 2002). This phenomenon has been referred to as the Pacific Decadal Oscillation. In addition, large-scale climatic regime shifts, such as the El Niño condition, appear to change productivity levels over large expanses of the Pacific Ocean. A further confounding effect is the fluctuation between drought and wet conditions in the basins of the American west. During the first part of the 1990s, much of the Pacific Coast was subject to a series of very dry years, which reduced inflows to watersheds up and down the west coast.

"El Niño" is an environmental condition often cited as a cause for the decline of West Coast salmonids (NMFS 1996b). El Niño is an unusual warming of the Pacific Ocean off South America and is caused by atmospheric changes in the tropical Pacific Ocean (Southern Oscillation-ENSO) resulting in reductions or reversals of the normal trade wind circulation patterns. The El Niño ocean conditions are characterized by anomalous warm sea surface temperatures and changes to coastal currents and upwelling patterns. Principal ecosystem alterations include decreased primary and secondary productivity in affected regions and changes in prey and predator species distributions. Cold-water species are displaced towards higher latitudes or move into deeper, cooler water, and their habitat niches occupied by species tolerant of warmer water that move upwards from the lower latitudes with the warm water tongue.

A key factor affecting many West Coast stocks has been a general 30-year decline in ocean productivity. The mechanism whereby stocks are affected is not well understood, partially because the pattern of response to these changing ocean conditions has differed among stocks, presumably due to differences in their ocean timing and distribution. It is presumed that survival in the ocean is driven largely by events occurring between ocean entry and recruitment to a sub-adult life stage.

10. Ecosystem Restoration

a. *California Bay-Delta Authority (CBDA)*

Two programs included under CBDA; the Ecosystem Restoration Program (ERP) and the Environmental Water Program (EWP), were created to improve conditions for fish, including listed salmonids, in the Central Valley (CALFED 2000). Restoration actions implemented by the ERP include the installation of fish screens, modification of barriers to improve fish passage, habitat acquisition, and instream habitat restoration. The majority of these actions address key factors affecting listed salmonids and emphasis has been placed in tributary drainages with high potential for steelhead and spring-run Chinook salmon production. Additional ongoing actions include new efforts to enhance fisheries monitoring and directly support salmonid production through hatchery releases. Recent habitat restoration initiatives sponsored and funded primarily by the ERP Program have resulted in plans to restore ecological function to 9,543 acres of shallow-water tidal and marsh habitats within the Delta. Restoration of these areas primarily involves flooding lands previously used for agriculture, thereby creating additional rearing habitat for juvenile salmonids. Similar habitat restoration is imminent adjacent to Suisun Marsh (*i.e.*, at the confluence of Montezuma Slough and the Sacramento River) as part of the Montezuma Wetlands project, which is intended to provide for commercial disposal of material dredged from San Francisco Bay in conjunction with tidal wetland restoration.

The Reasonable and Prudent Action developed within the 2009 Long-term Operations of the CVP and SWP (OCAP) Biological Opinion is designed to minimize or remove the adverse impacts associated with many of the OCAP project related stressors. Within the Delta, stressors such as the DCC gates and export operations have been modified to reduce the hydraulic changes created by the project operations. Earlier closures of the DCC gates prevent early emigrating listed salmonids from entering the Delta interior through the open DCC gates. Management of the Old and Middle river flows prevents an excessive amount of negative flow towards the export facilities from occurring in the channels of Old and Middle river. When flows are negative, water moves in the opposite direction than would occur naturally, drawing fish into the south Delta and towards the export facilities or delaying their migration through the system.

In 2010, the California legislature created the Delta Stewardship Council made up of diverse community representatives and water interests. The Delta Stewardship Council is the successor to the CBDA and CALFED Bay-Delta Program. The Delta Stewardship Council adopted a comprehensive management plan for the Sacramento-San Joaquin Delta, called "The Delta Plan" on May 16, 2013, which became effective with legally-enforceable regulations on September 1, 2013 (Delta Reform Act 2009; http://deltacouncil.ca.gov/delta-plan-0).

b. *Central Valley Project Improvement Act*

The CVPIA, implemented in 1992, requires that fish and wildlife get equal consideration with other demands for water allocations derived from the CVP. From this act arose several programs that have benefited listed salmonids: the AFRP, the Anadromous Fish Screen Program (AFSP), and the Water Acquisition Program (WAP). The AFRP is engaged in monitoring, education, and restoration projects geared toward recovery of all anadromous fish species residing in the Central Valley. Restoration projects funded through the AFRP include fish passage, fish screening, riparian easement and land acquisition, development of watershed planning groups, instream and riparian habitat improvement, and gravel replenishment. The AFSP combines Federal funding with State and private funds to prioritize and construct fish screens on major water diversions mainly in the upper Sacramento River. The goal of the WAP is to acquire water supplies to meet the habitat restoration and enhancement goals of the CVPIA and to improve the DOI's ability to meet regulatory water quality requirements. Water has been used successfully to improve fish habitat for spring-run Chinook salmon and steelhead by maintaining or increasing instream flows in Butte and Mill Creeks and the San Joaquin River at critical times.

c. *Iron Mountain Mine Remediation*

Environmental Protection Agency's Iron Mountain Mine remediation involves the removal of toxic metals in acidic mine drainage from the Spring Creek Watershed with a state-of-the-art lime neutralization plant. Contaminant loading into the Sacramento River from Iron Mountain Mine has shown measurable reductions since the early 1990s (Reclamation 2004). Decreasing the heavy metal contaminants that enter the Sacramento River should increase the survival of salmonid eggs and juveniles. However, during periods of heavy rainfall upstream of the Iron Mountain Mine, Reclamation substantially increases Sacramento River flows in order to dilute heavy metal contaminants being spilled from the Spring Creek debris dam. This rapid change in flows can cause juvenile salmonids to become stranded or isolated in side channels below Keswick Dam.

d. *State Water Project Delta Pumping Plant Fish Protection Agreement (Four-Pumps Agreement)*

The Four Pumps Agreement Program has approved about $49 million for projects that benefit salmon and steelhead production in the Sacramento-San Joaquin basins and Delta since the agreement inception in 1986. Four Pumps projects that benefit spring-run Chinook salmon and steelhead include water exchange programs on Mill and Deer creeks; enhanced law enforcement efforts from San Francisco Bay upstream to the Sacramento and San Joaquin rivers and their tributaries; design and construction of fish screens and ladders on Butte Creek; and screening of diversions in Suisun Marsh and San Joaquin tributaries. Predator habitat isolation and removal, and spawning habitat enhancement projects on the San Joaquin tributaries benefit steelhead (Reclamation 2004).

11. Non-Native Invasive Species

As currently seen in the San Francisco estuary, NIS can alter the natural food webs that existed prior to their introduction. Perhaps the most significant example is illustrated by the Asiatic freshwater clams *Corbicula fluminea* and *Potamocorbula amurensis*. The arrival of these clams in the estuary disrupted the normal benthic community structure and depressed phytoplankton levels in the estuary due to the highly efficient filter feeding of the introduced clams (Cohen and Moyle 2004). The decline in the levels of phytoplankton reduces the population levels of zooplankton that feed upon them, and hence reduces the forage base available to salmonids transiting the Delta and San Francisco estuary which feed either upon the zooplankton directly or their mature forms. This lack of forage base can adversely impact the health and physiological condition of these salmonids as they emigrate through the Delta region to the Pacific Ocean.

Attempts to control the NIS also can adversely impact the health and well-being of salmonids within the affected water systems. For example, the control programs for the invasive water hyacinth (*Eichhornia crassipes*) and Brazilian waterweed (*Egeria densa*) plants in the Delta must balance the toxicity of the herbicides applied to control the plants to the probability of exposure to listed salmonids during herbicide application. In addition, the control of the nuisance plants have certain physical parameters that must be accounted for in the treatment protocols, particularly the decrease in DO resulting from the decomposing vegetable matter left by plants that have died.

12. Summary

For CV spring-run Chinook salmon, and CV steelhead, the construction of high dams for hydropower, flood control, and water supply resulted in the loss of vast amounts of upstream habitat (*i.e.*, approximately 80 percent, or a minimum linear estimate of over 1,000 stream miles), and often resulted in precipitous declines in affected salmonid populations. For example, the completion of Friant Dam in 1947 has been linked with the extirpation of spring-run Chinook salmon in the San Joaquin River upstream of the Merced River within just a few years. The reduced populations that remain below Central Valley dams are forced to spawn in lower elevation tailwater habitats of the mainstem rivers and tributaries that were previously not used for this purpose. This habitat is entirely dependent on managing reservoir releases to maintain cool water temperatures suitable for spawning, and rearing of salmonids. This requirement has been difficult to achieve in all water year types and for all life stages of affected salmonid species. Steelhead, in particular, seem to require the qualities of small tributary habitat similar to what they historically used for spawning; habitat that is largely unavailable to them under the current water management scenario. All salmonid species considered in this consultation have been adversely affected by the production of hatchery fish associated with the mitigation for the habitat lost to dam construction (*e.g.*, from genetic impacts, increased competition, exposure to novel diseases, *etc*.).

Land-use activities such as road construction, urban development, logging, mining, agriculture, and recreation are pervasive and have significantly altered fish habitat quantity and quality for Chinook salmon and steelhead through alteration of streambank and channel morphology; alteration of ambient water temperatures; degradation of water quality; elimination of spawning and rearing habitat; fragmentation of available habitats; elimination of downstream recruitment of LWM; and removal of riparian vegetation resulting in increased streambank erosion. Human-induced habitat changes, such as: alteration of natural flow regimes; installation of bank revetment; and building structures such as dams, bridges, water diversions, piers, and wharves, often provide conditions that both disorient juvenile salmonids and attract predators. Harvest activities, ocean productivity, and drought conditions provide added stressors to listed salmonid populations. In contrast, various ecosystem restoration activities have contributed to improved conditions for listed salmonids (*e.g.*, various fish screens). However, some important restoration activities (*e.g.*, Battle Creek Restoration Project) have not yet been completed. Even in degraded reaches, spawning habitat, juvenile rearing habitat, migration corridors, and estuarine areas have a high conservation value as these functions directly affect the survival of listed salmonids.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species within the action area. The environmental baseline "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" (50 CFR § 402.02).

Clear Creek is a perennial stream that that drains an area of 238 square miles and originates in the Trinity Mountains northwest of the city of Redding, California, and terminates in the Sacramento River south of the city of Redding. Clear Creek is part of the Trinity River Division of the Central Valley Project, and receives diversions from the Trinity River through the Clear

Creek Tunnel, which discharges some water into the Clear Creek watershed at the Judge Carr Powerhouse, while the rest is diverted and discharged into Keswick Lake at the Spring Creek Powerhouse, upstream of Whiskeytown Dam. Reclamation's operations of Whiskeytown Dam, which is located 18.1 miles upstream from Clear Creek's confluence with the Sacramento River, follow the CVPIA AFRP guidelines for temperature and streamflow releases to Clear Creek.

Whiskeytown Dam has presented an impassable fish barrier to anadromous fish since its completion in 1963. The reach downstream of Whiskeytown Dam is commonly referred to as lower Clear Creek, and is the geographical setting of this project.

Lower Clear Creek flows from an elevation of approximately 1,000 feet above mean sea level (msl) at Whiskeytown Dam to 460 feet msl at the Sacramento River confluence. The area has a Mediterranean climate with cool, wet winters and hot, dry summers. Average precipitation is approximately 25 to 35 inches per year and falls mostly as rain. The average annual air temperature is approximately 62 ºF and the average frost-free period is approximately 200 to 250 days (USDA Soil Conservation Service 1974).

Gold was discovered at Reading Bar, approximately eight miles upstream from the Sacramento River confluence, in 1848. This discovery resulted in large-scale placer mining activities that occurred through the 1940s. Gold mining activities significantly affected hydrogeomorphological processes and aquatic habitat quality through the removal, processing, and redeposition of fluvial deposits. More recently, commercial aggregate mining in both the floodplain and stream channel contributed to the alteration and loss of fluvial deposits.

Whiskeytown Dam exacerbated these fluvial alterations by reducing gravel recruitment into Clear Creek. All sediment from the upper watershed is trapped by the reservoir, resulting in an alluvial sediment deficit and reduction in fish habitat quality (Coots 1971 as cited in McBain and Trush et al. 2001, Graham Matthews and Associates 2006). In addition to the reduction of sediment supply, recruitment of LWM to the stream channel and floodplain has also declined in Clear Creek due to a reduction in bank erosion and large flood flows downstream of Whiskeytown Dam.

McCormick-Saeltzer Dam was constructed in 1903 approximately six and a half miles upstream of the Sacramento River confluence to divert water for mining and agricultural irrigation. This created a partial barrier to fish migration that was compounded by a difficult passage through the bedrock stream channel immediately downstream of the dam. Few anadromous fish were known to have spawned above these passage impediments (Newton and Brown 2004).

The combination of degraded physical habitat characteristics, fish passage barriers, and changes in hydrology resulting from gold and aggregate mining, dams, and diversions since the mid 1800s was associated with the near-extirpation of anadromous fish in Clear Creek by the late 1900s.

Upon implementation of CVPIA and the ERP sponsored projects in Clear Creek, habitat conditions and anadromous fish populations have continued to improve. In 1995, streamflows were increased and water temperature standards implemented in Clear Creek to improve salmon and steelhead habitat. Suitable spawning and rearing habitat were identified as limiting factors for anadromous fish populations in Clear Creek, and as a result, gravel has been injected into Clear Creek on an annual basis since 2002, and instream habitat structures have also been installed at various locations. Juvenile spring-run Chinook from Feather River Hatchery were released into Clear Creek in 1991-1993. Coded-wire tagged adults returned from these releases in 1993 to 1996 including 26 in 1995 (Brown 1996). Genetic analysis suggests that strays from Butte Creek and Mill or Deer Creek have also recently spawned in Clear Creek. In addition, coded-wire tagged spring-run strays from Feather River Hatchery have been recovered after spawning in Clear Creek. McCormick-Saeltzer Dam was removed in the fall of 2000, and anadromous fish began using the 11.6 miles of stream upstream of the former dam site for spawning, rearing, and holding (Newton and Brown 2004).

A small (approximately 200 fish) but increasing number of spring-run Chinook salmon continues to spawn annually in Clear Creek (NMFS 2009a). As the issue of hybridization and redd superimposition between the fall/late-fall run and spring-run of Chinook salmon became a concern, these runs were segregated using a seasonally-installed weir beginning in 2002 to minimize spawning of the fall run in the same areas as the spring run. Steelhead spawning has also increased in Clear Creek. Anadromous fish populations in Clear Creek have improved relative to their Central Valley metapopulations since 2002. Anadromous fish escapement, redd counts, and carcass indices in Clear Creek have either increased, remained stable, or decreased significantly less than their Central Valley metapopulations in the years after implementation of habitat improvement activities. However, spawning habitat continues to limit anadromous fish production in Clear Creek (NMFS 2009a).

A. Status of the Listed Species and Critical Habitat within the Action Area

The action area provides spawning habitat for spring-run Chinook salmon and steelhead. The action area also functions as a migratory corridor for adult and juvenile spring-run Chinook salmon and steelhead, and as juvenile rearing habitat. Due to the life history timing of spring-run Chinook salmon and steelhead, it is possible for one or more of the following life stages: adult migrants, spawners, incubating eggs, or rearing and emigrating juveniles to be present within the action area throughout the year.

1. Status of Species

a. *CV spring-run Chinook Salmon*

Clear Creek has supported a small population of CV spring-run Chinook salmon, which has been monitored since 1998. The August adult index count has averaged less than 100 adults, with the highest count in the year 2008, of 200 adults, until the year 2012, which observed the highest count on record of 651 adults (Giovannetti and Brown 2013). The removal of Saeltzer Dam in 2000 opened nearly 12 miles of access to areas just downstream of Whiskeytown Dam for a total of 18 miles for CV spring-run Chinook salmon (and CV steelhead). Adult CV spring-run Chinook salmon migrate up-stream beginning early June in lower Clear Creek, throughout the project area, to the upper most reaches to spawn beginning early September and continue through early to mid-October. Since 2003, the USFWS has installed a temporary picket weir from late August through early November, to allow spring-run Chinook salmon a spatial separation from fall-run Chinook salmon, which otherwise have an overlap in spawning timing.

b. *CV Steelhead*

A significant portion of the CV steelhead DPS spawn and rear in the Sacramento River and its tributaries (Reynolds, *et al*. 1993). Adult CV steelhead begin spawning in Clear Creek in early December and continue till about mid-March. Adult CV steelhead populations in Clear Creek have been relatively stable between 2003 and 2011 with redd counts ranging from 42 to 409, with an average of 176 (Giovannetti and Brown 2013a). Rotary screw traps have also been used to estimate juvenile production of steelhead in Clear Creek. Lower Clear Creek has a high conservation value (significant habitat features) because it supports several life stage functions for CV steelhead such as spawning, rearing and migration and because it has a high potential to support more fish through continued restoration.

2. Status of Critical Habitat

The action area is located in the CalWater Hydrologic Sub-Area 550810, which provides 98 miles of spawning/rearing, rearing/migration, and presence/migration PCEs for CV spring-run ESU Chinook salmon and 153 miles of spawning/rearing and rearing/migration with 147 miles of presence/migration habitat for Central Valley ESU steelhead (NMFS 2004). The action area contains PCEs that support spawning, rearing, and migration for Chinook salmon and steelhead.

Lower Clear Creek, including the project area, was designated as critical habitat for spring-run Chinook salmon on September 2, 2005 (70 FR 52488). Lower Clear Creek is characterized by alternating pools and riffles. The channel form, along with boulders, ledges, and turbulence, provides key characteristics supporting the PCEs of critical habitat (*i.e.*, spawning habitat is located upstream but not in the action area, freshwater rearing sites, and freshwater migration corridors). Lower Clear Creek has a high conservation value (significant habitat features) because it supports several life stage functions for CV spring-run Chinook such as spawning, rearing and migration and because it has a high potential to support more fish through continued restoration. Spawning values in the action area are low because much of the suitable spawning substrate (gravel) has migrated downstream and Whiskeytown Dam has blocked its natural replenishment.

Steelhead critical habitat was designated September 2, 2005 (70 FR 52488). The PCEs of proposed critical habitat for steelhead within the action area are nearly identical to those for spring-run Chinook salmon. Therefore, the status of proposed critical habitat for steelhead can be considered the same as that provided above for spring-run Chinook salmon.

B. Factors affecting species and critical habitat in the action area

There is evidence that Clear Creek may have supported all runs of Central Valley salmonids (Yoshiyama *et al.* 1996). Gravel mining within the watershed of lower Clear Creek has resulted in a reduction of salmon and steelhead habitat. The properly functioning condition of lower Clear Creek basin has been compromised to some extent in its ability to provide rearing habitat for juvenile salmonids, and as a corridor for migrating juvenile and adult salmonids. Carrying capacity and complexity of the habitat has decreased with removal of riverine trees and instream woody material, riprap actions or other modification to the embankment, and water diversion.

The proposed fish habitat restoration and management project will allow natural processes to increase the ecological function of the habitat, while at the same time removing adverse impacts of past practices. The purpose of the proposed action is to further restore, enhance, and protect stream and riparian habitat suitability; and increase overall fish production of anadromous salmonids inhabiting Clear Creek.

1. Hydroelectric Development and Water Diversions

The essential features of freshwater salmonid habitat within the action area include: adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. These features have been affected by human activities such as water management, flood control, agriculture, and urban development throughout the action area.

Clear Creek flows have been diverted into Wiskeytown Lake primarily for hydroelectric development. The habitat in lower Clear Creek is strongly influenced by Wiskeytown Dam operations. Construction of Wiskeytown Dam cut off most of the original salmonid habitat in Clear Creek by the early 1900s, and current operations of the dam continue to have an impact on salmon and steelhead by limiting the availability of water, particularly during periods of high human water demands.

2. Habitat Restoration

Clear Creek habitat restoration has been driven6 in large part by a Fisheries Management Plan (FMP) developed for Clear Creek. Reclamation developed an FMP in coordination with the LCC TAC, a working group comprised of fishery biologists, geologists, and other river and land management specialists from CDFW, USFWS, NMFS, Reclamation, and BLM. The FMP balances instream flow and temperature requirements of spring-run Chinook salmon, fall-run Chinook salmon, and steelhead with the impact of operations on CVP objectives.

Habitat restoration in Clear Creek below the Wiskeytown Dam has occurred since the late 1990s. The CVPIA, and the goals of CALFED, have identified the lack of spawning gravel as a limiting factor for anadromous fish production in Clear Creek. Since 1995, projects have been implemented for habitat restoration has contributed to significant increases in the numbers of anadromous fish spawning and rearing within Clear Creek. The sediment deficit and spawning habitat degradation downstream of Whiskeytown Dam have been addressed with channel and floodplain restoration projects and gravel injections of various types since 1996. Over 130,000 tons of spawning gravel has been added to Clear Creek downstream of Whiskeytown.

The PCEs of salmonid habitat within the action area include: freshwater spawning habitat, freshwater rearing habitat, and freshwater migration corridors, containing adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food; riparian vegetation, space, and safe passage conditions. Habitat within the action area primarily is used as freshwater rearing and migration for juveniles and as freshwater migration for adults. The conservation value of the action area is high because its entire length is used for extended periods of time by federally listed fish species.

C. Likelihood of species survival and recovery in the action area

CV spring-run Chinook salmon and California Central Valley steelhead utilize Clear Creek. Clear Creek has a high conservation value for these species because of the location, and the habitat features provided that are essential to fulfilling nearly all of the fresh water life history requirements of these species. Improving population trends and ongoing habitat improvements to Clear Creek make it highly likely that these species will continue to survive and recover within the action area. The draft Central Valley Salmon and Steelhead Recovery Plan has indicated that populations of CV spring-run Chinook salmon and CV steelhead in Clear Creek are considered to be "Core 1" populations, which indicates that reaching viable status is achievable and needed for recovery of the ESU/DPS. Core 1 populations form the foundation of the recovery strategy and must meet the population-level biological recovery criteria for low risk of extinction, as described in the draft Plan (NMFS 2009b).

V. EFFECTS OF THE ACTION

A. Approach to the Assessment

Pursuant to section 7(a)(2) of the ESA (16 U.S.C. 1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat as defined in 50 CFR 402.02. Instead, this biological opinion relies upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat. NMFS will evaluate destruction or adverse modification of critical habitat by determining if the proposed action reduces the value of critical habitat for the conservation of the species. This biological opinion assesses the effects of the proposed LCC Habitat Restoration project on threatened CV spring-run Chinook salmon and CV steelhead, and their designated critical habitats.

In the section II, "Description of the Proposed Action," of this biological opinion, NMFS provided an overview of the action. In the sections III and IV, "Status of the Species and Critical Habitat" and "Environmental Baseline," respectively, NMFS provided an overview of the threatened and endangered species and critical habitat in the action area of this consultation.

Regulations that implement section 7(a)(2) of the ESA require biological opinions to evaluate the direct and indirect effects of Federal actions and actions that are interrelated with or interdependent to the Federal action to determine if it would be reasonable to expect them to reduce appreciably listed species' likelihood of surviving and recovering in the wild by reducing their reproduction, numbers, or distribution (16 U.S.C. 1536; 50 CFR 402.02). Section 7 of the ESA and its implementing regulations also require biological opinions to determine if Federal actions would destroy or adversely modify the conservation value of designated critical habitat (16 U.S.C. 1536).

NMFS generally approaches "jeopardy" analyses in a series of steps. First, we evaluate the available evidence to identify the direct and indirect physical, chemical, and biotic effects of the proposed action on individual members of the listed species or aspects of the species' environment (these effects include direct, physical harm or injury to individual members of a species; modifications to something in the species' environment - such as reducing a species' prey base, enhancing populations of predators, altering spawning substrate, altering ambient temperature regimes; or adding something novel to a species' environment - such as introducing exotic competitors or noise disturbance). Once we have identified the effects of an action, we evaluate the available evidence to identify a species' probable exposure to those effects (the extent of temporal and spatial overlap between individuals of the species and the effects of the action). Once we have identified the exposure of the species to the effects of an action, we evaluate the available evidence to identify a species' probable response (including behavioral responses) to those effects to determine if those effects could reasonably be expected to reduce a species' reproduction, numbers, or distribution (for example, by changing birth, death, immigration, or emigration rates; increasing the age at which individuals reach sexual maturity; decreasing the age at which individuals stop reproducing; among others). We then use the evidence available to determine if these reductions, if any, could reasonably be expected to appreciably reduce a species' likelihood of surviving and recovering in the wild.

The final step in conducting the "jeopardy" analysis is to consider the additive effects of the environmental baseline, the effects of the action and any reasonably foreseeable cumulative effects to determine the potential for the action to affect the survival and recovery of the species, or the conservation value of their designated critical habitat.

To evaluate the effects of the proposed action, NMFS examined Reclamation's Biological Assessment, to identify likely impacts to listed anadromous salmonids within the action area, based on the best available information. In addition, there were a number of discussions on the project components with USFWS and Reclamation, and to make clarifications as needed (see "Consultation History" section above for more detail).

The primary information used in this assessment includes fishery information previously described in the "Status of the Species and Critical Habitat" and "Environmental Baseline" sections of this biological opinion; studies and accounts of the impacts of water diversions, dams, and artificial flow fluctuations on anadromous species; and documents prepared in support of the proposed action.

B. Assessment

The assessment will consider the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of federally listed CV spring-run Chinook salmon and CV steelhead, and the magnitude, timing, frequency, and duration of project impacts to these listed species. Specifically, the assessment will consider the potential impacts related to adverse effects to these species and their habitat resulting from the LCC Habitat Restoration project. The project includes avoidance and minimization measures for the potential impacts.

1. Presence of listed species

Due to the life history timing of spring-run Chinook salmon and steelhead, it is possible for one or more of the following life stages: adult migrants, spawners, incubating eggs, or rearing and emigrating juveniles to be present at some point within the action area throughout the year. Timing of construction varies in the action area as described in three zones (Table 6). These seasonal work windows are designed to avoid harm to incubating spring-run Chinook salmon and steelhead eggs and pre-emergent fry. Additionally, redd surveys will be conducted by a qualified biologist prior to construction activities that occur near spawning habitat during spawning and incubation periods; work would be conducted only after surveys were completed to ensure that no redds would be impacted by gravel.

Table 6. Zone Locations and Work Windows.

Zone	Location	Work Window
Zone 1	Whiskeytown Dam to approximately ¾ mile downstream	All year (pre-construction surveys conducted if work is planned in spawning habitat between September 1 and April 30)
Zone 2	Approximately ¾ mile downstream of Whiskeytown Dam to picket weir	November 1 to November 30 (pre-construction surveys conducted) and May 1 to August 31
Zone 3	USFWS picket weir to Sacramento River confluence	June 1 to September 30

2. Construction impacts of spawning gravel augmentation and placement of instream habitat structures

a. Hazardous materials

The potential spill of hazardous materials (e.g., fuel, lubricants, hydraulic fluid) during construction and staging activities into Clear Creek could have deleterious effects on all life stages of spring-run Chinook salmon and steelhead. Additionally, operation of construction equipment in or adjacent to the river would present the risk of a spill of hazardous materials into the river (e.g., construction equipment leaking fluids).

Construction activities typically include the refueling of construction equipment on location. As a result, minor fuel and oil spills could occur, and there would be a risk of larger releases. Without rapid containment and clean up, these materials could have deleterious effects on all salmonid life stages within close proximity to construction activities. Incubating fry would be at greatest risk due to their limited mobility and their physiological kinetics of toxicant metabolism. Juvenile and adult fish exhibit a greater level of mobility and thus possess a greater ability to avoid potentially hazardous materials. The use of conservation measures for the handling and containment of hazardous materials would minimize the risk of injury or mortality to all life stages of spring-run Chinook salmon and steelhead.

The contractor will develop and implement a SPCCP prior to the onset of construction. The SPCCP will include measures to be implemented onsite that will keep construction and hazardous materials out of waterways and drainages. The SPCCP will include provisions for daily checks for leaks; hand-removal of external oil, grease, and mud; and the use of spill containment booms for refueling. In addition, all construction equipment refueling and maintenance would be restricted to designated staging areas located away from streams and sensitive habitats.

NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. If BMPs are successfully implemented, NMFS does not expect fuel spills or toxic compounds to cause injury or death to individual fish. The likelihood of this potential impact is therefore considered to be discountable.

b. Loss of Riparian Vegetation

Impacts to existing vegetation would be avoided to the extent practicable. Disturbed areas, not intended for future road access or gravel placement, would be revegetated with native plant species and mulched with certified weed-free hay following the completion of construction activities. The loss of riparian vegetation is an indirect effect of creating and maintaining access points to the river, and covering vegetation with gravel. Riparian vegetation provides overhead cover and a substrate for food production for juvenile salmonids. The loss of riparian vegetation can therefore increase predation rates and reduce feeding rates for juveniles. The riparian loss that will be replanted will be a temporary loss (approximately 1 growing season to be replaced), the few areas that will not be replanted to maintain road access will be limited. Loss of riparian vegetation is unlikely at lateral berms due to the placement in cobbled or graveled portions of the channel that contain little soil for the production of riparian vegetation. The riffle supplementation and end-dump talus cone gravel augmentation methods and the construction of instream habitat structures would impact little to none of the riparian vegetation surrounding the site. Overall, the amount of riparian vegetation that would be lost is very small, and juveniles would have access to adjacent suitable rearing habitat. The impacts are considered to be insignificant.

c. Increased Turbidity

The re-suspension and deposition of instream sediments is an indirect effect of construction equipment and gravel entering the stream. Increased turbidity and suspended sediment levels associated with construction may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, and exposure to toxic sediment released into the water column. Fish responses to increased turbidity and suspended sediment can range from behavioral changes (alarm reactions, abandonment of cover, and avoidance) to sublethal effects (e.g., reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe and Jensen 1996). If this occurs while salmon are spawning or embryos are incubating, injury or mortality to incubating eggs or alevins may occur through the infiltration of fine sediment into salmonid redds with a reduction of intra-gravel water circulation and in severe cases entombment of salmonid eggs. The deposition of fine sediments in food producing riffles could also reduce the abundance and availability of aquatic insects on which juvenile salmonids feed, and result in the loss of cover for juvenile salmonids (Bjornn and Reiser 1991); in the action area, silt and sand on the stream bottom would be disturbed during placement of new materials, however, the amount of sediment that may be re-suspended during project installations is not likely to be significant; any re-suspension and re-deposition of instream sediments is expected to be localized and temporary and would not reach a level that would acutely affect aquatic organisms. The use of seasonal work windows would generally prevent the siltation of spring-run Chinook salmon and steelhead redds. In Zone 2 during the month of November, pre-construction surveys for spawning salmonids and redds would minimize the likelihood of injury resulting from the re-suspension and re-deposition of instream sediments.

Suspended solids and turbidity generally do not acutely affect aquatic organisms unless they reach extremely high levels (i.e., levels of suspended solids reaching 25 mg/L). At these high levels, suspended solids can adversely affect the physiology and behavior of aquatic organisms and may suppress photosynthetic activity at the base of food webs, affecting aquatic organisms either directly or indirectly (Alabaster and Lloyd 1980). All gravel placed in the stream would be washed at least once to maintain water quality standards, with a cleanness value consistent with California Department of Transportation's Test #227 (California Department of Transportation 1999). Furthermore, the Clean Water Act § 401Water Quality Certification issued for the LCC Habitat Restoration project limits the potential effects of fine sediment on fish by limiting the maximum increase of Nephelometric Turbidity Units over background levels.

BMPs to control erosion and storm water sediment runoff would be implemented. This may include, but is not limited, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from project areas.

Equipment would not operate in an active stream channel except as may be necessary to construct temporary stream crossings and place in-stream habitat structures and spawning gravel. When in-channel work is unavoidable, clean spawning gravel would be used to create a pad in the channel from which equipment will operate. Clean spawning gravel would also be used to construct any required in-stream crossings. In-stream construction would proceed in a manner that minimizes sediment discharge. Following completion of restoration activities, the spawning gravel will be removed from the stream channel or spread evenly across the bottom of the channel, consistent with existing gravels. All stream crossings would be designed to ensure that conditions are maintained for effective upstream and downstream fish passage, at all times and under all flow conditions. Stream crossings or instream work that may cause turbidity within 200 feet upstream of active redds would be avoided. Impacts of potential increased turbidity are expected to be either discountable or insignificant, due to timing of gravel augmentation to avoid sensitive life stages, and BMPs.

d. Changes to habitat

3. Impacts of in-water work

a. Physical disturbance

Physical disturbance is a direct result of construction activities, and the placement of materials, which has the potential to affect all life stages of salmonids except incubating embryos through displacement and disruption of normal behaviors. Displacement may temporarily expose juvenile steelhead to a greater risk of predation in all zones, but because most spring-run Chinook emigrate soon after emergence during the winter and spring months in Clear Creek, limiting in-water construction to the late summer and fall months would minimize effects to this life stage. Repeated disturbance may potentially lower reproductive success in adult spring-run Chinook and steelhead. Holding habitat is not limiting in Clear Creek and, therefore, disturbance, followed by movement of fish to other holding sites is not expected to be a significant stressor for adults. Rearing habitat for juvenile fish has also been greatly expanded and improved since the year 2000 in Clear Creek and is generally well-distributed in the creek for fish that move to avoid the physical disturbance of construction activities. Disturbance to listed fishes resulting from gravel augmentation and habitat structure placement is likely to be short-term due to the nature of the proposed in-water and along-shore work. The duration of exposure is temporary and would vary by gravel augmentation site (Table 1); and is expected to be on the order of several days for each instream habitat structure, up to a maximum of 40 structures between Whiskeytown Dam and the Sacramento River over the life of the project.

Direct injury or death may occur during in-water construction activities during theinstallation of spawning gravel, and instream habitat structures, and while grading the streambed. Materials added to the streambed and equipment working in the stream could injure or kill salmonid adults, eggs, and juveniles. Adult salmonids would be potentially vulnerable when they are holding in deep pools or tending redds. However, the risk is higher for juveniles, which rear in shallow water.

However, the location of sites and the use of pre-construction surveys minimize the risk to holding or spawning salmonids, and incubating eggs. Additional conservation measures included as part of the proposed action are designed to alert fish to equipment operation in the channel before gravel is placed in the water (e.g., slow, deliberate equipment operation and tapping water surface prior to entering stream channel). Adult salmonids would be expected to move out of the area to adjacent suitable habitat before gravel, logs, or boulders were placed over them or equipment enters the water. Therefore, the potential impact to adult salmonids and eggs are considered discountable.

Although there is risk to juveniles, a high proportion of Clear Creek spring-run Chinook salmon outmigrate soon after emergence from gravel during the winter months, and subsequently, their risk of exposure to the proposed activities is minimal. Any remaining juvenile spring-run Chinook salmon would be a larger size, thus more able to avoid any disturbance and move to adjacent suitable habitat. The risk of exposure to these activities for juvenile steelhead is greater because they are known to inhabit Clear Creek year-round. The construction work windows restrict in-water activities to avoid spawning and egg incubation periods of the listed species, except for Zone 1, the month of November in Zone 2, and the month of September in Zone 3.

Additionally, where gravel is deposited on previously formed augmentation sites, such as lateral berms or end-dump talus cones, potential impact is very low, as gravel is very unlikely to contact and adversely affect juveniles. Potential impacts from these methods are therefore considered to be discountable, except for one end-dump talus cone site in Zone 3 that will require a stream crossing; minimal impacts may occur. Riffle supplementation sites, however, require applying the gravel directly to the streambed and grading it, thereby increasing the likely exposure and chance for adverse effects to listed juveniles. Similarly, placement of habitat structures that require heavy equipment to enter the stream via a placed gravel bar may impact juveniles. Minimal effects to juveniles are expected to occur as a result of the riffle supplementation method as well as placement of habitat structures within the channel.

4. Description of Gravel Augmentation and Instream Habitat Structure Construction Effects by Zone

a. Zone 1

No instream habitat structures are anticipated in Zone 1, and the only planned gravel augmentation activity is replenishing the Whiskeytown Dam end-dump *talus cone* augmentation site. The work window in this zone is year-round. Spring-run Chinook salmon and steelhead hold and spawn within this zone, but are not likely to spawn in the immediate vicinity of this site. Only about 20 percent of the deposited gravel is expected to enter the stream at the time of placement, along approximately 90 linear feet of shoreline. All age classes of spring-run Chinook salmon and steelhead would have adjacent space to temporarily avoid the area and direct injury from gravel. Gravel would be cleaned prior to placement minimizing introduced turbidity. The area where the equipment dumps gravel is approximately 120 feet from the streambank, and equipment re-fueling and maintenance is not likely to occur there, so the likelihood of a hazardous material spill is extremely low. Any other (currently unplanned) work in this zone would be conducted following pre-construction surveys for holding, spawning, incubating, or rearing salmonids. Spring-run Chinook salmon and steelhead exposure to potential adverse effect in all zones is shown in Table 7. Exposure to potential adverse effects in Zone 1 is extremely unlikely to occur and is therefore considered discountable.

b. Zone 2

All three methods of gravel augmentation at specified locations and various instream habitat structures at unspecified locations are proposed in Zone 2. The work window in this zone is May 1 to August 31 and also November 1 through November 30. Adult spring-run Chinook salmon hold in this zone during the summer, and some redds may contain incubating eggs and alevin in the month of November. Steelhead hold and rear in this zone, but the work windows are outside of their spawning and incubating periods. Any gravel augmentation during the month of November, the only time during the work window when spring-run Chinook salmon incubating eggs and alevins may be present, would be preceded by surveys by a qualified biologist. Sites will be avoided if redds are found, therefore we don't expect incubating eggs or alevins to be harmed. Monitoring has shown that Chinook salmon and steelhead spawning and rearing does not occur within the footprint of the gravel injections. All age classes of spring-run Chinook salmon and steelhead would have adjacent space to temporarily avoid the area and direct injury from gravel, although some impacts may occur to juveniles through the use of the riffle supplementation method and placement of habitat structures. Spring-run Chinook adults, incubating eggs, and alevin; and steelhead adults, juveniles, and fry are potentially at risk of harm due to hazardous materials spills. The use of conservation measures would minimize this exposure and the potential for adverse effects to a level that is insignificant or discountable.

Impacts to spring-run Chinook salmon and steelhead fry, juveniles, and adults are discountable, as they are unlikely to be injured or killed from end-dump *talus cone* gravel augmentation in this zone via direct injury, turbidity, physical disturbance, orhazardous materials spills. Spring-run Chinook salmon and steelhead exposure to potential adverse effect is shown in Table 7.

Potential impacts due to the *lateral berm* method are discountable, as it is unlikely to affect spring-run Chinook salmon and steelhead, because the majority of work is done outside of the stream bank and relatively little gravel enters the stream at the time of placement. However, juvenile steelhead may be at risk of harm due to some loss of riparian vegetation where new lateral berms are placed over existing riparian vegetation. This effect is expected to be insignificant, however, because of the relatively small amount of riparian habitat that would be affected, and suitable adjacent riparian habitat is readily available.

Gravel would be augmented using the *riffle supplementation* method at four new sites and one existing site in Zone 2. However, any work conducted during November would be preceded by surveys to minimize the risk of harm to incubating eggs and alevins to a discountable level. Spring-run Chinook salmon and steelhead fry, juveniles, and adults are at risk of harm from direct injury, turbidity, physical disturbance, and hazardous materials spills from riffle supplementation in this zone. Because gravel would be placed in water that is not sufficiently deep to provide holding habitat for spring-run Chinook salmon and steelhead, direct mortality to adults is very unlikely (discountable). The use of conservation measures would minimize the risk to fry and juvenile spring-run Chinook salmon and steelhead, but some level of take is likely to occur.

Instream habitat structures would be placed throughout the zone. As with the riffle supplementation method of gravel augmentation, impacts to spring-run Chinook and steelhead incubating eggs and alevin is discountable due to timing, pre-construction surveys, and use of BMPs, from re-suspension and re-deposition of instream sediments, and hazardous materials spills. Spring-run Chinook salmon and steelhead fry and juveniles are at risk of harm from direct injury, turbidity, physical disturbance, and hazardous materials spills from instream habitat structure construction in this zone, and some level of take is likely to occur. Adults are expected to temporarily avoid any areas of disturbance, and move to adjacent suitable habitat; potential for impacts are discountable. Potential impacts from turbidity or hazardous material spills are discountable due to BMPs in place.

c. Zone 3

All three methods of gravel augmentation to be used at specified and as yet unspecified locations and various instream habitat structures at specified and as yet unspecified locations are proposed for Zone 3. The work window in this zone is June 1 to September 30. Adult spring-run Chinook salmon and steelhead may hold in and migrate through this zone during this in-water work window, but few spring-run Chinook salmon currently spawn in this zone, preferring to spawn upstream. Steelhead may likely rear in this zone during the in-water work window. All age classes of spring-run Chinook salmon and steelhead would have adjacent space to temporarily avoid the area and direct injury from gravel. The work window is outside the steelhead spawning period and outside of the peak period of spring-run Chinook salmon juvenile emigration. Monitoring has shown that Chinook salmon and steelhead spawning and rearing does not occur within the footprint of the gravel injections. Spring-run Chinook salmon and steelhead exposure to potential adverse effect is shown in Table 7.

Gravel augmentation using the end-dump *talus cone* method is currently planned for an existing restoration site, although this method may also be used at additional as yet unidentified sites within this zone. Spring-run Chinook salmon incubating eggs and alevins are potentially at risk from injury or mortality due to direct injury, physical disturbance, and hazardous materials spills. However, few spring-run Chinook salmon are likely to spawn in Zone 3 during the proposed work window. If any end-dump talus cone gravel augmentation was planned during the month of September near suitable spawning habitat, pre-construction surveys would minimize the risk of harm to incubating eggs and alevins to a discountable level. Spring-run Chinook and steelhead adults, fry, and juveniles are unlikely to be at risk of direct injury, turbidity, physical disturbance, or hazardous materials spills from this method. In addition, ample suitable habitat exists within this zone for fish that are temporarily displaced from construction sites, therefore, potential impacts are discountable.

Gravel would be augmented with the *lateral berm* method at two existing sites in Zone 3, and this method may also be used at as yet unidentified additional sites within this zone. Potential impacts due to this method are discountable, as it is unlikely to affect spring-run Chinook salmon and steelhead, because the majority of work is done outside of the stream bank and relatively little gravel enters the stream at the time of placement. However, juvenile steelhead may be at risk of harm due to some loss of riparian vegetation where new lateral berms are placed over existing riparian vegetation. This effect is expected to be insignificant, however, because of the relatively small amount of riparian habitat that would be affected, and suitable adjacent riparian habitat is readily available.

Gravel would be augmented with the *riffle supplementation* method at two existing sites in Zone 3, and this method may also be used at as yet additional unidentified sites within this zone. Spring-run Chinook incubating eggs are potentially at risk of direct injury, the re-suspension, and re-deposition of instream sediments, and hazardous materials spills. However, few spring-run Chinook salmon are likely to spawn in Zone 3 during the proposed work window, and surveys conducted prior to any work near suitable spawning habitat during the month of September would decrease this risk to a discountable level. Spring-run Chinook salmon and steelhead fry, juveniles, and adults are potentially at risk of direct injury, turbidity, physical disturbance, and hazardous materials spills. Because gravel would be placed in water that is not sufficiently deep to provide holding habitat for spring-run Chinook salmon and steelhead, impacts to adults is unlikely. The use of conservation measures would minimize the effects to larger spring-run Chinook salmon juveniles and steelhead fry and juveniles, but some level of take is likely to occur.

Instream habitat structures would be placed throughout Zone 3. Spring-run Chinook salmon incubating eggs are potentially at risk of injury or mortality due to direct injury, re-suspension and re-deposition of instream sediments, and hazardous materials spills. The low number of spring-run Chinook salmon that spawn in this zone reduce the likelihood that this effect would occur, surveys conducted prior to any work near suitable spawning habitat during the month of September, and BMPs would decrease this risk to a discountable level. Spring-run Chinook salmon and steelhead fry and juveniles are at risk of harm from direct injury, turbidity, physical disturbance, and hazardous materials spills from instream habitat structure construction in this zone, and some level of take is likely to occur. Adults are expected to temporarily avoid any areas of disturbance, and move to adjacent suitable habitat; potential for impacts are discountable. Potential impacts from turbidity or hazardous material spills are discountable due to BMPs in place.

Table 7. Various life stages of spring-run Chinook salmon and steelhead exposure to Project activities.

Zone	**Work Window**	**Exposure**	**Insignificant or Discountable Activity**	**Activity likely to Adversely Affect**
Zone 1	All Year	None expected	End Dump Talus Cone	None
Zone 2	May 1 – August 31 and November 1–30	May and June small number of steelhead outmigrating Rearing steelhead November small number of spring-run outmigrating Rearing larger juvenile spring-run	End Dump Talus Cone Lateral Berm	Riffle Supplementation Habitat Structures
Zone 3	June 1 – September 30	June steelhead outmigrating Rearing steelhead	End Dump Talus Cone Lateral Berm	Riffle Supplementation Habitat Structures End Dump Talus Cone requiring stream crossing

5. Affects to Critical Habitat

Overall the Project will not diminish, but will improve and increase the conservation value of the PCEs spawning habitat and rearing habitat for CV spring-run Chinook salmon and CV steelhead. Some short-term effects to the action area's water quality have the potential to occur. The potential for hazardous materials to enter Clear Creek is discountable as a result of BMP in place. There may be some short-term loss of riparian habitat as a result of access to the creek. Impacts to existing vegetation would be avoided to the extent practicable, and most disturbed areas will be revegetated. Those areas that will continue to be used for access, or new gravel injection sites, will not be revegetated. These areas are minimal, and because Clear Creek contains adjacent riparian habitat, this potential effect is considered to be insignificant.

Gravel injections and placement of instream habitat structures may cause a temporary increase in turbidity and may deposit silt or sand into Clear Creek, which could degrade current spawning gravel and reduce food availability. In addition, physical disturbance to spawning or rearing habitat could occur during gravel placement or instream habitat structure placement. BMPs will be in place during implementation of the Project, including timing of implementation, which would avoid spawning timing, so that spawning gravel would not be negatively affected. In addition, BMPs to wash the gravel prior to injecting will minimize and localize turbidity plumes. Implementation of these BMPs will ensure these potential effects remain insignificant.

6. Beneficial Effects

All sediment from the upper watershed is trapped by Whiskeytown Dam, which has resulted in a sediment deficit and reduction in fish habitat quality (Graham Matthews and Associates 2006). In addition to the reduction of sediment supply, recruitment of LWM to the stream channel and floodplain has also declined in Clear Creek. As a result of the Project components to augment spawning gravel and place instream habitat structures, spawning and rearing habitat are expected to improve and increase. Monitoring by the USFWS has indicated that gravel from past gravel injections have created new spawning habitat for CV spring-run Chinook salmon and for CV steelhead.

Instream habitat structures such as LWM, logs, rootwads and boulders contribute to habitat diversity and create and maintain foraging, cover, and resting habitat for both adult or juvenile anadromous fish. LWM recruitment into Clear Creek decreased after Whiskeytown Dam was built. Placement of structures in the active channel would create instantly available habitat. The primary use of digger logs is to enhance pool habitat by creating diverse cover for rearing juveniles as well as for migrating adults. Spider logs provide cover for juvenile rearing and adult spawning salmonids and collect woody material to increase diversity.

Following emergence, salmonid fry benefit from structures that create quiet water or debris accumulation at the stream margins. Coupled with gravel augmentation, both log structures and boulder clusters, help to sort gravels as they are mobilized during high stream flows, and to hydraulically scour and maintain pools. The enhancement or creation of large, deep pools with abundant cover can improve rearing habitat for juvenile salmonids.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA. The Habitat Restoration project described is a longer term plan for implementation through 2030.

Non-Federal actions that may affect the action area include angling and State angling regulation changes, voluntary State or private sponsored habitat restoration activities, agricultural practices, water withdrawals and diversions, adjacent mining activities, and increased population growth resulting in urbanization and development of floodplain habitats. While state angling regulations have moved towards restrictions on selected sport fishing to protect listed fish species, incidental hooking of Chinook salmon, hook and release mortality of steelhead, and trampling of redds by wading anglers may continue to cause a threat. Habitat restoration projects may have short-term negative effects associated with in-water construction work, but these effects typically are temporary, localized, and the outcome is expected to benefit listed species and habitats. Increased water turbidity levels for prolonged periods of time may result from agricultural practices, adjacent mining activities, and increased urbanization and/or development of riparian habitat, and could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile Chinook or steelhead in the vicinity and downstream of the project area. High turbidity concentration can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg and Northcote 1985, McLeay *et al.* 1984, NMFS 1996a). Farming and ranching activities within or adjacent to the action area may have negative effects on water quality due to runoff laden with agricultural chemicals. Water withdrawals and diversions may result in entrainment of individuals into unscreened or improperly screened diversions, and may result in depleted river flows that are necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of LWM. Future urban development may adversely affect water quality, riparian function, and stream productivity.

These actions will occur without respect to whether the Restoration project is implemented, and there are statutes in place to control all these activities to minimize their detrimental impacts. No reasonably foreseeable future projects within the current project action area are known at this time. Implementation of the proposed action is not expected to result in significant cumulative effects, in combination with other projects, within or outside of the action area.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

The purpose of this section is to summarize the effects of the action and add those effects to the impacts described in the “Environmental Baseline” and “Cumulative Effects” sections of this biological opinion in order to inform the conclusion of whether or not the proposed action is likely to jeopardize the continued existence of the listed salmonids, or destroy or adversely modify designated critical habitat.

Populations of spring-run Chinook salmon and steelhead in California have declined drastically over the last century, and some subpopulations have been extirpated. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good *et al*. 2005). This severe decline in population over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of CV spring-run Chinook salmon and CV steelhead could be at risk.

A. Status of the Listed Species and Critical Habitat

1. CV spring-run Chinook salmon

Lindley et al. (2007) stated that perhaps 15 of the 19 historical populations of spring-run Chinook salmon are extinct, with their entire historical spawning habitats behind various impassable dams. Those authors only considered Butte, Deer, and Mill Creeks as watersheds with persistent populations of Chinook salmon confirmed to be spring-run Chinook salmon, although they recognized that Chinook salmon exhibiting spring-run characteristics persist within the FRFH population spawning in the Feather River below Oroville Dam and in the Yuba River below Englebright Dam. The populations in Butte, Deer, and Mill creeks and in the Feather and Yuba rivers fall within the Northern Sierra Nevada diversity group. Butte and Deer creek spring-run Chinook salmon populations had recently been considered at a low risk of extinction, and the Mill Creek population at a moderate or low risk (Lindley et al. 2007), but in the last four years returning spring-run Chinook salmon have declined in these creeks. Other small populations of spring-run Chinook salmon continue to persist in this diversity group in Antelope and Big Chico creeks, albeit at an annual population size in the tens or hundreds of fish, with no returning mature adults in some years.

In addition, small populations of spring-run Chinook salmon occur in the Basalt and Porous Lava diversity group in the main stem of the Sacramento River and in Battle Creek. Although, similar to the Antelope and Big Chico creek populations, these populations are made up of only tens or hundreds of fish and may be dependent on strays from other populations, although the extent of this dependency is not known. Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the potential to physically separate spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon has made identification of a spring-run Chinook salmon in the mainstem very difficult to determine, and there is speculation as to whether a true spring-run Chinook salmon population still exists downstream of Keswick Dam. Although the physical habitat conditions downstream of Keswick Dam are capable of supporting spring-run Chinook salmon, some years have had high water temperatures resulting in substantial levels of egg mortality. Less than 15 redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 salmon redds from Keswick Dam downstream to the RBDD, ranging from three to 105 redds (CDFG, unpublished data, 2011). This is typically when spring-run spawn, however, these redds also could be early spawning fall-run. Therefore, even though physical habitat conditions may be suitable, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely to have caused extensive introgression between the populations (CDFG 1998). Lindley et al. (2007) concluded that these populations are entirely composed of strays as spring-run Chinook salmon had been extirpated from the entire diversity group.

Battle Creek spring-run Chinook salmon are at an abundance level that makes the population vulnerable to extirpation from demographic stochasticity - random effects of variation in individual survival or fecundity with little or no environmental pressure (Shaffer 1981, Allendorf et al. 1997, McElhany et al. 2000). As such, the population would fall into the high risk of extinction category based on abundance, as described in Lindley et al. (2007).

Ephemeral populations of CV spring-run Chinook salmon are found in the Northwestern California Diversity Group in Beegum and Clear Creeks, and salmon have been observed in Thomes Creek during the spring, although monitoring in that creek has not been conducted consistently due to poor access and difficult terrain. Returning adult spring-run Chinook salmon population sizes in Beegum and Clear creeks have generally ranged from tens up to a few hundred fish. Habitat restoration in Clear Creek has improved conditions for spring-run Chinook salmon and the population has been responding positively to these improvements. The draft Central Valley Salmon and Steelhead Recovery Plan considers Clear Creek to be a core 1 population that will be capable of reaching viable status (NMFS 2009b).

Historically, the majority of spring-run Chinook salmon in the Central Valley were produced in the Southern Sierra Nevada Diversity Group, which contains the San Joaquin River and its tributaries. All spring-run Chinook salmon populations in this diversity group have been extirpated (Lindley et al. 2007). Current San Joaquin River Restoration Program plans are underway to establish spring-run Chinook salmon production in the San Joaquin River downstream of Friant Dam (U.S. District Court 2006).

With demonstrably viable populations in only one of four diversity groups that historically contained them, spring-run Chinook salmon fail the representation and redundancy rule for ESU viability (Lindley et al. 2007). The current distribution of viable populations makes spring-run Chinook salmon vulnerable to catastrophic disturbance. All three extant independent populations are in basins whose headwaters occur within the debris and pyroclastic flow radii of Mount Lassen, an active volcano that the USGS views as highly dangerous (Hoblitt et al. 1987). The current ESU structure is, not surprisingly, also vulnerable to drought. Even wildfires, which are of much smaller scale than droughts or large volcanic eruptions, pose a significant threat to the ESU in its current configuration. A fire with a maximum diameter of 30 km, big enough to burn the headwaters of Mill, Deer and Butte creeks simultaneously, has roughly a 10 percent chance of occurring somewhere in the Central Valley each year (Lindley et al. 2007).

2. California Central Valley steelhead

CV steelhead were listed as threatened on March 19, 1998 (63 FR 3347). Their classification was retained following a status review on January 5, 2006, (71 FR 834) and again on August 15, 2011 (76 FR 50447). This DPS includes all naturally-spawned steelhead populations (and their progeny) in the Sacramento and San Joaquin Rivers and their tributaries (inclusive of and downstream of the Merced River), excluding steelhead from San Francisco and San Pablo Bays and their tributaries. Historically, steelhead were well distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al*. 1996). Steelhead were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams), south to the Kings and possibly the Kern River systems (now inaccessible due to extensive alteration from water diversion projects), and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al*. 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996), with nearly all historic spawning habitat blocked behind impassable dams in many major tributaries, including in the Northwestern California (Clear Creek), the Basalt and Porous Lava (Sacramento, Pitt, and McCloud rivers), the northern Sierra Nevada (Feather, Yuba, American, and Mokelumne rivers), and the southern Sierra Nevada (Stanislaus, Tuolumne, Merced, Calaveras, and San Joaquin rivers) diversity groups (Lindley *et al*. 2007).

Historic abundance of CV steelhead is difficult to estimate given limited data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, CV steelhead abundance had declined to about 40,000 adults (McEwan 2001). Over the past 30 years, the naturally spawned steelhead populations in the upper Sacramento River have declined substantially. Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead in the Sacramento River, upstream of the Feather River, through the 1960s. Steelhead counts at the RBDD declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996; McEwan 2001). Steelhead escapement surveys at the RBDD ended in 1993 due to changes in dam operations.

The only consistent data available on steelhead numbers in the San Joaquin River basin come from CDFG mid-water trawling samples collected on the lower San Joaquin River at Mossdale. These data indicate a decline in steelhead numbers in the early 1990s, which have remained low through 2002 (CDFG 2003). In 2004, a total of 12 steelhead smolts were collected at Mossdale (CDFG unpublished data).

Existing wild steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Battle, Deer, and Mill creeks and the Yuba River. Small populations may also exist in Big Chico and Butte creeks. A few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Steelhead redd surveys in Clear Creek observed the highest count in 2009, possibly due to restoration activities (S. Giovannetti and Brown 2009). Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected small self-sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other streams previously thought to be void of steelhead (McEwan 2001). It is possible that naturally spawning populations exist in many other streams; however, these populations are undetected due to lack of monitoring programs (IEPSPWT 1999).

Steelhead returns to the Battle Creek watershed constitute a significant portion of the CV steelhead DPS, and most of the Battle Creek return originates at the Coleman NFH. Differentiating abundance between hatchery- and natural-origin steelhead in Battle Creek has been reliably estimable since 2002, when the first full cohort of 100 percent marked hatchery fish returned to the Coleman NFH. Prior to that year, hatchery and natural steelhead in Battle Creek were not differentiable, and all steelhead were managed as a single, homogeneous stock. Abundance estimates of natural origin steelhead in Battle Creek from 2001 to 2009 ranged from 222 to 545 (mean of 387, std.=101). The abundance of hatchery produced steelhead returning to Coleman NFH from 2003 to 2009 ranged from 1,004 to 3,193 (avg. = 1,993, std.=763). These estimates of steelhead abundance include all variants of life history types of the species *Oncorhynchus mykiss*, including ocean-going fish commonly referred as "steelhead" and nonanadromous types commonly referred as "rainbow trout". During recent years there has been a marked paucity of larger-sized natural-origin *Oncorhynchus mykiss* observed in Battle Creek (K. Niemela, USFWS, personal communication, 2010). This decline of larger-sized *O. mykiss* may indicate selection against an anadromous life history type.

3. Designated Critical Habitat

a. CV spring-run Chinook salmon - composed of primary constituent elements that are essential for the conservation of the species including, but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Most of the historic spawning and rearing habitat for spring-run Chinook salmon is above impassable dams as is the case for the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers. Current spring-run Chinook salmon spawning habitat largely occurs in areas that historically functioned as either rearing habitat or migratory corridors, or spawning habitat for fall-run Chinook salmon. In areas where the spawning distributions of fall and spring-run Chinook salmon overlap, the quality of spawning habitat used by spring-run Chinook salmon is diminished when fall-run Chinook salmon, which spawn later than but still during spring-run Chinook salmon spawning, arrive at the spawning grounds and physically disturb spring-run Chinook salmon redds during their redd construction. This competition for spawning habitat between spring-run and fall-run Chinook salmon, which is the result of dam construction, occurs on several Central Valley rivers.

   Clear Creek is located in the northwestern California diversity group and provides suitable habitat for CV spring-run Chinook salmon, largely due to cool water releases out of Wiskeytown Dam. Lower Clear Creek is characterized by alternating pools and riffles. The channel form, along with boulders, ledges, and turbulence, provides key characteristics supporting the PCEs of critical habitat (*i.e.*, spawning habitat, freshwater rearing sites, and freshwater migration corridors). Lower Clear Creek has a high conservation value (significant habitat features) because it supports several life stage functions for CV spring-run Chinook such as spawning, rearing and migration and because it has a high potential to support more fish through continued restoration. Spawning values in the action area are low because much of the suitable spawning substrate (gravel) has migrated downstream and Whiskeytown Dam has blocked its natural replenishment.

At the scale of the ESU of CVspring-run Chinook salmon, substantial habitat degradation and alteration also has affected the rearing, migratory, and estuarine areas used by spring-run Chinook salmon. Some general examples of how spring-run Chinook salmon critical habitat has been degraded include the direct loss of floodplain and riparian habitat, the loss of natural river function and floodplain connectivity through levee construction, and effects to water quality associated with agricultural, urban, and industrial land use. One specific example of degradation to estuarine habitats used by spring-run Chinook salmon is that human activities in the San Francisco Bay-Delta Estuary have caused the loss or conversion of more than 500,000 acres of tidal wetlands and thousands of acres of shoreline and stream habitat (http://sfep.abag.ca.gov/pdfs/fact_sheets/SF_Bay_Delta_Estuary.pdf). Perhaps the most striking indication that the status of estuarine habitats used by spring-run Chinook salmon has been degraded is the collapse of the pelagic community in the Delta that has been observed in recent years (Sommer et al. 2007). It is not immediately clear how the changes in the Delta ecosystem affect spring-run Chinook salmon, but it is certain that substantial changes to spring-run Chinook salmon estuarine habitat are occurring. It should be noted that the area in which the pelagic organism collapse is occurring does overlap with spring-run Chinook salmon critical habitat in the Delta, but the area of collapse also occurs in areas of the Delta that are not designated as spring-run Chinook salmon critical habitat.

The current condition of critical habitat for the ESU of CV spring-run Chinook salmon is highly degraded, and does not provide the conservation value necessary for the survival and recovery of the species.

b. CV steelhead - It is estimated that 80 percent of the historic spawning and rearing habitat for CV steelhead is above impassable dams as is the case for the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers. All critical habitat for CV steelhead occurs below impassable barriers. As such, steelhead critical habitat largely occurs in areas that historically functioned as either rearing or migratory habitats.

   Critical habitat for CV steelhead is composed of PCEs that are essential for the conservation of the species including, but not limited to, spawning habitat, rearing habitat, migratory corridors, and estuarine areas. Stressors to CV steelhead PCEs are similar to the stressors described for CV spring-run Chinook salmon critical habitat and include water diversions and water management, dams and other structures, loss of floodplain connectivity, loss of natural riverine function, bank protection, dredging, sediment disposal, gravel mining, invasive aquatic organisms, and agricultural, urban, and industrial land use (McEwan 2001). In the Sacramento-San Joaquin Delta, while both CV spring-run Chinook salmon and CV steelhead critical habitat include the Sacramento Delta Hydrological Unit, CV steelhead critical habitat additionally includes the San Joaquin Delta Hydrological Unit. The Sacramento-San Joaquin Delta is an ecosystem that has had dramatic habitat changes in recent years related to water quality, toxic algae blooms (e.g., Microcystis), and invasive species (e.g., the aquatic macrophyte Egeria densa). Based on the host of stressors to spawning, rearing, migratory, and estuarine habitats in the Central Valley, it is apparent that the current condition of CV steelhead critical habitat is degraded, and does not provide the conservation value necessary for the survival and recovery of the species.

CV steelhead habitat in Clear Creek is generally considered to be suitable similarly to CV spring-run Chinook salmon habitat described above.

B. Effects of the Proposed Action on Listed Species

Although steelhead and spring-run Chinook salmon have the potential to be exposed to hazardous materials as a result of the project, the best management practices and conservation measures in place make this a discountable effect. Loss of riparian vegetation due to road maintenance or gravel placement may occur as a result of the project, but Reclamation will be replanting where possible, and any additional loss is considered to be at an insignificant level to affecting listed species. Increased turbidity as a result of the project may occur, although temporary in nature. Depending on the life stage of the listed species, impacts from increased turbidity would vary. Juvenile and adult salmonids would have adjacent suitable habitat to temporarily move to if needed. Incubating eggs would be at the highest risk. However, with the measure to check for spawning and redds prior to gravel augmentation at each site, and to not proceed in sites that contain redds in place, this potential impact is considered to be insignificant.

The impact of in-water work during gravel augmentation or habitat structure placement has the highest likelihood to affect listed species. The effects vary depending on the method of gravel placement. The End Dump Talus Cone and Lateral Berm methods are unlikely to result in take of a listed species. Juvenile and adult salmonids will have the opportunity to temporarily avoid the area for suitable adjacent habitat during implementation, and redd surveys will be conducted prior to gravel placement. The potential for impacts from these gravel augmentation methods is discountable. The Riffle Supplementation Method and habitat structure placement has the highest likelihood of killing, injuring, or harassing juvenile salmonids when they are outmigrating or rearing in larger numbers during augmentation or placement.

As a result of implementation of spawning gravel augmentation and placement of instream habitat structures, spawning and rearing habitats are expected to increase and improve for CV spring-run Chinook salmon and CV steelhead. A long-term benefit of the continued project is that population abundances are expected to increase.

C. Impacts of the Proposed Action on ESU/DPS Survival and Potential for Recovery

Long-term gravel augmentation was identified as a high priority recovery action in the draft Central Valley Salmon and Steelhead Recovery Plan. The "Effects of the Action" section acknowledges and analyzes the potential effects of the habitat restoration project in Lower Clear Creek. Some potential effects of the implementation of the project are expected to result in take of listed anadromous fish in the action area, although negative effects are expected to be minimal. Most significant immediate and long-term effects of the habitat restoration project will be to improve overall conditions for listed salmonids by increasing and improving habitat. This improvement of habitat will be achieved through increasing spawning and rearing habitat.

The adverse effects that are anticipated to result from the implementation are not the type or magnitude that would be expected to appreciably reduce the likelihood of survival and recovery of the affected species in the action area, or at the ESU/DPS level. VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be reduced; in contrast, implementing this Project is expected to improve these parameters, which will be necessary for the Clear Creek population to reach a viable status. The draft Central Valley Salmon and Steelhead Recovery Plan has identified Clear Creek as a necessary (Core 1) population for recovery of the ESU/DPS. NMFS expects that any adverse effects of this project will be outweighed by the immediate and long-term benefits to species survival, and increasing abundance, produced by the improvement in habitat for spring-run Chinook salmon and steelhead.

Impacts of the Proposed Action on Critical Habitat

Overall the Project will not diminish, but will improve and increase the conservation value of the PCEs spawning habitat and rearing habitat, for CV spring-run Chinook salmon and CV steelhead. The immediate and long-term effects of the LCC Habitat Restoration project are anticipated to be beneficial to designated critical habitat for these species.

Gravel injections and placement of instream habitat structures may cause a temporary increase in turbidity and may deposit silt or sand into Clear Creek, which could degrade current spawning gravel and reduce food availability. In addition, physical disturbance to spawning or rearing habitat could occur during gravel placement or instream habitat structure placement. BMPs will be in place during implementation of the Project, including timing of implementation, which would avoid spawning timing, so that spawning gravel would not be negatively affected. In addition, BMPs to wash the gravel prior to injecting will minimize and localize turbidity plumes. Implementation of these BMPs will ensure these potential effects remain insignificant.

VIII. CONCLUSION

After reviewing the best scientific and commercial data available, including the current status of the listed salmonid species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the LCC Anadromous Fish Habitat Restoration and Management Project is not likely to jeopardize the continued existence of CV spring-run Chinook salmon and CV steelhead.

In addition, NMFS has determined that the habitat restoration action, as proposed, is not likely to destroy or adversely modify the designated critical habitat for CV spring-run Chinook salmon and CV steelhead.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Reclamation so that they become binding conditions of any licenses issued, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activities covered by this Incidental Take Statement. If Reclamation: (1) fails to assume and implement the terms and conditions; or (2) fails to require the LCC TAC adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the license, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation must report the progress of the action and its impact on the species to NMFS as specified in this Incidental Take Statement (50 CFR §402.14(I)(3)).

A. Amount or Extent of Take

NMFS anticipates incidental take of CV spring-run Chinook salmon and CV steelhead through the implementation of the LCC Fish Habitat Restoration and Management project. Specifically, NMFS anticipates that fry and juvenile spring-run Chinook salmon and steelhead may be killed, injured, or harassed during the implementation of the project.

Ecological surrogates are those elements of the project that are expected to result in take, and that are also somewhat predictable and/or measurable, and to monitor those surrogates to determine the level of take that is occurring. The most appropriate threshold for minimal take, is an ecological surrogate of temporary habitat disturbance during the riffle supplementation method of gravel augmentation, and habitat structure placement (Table 8). We used estimates of the number of fish based on fish density data, and a description of ecological surrogates associated with the action to fully describe the amount and extent of take. Since Reclamation is proposing to implement the project outside of peak migration times, and only small numbers of fish are expected to rear within riffle supplementation sites, we anticipate actual take to be very low.

Assumptions include anticipated density of rearing juvenile salmonids. The USFWS' Clear Creek juvenile habitat use studies in the lower section (Zone 3) have included *O.mykiss* densities, which were 0.02 fish per square meter, or 0.186 fish per 100 square feet (Stafford and Brown 2012). We assume the same density for Zone 2. Since most juvenile spring-run Chinook salmon will have emigrated prior to implementation, we expect there will be less than half the density of steelhead.

In addition, any remaining spring-run Chinook salmon will be larger juveniles, and more able to avoid the temporary disturbance.

NMFS anticipates take will be limited to:

1. Take in the form of harm to rearing juvenile CV steelhead and spring-run Chinook salmon and temporary loss of 3,600 to 12,000 square feet of mid-channel riffle rearing habitat due to gravel augmentation using the riffle supplementation method.
2. Take in the form of harm to rearing juvenile CV steelhead and spring-run Chinook salmon and temporary loss of 1,600 square feet of rearing habitat due to placement of up to five-foot diameter boulder clusters, which will likely require the use of heavy equipment and temporary gravel bar for placement.
3. Take in the form of harm to rearing juvenile CV steelhead and spring-run Chinook salmon and temporary loss of 1,600 square feet of rearing habitat due to the placement of spider logs (log jam) within the stream channel, using heavy machinery and temporary gravel bar.
4. Take in the form of harm to rearing juveniles CV steelhead and spring-run Chinook salmon and temporary loss of 1,600 square feet of rearing habitat due to heavy machinery stream crossing to implement an End Dump Talus Cone gravel augmentation site.
5. Take in the form of capture of juvenile CV steelhead and spring-run Chinook salmon as a result of monitoring requirements of Term and Condition number 2a. Tracking direct mortality at a riffle supplementation gravel augmentation site (described in number 1 above), may result in temporary capture of juveniles fleeing the gravel augmentation site, into a seine or other monitoring equipment. Potential take is not expected to exceed the amount and extent of take described in Table 8 below for a riffle supplementation site.

The take from the above five described activities may include injury or death of a small number of juvenile CV steelhead and spring-run Chinook salmon (see “amount and extent of take” in Table 8 below). Gravel sites will be selected each year, so the take levels indicated in Table 8 are potentially annual. The habitat structure placements are total (as opposed to annual) from 2014 through 2030 (20 total boulders, 20 total log structures). Take may occur during the placement of habitat structures which will require the use of heavy machinery, which could crush juveniles. Injury or death may also occur as a result of the riffle supplementation method of gravel augmentation, as juveniles may be crushed by falling gravel, or by machinery, if grading is needed after gravel has been placed. Monitoring to track direct take may also result in injury or death to juveniles. In addition, take from these activities is expected to harm the species by temporarily modifying important elements of rearing habitat. Juvenile CV steelhead and spring-run Chinook salmon will be affected because they will temporarily lose access to and use of this habitat for rearing. Loss of habitat will cause the fish to be displaced, which may result in increased predation risk, decreased feeding, and increased competition. The behavioral modifications that result from the habitat modification are the ecological surrogates for take. There is not a stronger ecological surrogate based on the information available at this time because it is not possible to quantify the exact numbers of individuals that may be affected.

Table 8. Ecological Surrogate of take anticipated as a result of the project

<table>
<tr><th>Species and life stage</th><th>Activity (Zone)</th><th>Life Stage Presence</th><th>Habitat Disturbance Amount</th><th>Amount and Extent of Take per site</th></tr>
<tr><td>Central Valley steelhead Juveniles</td><td rowspan="2">Zone 2:
RS (5 sites)

Zone 3:
RS (3 sites);
EDTC (1 site with stream crossing)

Throughout LCC:
HS -
boulder clusters (20), log structures (20)</td><td>Zone 2:
May 1 – August 31;
Outmigrating juveniles;

Zone 3: June 1 – September 30;
Outmigrating juveniles;

LCC Rearing Density:
0.186 fish per 100 square feet</td><td rowspan="2">RS: 90 feet to 300 feet long by 40 feet wide.

HS:
5 foot diameter boulders; logs 40 feet long, 20-inch diameter, area of disturbance 40 feet by 40 feet.

EDTC: 1 site in Zone 3 that would require stream crossing, area of disturbance: 40 feet by 40 feet</td><td>RS: Ranges from 7 fish in a 3,600 square foot site, to 22 fish in a 12,000 square foot site

HS/EDTC: 3 fish in a 1,600 square foot area</td></tr>
<tr><td>Central Valley spring-run Chinook salmon Juveniles</td><td>Zone 2: November 1– 30;
Outmigrating juveniles;

Zone 3: yearling juveniles may occur in summer

LCC Rearing Density:
0.093 fish per 100 square feet</td><td>RS: Ranges from 3 fish in a 3,600 foot site, to 11 fish in a 12,000 square foot site

HS/EDTC: 1.5 fish in a 1,600 square foot area</td></tr>
</table>

RS: Riffle Supplementation gravel augmentation; LCC: Lower Clear Creek (below Whiskeytown Dam to confluence); HS: Habitat Structures; EDTC: End Dump Talus Cone

B. Effect of the Take

In the accompanying biological opinion, NMFS determined that this level of anticipated take is not likely to result in jeopardy to CV spring-run Chinook salmon or CV steelhead. In addition, NMFS determined that this level of anticipated take is not likely to result in the destruction or adverse modification of designated critical habitat for CV spring-run Chinook salmon or CV steelhead.

C. Reasonable and Prudent Measures

Pursuant to section 7(b)(4) of the ESA, the following reasonable and prudent measures are necessary and appropriate to minimize take of CV spring-run Chinook salmon and CV steelhead:

1. Reclamation shall develop a pool monitoring plan (for the LCC project area) in coordination with USFWS and NMFS before the end of 2015, and begin implementation of the plan during the 2016 gravel augmentation season.

2. Reclamation shall develop a monitoring plan to track the level of direct mortality that occurs during implementation of the Project, in coordination with the USFWS, before the end of the 2015 season, and begin implementation of the plan during the 2016 season.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, Reclamation comply with the following terms and conditions, which implement the reasonable and prudent measures, described above, and outline reporting/monitoring requirements. These terms and conditions are non-discretionary.

1. Reclamation shall develop a pool monitoring plan (for the LCC project area) in coordination with USFWS and NMFS before the end of 2015, and begin implementation of the plan during the 2016 gravel augmentation season.
    a. This plan will expand the current monitoring of spawning gravel, and may include measuring depths before and after gravel augmentation, after storms, etc.;
    b. Reclamation shall analyze data collected, to help evaluate the ability of the project to enhance or create large, deep pools, and may include recommendations for changes to pulse flows, or locations, timing, and amounts of augmented gravel. Reports shall be provided to NMFS at the end of the midterm of the project (2022), and at the end of the Project (2030).

2. Reclamation shall develop a monitoring plan to track the level of direct mortality that occurs during implementation of the Project, in coordination with the USFWS, before the end of the 2015 season, and begin implementation of the plan during the 2016 season.
    a. Reclamation shall monitor one riffle supplementation site, on years that a riffle supplementation site is selected to augment, to track the level of direct mortality. This may involve use of a seine net immediately below a riffle supplementation site and record observations of direct mortality, or other methods.
    b. Reclamation shall provide analysis of data collected and recommendations to NMFS at the end of the midterm of the project (2022), and at the end of the Project (2030).

Updates and reports required by these terms and conditions shall be submitted to:

Supervisor
California Central Valley Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento CA 95814
FAX: (916) 930-3629
Phone: (916) 930-3600

X. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of endangered and threatened species. "Conservation" is defined in the ESA as those measures necessary to delist a species. These conservation recommendations include discretionary measures that Reclamation can take to minimize or avoid adverse effects of a proposed action on a listed species or designated critical habitat or regarding the development of information. In addition to the terms and conditions of the Incidental Take Statement, NMFS provides the following conservation recommendation that will reduce or avoid adverse impacts on the listed species:

1. Reclamation should continue to work together with the LCC TAC to identify any concerns with the restoration efforts and continue to adaptively manage the project.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed LCC Habitat Restoration project. As provided in 50 CFR §402.16, reinitiation of formal consultation is required if: (1) the amount or extent of taking specified in the incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

A. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the Reclamation. Other interested users could include the Corps, the BLM, the USFWS, the CDFW, DWR and WSRCD. Individual copies of this opinion were provided to the Reclamation. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

B. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

C. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01, et seq., and the Magnuson-Stevens Fishery Conservation and Management Act (MSA) implementing regulations regarding Essential Fish Habitat (EFH), 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the Literature Cited. The analyses in this opinion and EFH in enclosure 2, contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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Magnuson-Stevens Fishery Conservation and Management Act

ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS[1]
Lower Clear Creek Anadromous Fish Habitat Restoration and Management Project

I. IDENTIFICATION OF ESSENTIAL FISH HABITAT

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended (U.S.C. 180 *et seq.*), requires that Essential Fish Habitat (EFH) be identified and described in Federal fishery management plans (FMPs). Federal action agencies must consult with NOAA's National Marine Fisheries Service (NMFS) on any activity which they fund, permit, or carry out that may adversely affect EFH. NMFS is required to provide EFH conservation and enhancement recommendations to the Federal action agencies.

EFH is defined as those waters and substrates necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle. Freshwater EFH for salmon consists of four major components: spawning and incubation habitat; juvenile rearing habitat; juvenile migration corridors; and adult migration corridors and adult holding habitat (Pacific Fishery Management Council 2003). Important components of EFH for spawning, rearing, and migration include suitable substrate composition; water quality (e.g., dissolved oxygen, nutrients, temperature); water quantity, depth and velocity; channel gradient and stability; food; cover and habitat complexity (e.g., LWM, pools, channel complexity, aquatic vegetation); space; access and passage; and floodplain and habitat connectivity (Pacific Fishery Management Council 2003). The proposed project site is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Salmon FMPs.

The Pacific Fishery Management Council (PFMC) has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley

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[1] The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) set forth new mandates for NOAA's National Marine Fisheries Service (NMFS) and Federal action agencies to protect important marine and anadromous fish habitat. Federal action agencies which fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and respond in writing to NMFS "EFH Conservation Recommendations." The Pacific Fisheries Management Council has identified essential fish habitat (EFH) for the Pacific salmon fishery in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan.

ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Central Valley. Fall-run Chinook salmon comprise the largest population of Chinook salmon in the Clear Creek watershed; additionally a smaller spring-run Chinook salmon population persists as well.

Factors limiting salmon populations in the Clear Creek Watershed include flow conditions affecting juvenile rearing and outmigration, water temperatures and water quality affecting adult immigration, holding, spawning and embryo incubation, and lack of spawning habitat due to sediment transport process being blocked by Whiskeytown Dam, sedimentation affecting embryo incubation, and hybridization between fall-run and spring-run Chinook salmon, affecting genetic integrity.

A. Life History and Habitat Requirements

1. Pacific Salmon

General life history information for Central Valley fall-run Chinook salmon is summarized below. Further detailed information on the other Central Valley Chinook salmon Evolutionarily Significant Units (ESUs) are available in the enclosed biological opinion, the NMFS status review of Chinook salmon from Washington, Idaho, Oregon, and California (Myers *et al.* 1998), and the NMFS proposed rule for listing several ESUs of Chinook salmon (63 FR 11482).

Adult Central Valley fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from July through December and spawn from October through December while adult Central Valley late fall-run Chinook salmon enter the Sacramento and San Joaquin Rivers from October to April and spawn from January to April (U.S. Fish and Wildlife Service [USFWS] 1998). Chinook salmon spawning generally occurs in clean loose gravel in swift, relatively shallow riffles, or along the edges of fast runs (NMFS 1997).

Egg incubation occurs from October through March (Reynolds *et al.* 1993). Shortly after emergence from their gravel nests, most fry disperse downstream towards the Delta and into the San Francisco Bay and its estuarine waters (Kjelson *et al.* 1982). The remaining fry hide in the gravel or station in calm, shallow waters with bank cover such as tree roots, logs, and submerged or overhead vegetation. These juveniles feed and grow from January through mid-May, and emigrate to the Delta and estuary from mid-March through mid-June (Lister and Genoe 1970). As they grow, the juveniles associate with coarser substrates along the stream margin or farther from shore (Healey 1991). Along the emigration route, submerged and overhead cover in the form of rocks, aquatic and riparian vegetation, logs, and undercut banks provide habitat for food organisms, shade, and protect juveniles and smolts from predation. These smolts generally spend a very short time in the Delta and estuary before entry into the ocean. Whether entering the Delta or estuary as fry or larger juveniles, Central Valley Chinook salmon depend on passage through the Delta for access to the ocean.

II. PROPOSED ACTION

The proposed action is described in section II (*Description of the Proposed Action*) of the preceding biological opinion for federally listed threatened Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened California Central Valley steelhead (*O. mykiss*), and their designated critical habitats (Enclosure 1).

III. EFFECTS OF THE PROPOSED ACTION

The effects of the proposed action on salmonid habitat are described at length in section V (*Effects of the Action*) of the preceding biological opinion, and generally are expected to apply to Pacific salmon EFH.

The proposed project would result in the addition or enhancement of salmonid spawning and rearing habitat. With the incorporation of conservation measures, any temporary negative impacts on habitat from the proposed project, would be insignificant in the long-term. It is anticipated that the proposed project would not result in any permanent net loss in anadromous salmonid spawning habitat.

Potential impacts from construction activities include: localized and temporary increases in turbidity and suspended sediment, and minor short-term loss of riparian vegetation.

Conservation measures consist of several components designed to avoid or to minimize potentially adverse effects to habitat. These components include:

Conduct in-stream work within the prescribed work windows.

Surveys for salmonids and redds will be conducted by a qualified biologist prior to implementation that occur near spawning habitat during spawning and incubation periods.

Appropriate BMPs to control erosion and storm water sediment runoff shall be implemented. This may include, but is not limited to, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from project areas.

Equipment shall not operate in an active stream channel except as may be necessary to construct temporary stream crossings and/or place in-stream habitat structures and spawning gravel. When in-channel work is unavoidable, clean spawning gravel shall be used to create a pad in the channel from which equipment will operate. Clean spawning gravel shall also be used to construct any required in-stream crossings. In-stream construction shall proceed in a manner that minimizes sediment discharge. Following completion of restoration activities, the spawning gravel will be removed from the stream channel or spread evenly across the bottom of the channel, consistent with existing gravels.

Spawning gravel used in restoration shall be clean and washed with a cleanness value consistent with California Department of Transportation's Test #227 (California Department of Transportation 1999).

Stream crossings or instream work that may cause turbidity within 200 feet upstream of active redds shall be avoided.

Impacts to existing vegetation shall be avoided to the extent practicable.

Disturbed areas, not intended for future road access or gravel placement, shall be revegetated with native plant species and/or mulched with certified weed-free hay following the completion of construction activities.

All equipment used for the project shall be thoroughly washed off-site to remove invasive plant seed, stems, etc. and inspected to prevent transfer of aquatic invasive species, such as quagga mussel and New Zealand mud snail, prior to arriving at the construction area. If construction involves work at two or more separate locations along the creek and project area, when possible, equipment shall be thoroughly cleaned after completing work at one location, before proceeding to the next location. This will minimize the dissemination of noxious or invasive plant species within the project areas.

Project activities shall avoid impacts to wetlands to the extent practicable. Wetlands located near construction areas, and at risk of inadvertent disturbance, shall be protected with high-visibility fencing.

The contractor shall develop and implement a Spill Prevention, Control and Countermeasures Plan (SPCCP) prior to the onset of construction. The SPCCP will include measures to be implemented onsite that will keep construction and hazardous materials out of waterways and drainages. The SPCCP will include provisions for daily checks for leaks; hand-removal of external oil, grease, and mud; and the use of spill containment booms for refueling.

All construction equipment refueling and maintenance shall be restricted to designated staging areas located away from streams and sensitive habitats.

IV. CONCLUSION

Based on the best available information, and upon review of the effects of the proposed Lower Clear Creek Anadromous Fish Habitat Restoration and Management Project, NMFS believes that the proposed action will have temporary adverse effects on EFH of Pacific salmon protected under MSA. Clear Creek provides all four major components of freshwater EFH for salmon, therefore, long term effects of the Habitat Restoration project are expected to include an increase in the amount of available habitat and enhance stream and riparian habitat suitability for Pacific salmon.

V. EFH CONSERVATION RECOMMENDATIONS

As the adverse effects to EFH associated with the proposed project will generally occur in the critical habitat utilized by the federally listed species addressed in the enclosed biological opinion, NMFS recommends that reasonable and prudent measure number 1 and the respective implementing terms and conditions as well as conservation recommendation number 1 described in the enclosed biological opinion, be adopted as EFH conservation recommendations. Those terms and conditions which require the submittal of reports and status updates can be disregarded for the purposes of this EFH consultation as there is no need to duplicate those submittals.

VI. STATUTORY REQUIREMENTS

Section 305 (b) 4(B) of the MSA requires that the Federal lead agency provide NMFS with a detailed written response within 30 days, and 10 days in advance of any action, to the EFH conservation recommendations, including a description of measures adopted by the lead agency for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920[j]). In the case of a response that is inconsistent with our recommendations, the lead agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreement with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

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