

Lover's Leap Restoration Project

Salmon Habitat Restoration in the Lower Stanislaus River

Final Report

July 16, 2008

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EXECUTIVE SUMMARY

The Lover's Leap Restoration Project was intended to replenish spawning gravel at existing and new restoration sites in the lower Stanislaus River near Lover's Leap and to restore riverbed topography. The overall objective was to increase and improve Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*) spawning and rearing habitat by adding cleaned spawning sized gravels to degraded areas within the 25.5 mile salmonid spawning reach. Project outcomes will contribute to the Central Valley Project Improvement Act (CVPIA) goal of at least doubling natural production of Central Valley anadromous fishes over the 1967-1991 population levels. In order to achieve these objectives, approximately 18,000 tons of cleaned spawning sized gravel, and roughly 7,000 tons of larger cobble was harvested from the project area and inserted into the river, creating or improving a total of 33 riffles, and restoring fluvial geomorphic processes. Increasing the area of suitable spawning habitat should increase the abundance and condition of Chinook salmon and steelhead trout by reducing the effect of density dependent factors such as redd superimposition and by decreasing the area of habitat available for predatory fish.

All in river work associated with the Lover's Leap Restoration Project was completed in September, 2007. Immediately following in-river construction, nearby floodplain habitat, temporary access routes and areas of disturbed river bank were seeded with perennial and annual rye grass mix, and dry pasture mix designed for local climate conditions. Additionally, monitoring of habitat use by adult steelhead at natural and restored sites in the Lover's Leap project area will continue for 2 years following restoration activities.

INTRODUCTION

The area of suitable salmonid spawning and rearing habitats in the Stanislaus River has been substantially reduced due to anthropogenic influences including dam construction, in river aggregate mining, and the conversion of floodplain habitat for agricultural uses. Suitable spawning habitat typically consists of framework grains of a size movable to females during redd construction (approximately 10% a fishes' body length), low levels of fine sediment accumulation, and gravel permeability sufficient to allow minimum intra-gravel dissolved oxygen and water velocity requirements of salmonid eggs (Kondolf 2000, Merz and Setka 2004).

In the Stanislaus River, as in many Central Valley systems, a series of dams in the upper watershed has blocked access to spawning habitat in the upper river, and has blocked the transport of gravel to downstream reaches. Gravel recruitment was reduced by 92% following construction of Goodwin Dam at river mile (RM) 58 in 1912. Mobilization of gravel and fines below Goodwin Dam was further reduced in 1981 when expansion of the New Melones Dam reduced the frequency and magnitude of flooding in the lower reaches (Kondolf et al. 2001) inhibiting the flushing of fine particles (<0.85mm) from coarser bed materials (CDWR 1994). High volumes of fine particles are detrimental to the survival of Chinook salmon and steelhead eggs (Reiser and White 1988) and have been found to reduce salmonid egg survival to emergence by as much as 95% (Meyer 2003). In 1994, the California Department of Water Resources found that 45% of the 22 riffles they surveyed between Goodwin Dam and Riverbank

on the Stanislaus River were unsuitable for salmonid spawning due to high levels of fine particle accumulation (CDWR 1994).

In addition to damming in the upper watershed, gold and aggregate mining have had a detrimental effect on spawning and rearing habitats. Approximately 40% of historic gravel beds were excavated from the 13.6-mile reach between Goodwin Dam and Orange Blossom Bridge between the years 1939 and 1980 for gold and aggregate mining purposes (Mesick 2003). Mining activities left instream pits and long, uniform ditches 5 to 10 feet deep and 100 to 165 feet wide in the active channel near Lover's Leap from RM 53.4 downstream to RM 51.8. Gravels entering the river from tributaries below Goodwin Dam, or mobilized in high flow events become trapped in these pits rather than replenishing downstream riffles (SRFG 2003). Furthermore, these ditches sustain large populations of predatory fish, but provide little habitat for salmonids.

Isolation of floodplain and riparian habitats from the river by dikes has also had a negative impact on salmonid spawning and rearing habitats. The Service (USFWS 1995) estimated that by 1994, approximately 50% of the riparian corridor along the lower Stanislaus River had been converted for agricultural, mining, and urban uses. Dikes confine flood flows to the river channel, increasing the rate of scouring of gravel from spawning and rearing habitat. Additionally, dikes block access to floodplain habitat which serves as an important source of refuge and terrestrial food for juvenile fish during flood events.

Reduced gravel recruitment, in-river gravel mining, and the loss of functional floodplain, have severely reduced the quality and quantity of the spawning and rearing habitat for Chinook salmon and steelhead trout in the lower Stanislaus River. The limited riffle habitat that remains has become armored and shortened due to erosion and the blockage of gravel recruitment (Mesick 2001). Limited availability of spawning habitat has increased the rate of redd superimposition in the lower Stanislaus River. Redd superimposition causes increased egg mortality by either smothering eggs or digging up pre-existing redds, exposing eggs to predation (CDWR 1994). CDFG's 2004 Stanislaus River salmon escapement report cites decreasing habitat and increased predation as the primary causes of the decline in Chinook salmon escapement over past 50 years (CDFG 2005).

As early as 1886 the California Fish Commission reported reduction in salmon stocks due to hydraulic mining occurring between 1853 and 1884 (SRFG 2003). Spring run Chinook salmon are believed to have been extirpated from the Stanislaus River following construction of the New Melones Dam in 1926 (CDWR 1994). Fall run Chinook escapement in the Stanislaus River decreased from a mean of 15,000 fish between 1947 and 1954 to 737 fish between 1990 and 1998 and has been fewer than 1,500 fish during 46% of the years from 1958 to 1998 (CMC 2002b). Escapement rates increased following flood level flows occurring between 1998 and 2000 to an average of 7,700 adult fish (CMC 2002b). However in 1998 Carl Mesick Consultants (CMC) estimated that the available spawning habitat in the Stanislaus River could support a maximum of only 1250 pairs of adult salmon (CMC 2002b).

In response to reduction in salmonid stocks the Anadromous Fish Restoration Program (AFRP) identified restoring and replenishing spawning gravel in the lower Stanislaus River as a high priority (USFWS 2001). In 1994 the California Department of Water Resources (CDWR 1994) recommended the import and placement of spawning sized gravels in river reaches downstream of dams on the Stanislaus, Tuolumne, and Merced Rivers, all of which host runs of Chinook salmon and Central Valley steelhead. During the summer of 1999, nine gravel beds were reconstructed in the Lover's Leap project area by CMC as part of the Knight's Ferry Gravel Replenishment Project (KFGRP) (CMC 2002a). The project was designed to evaluate the influence of varying gravel sources and sizes on Chinook salmon spawner use. Results indicated that Chinook salmon redd densities were highest in riffles constructed with ¼-inch screened gravel from the Stanislaus River. During the spawning season immediately following gravel bed construction, per spawner production of juvenile Chinook salmon increased by at least 30% in all KFGRP project gravel beds (CMC 2002a, 2002b).

PROJECT DESCRIPTION

With gravel size recommendations taken from CMC's work on the KFGRP, the work described here is intended to replenish spawning gravel at existing and new restoration sites in the Lower Stanislaus River near Lover's Leap and to restore riverbed topography. The overall objective is to increase and improve Chinook salmon and Central Valley steelhead spawning and rearing habitat in accordance with the AFRP's goal of at least doubling natural production of Central Valley anadromous fishes over the 1967-1991 population levels. The approach was to insert cleaned ¼-inch screened gravels into the active river channel, creating or improving a total of 33 riffles, and restoring fluvial geomorphic processes. Increasing the area of suitable spawning habitat should increase the abundance and condition of Chinook salmon and steelhead trout by reducing the effect of density dependent factors such as redd superimposition and by decreasing the area of habitat available for predatory fish.

Study Area

The project area is located within Stanislaus County between Knights Ferry and Lover's Leap extending from RM 53.4 downstream to RM 51.8 on the Stanislaus River (Figure 1). The Stanislaus River is one of three major tributaries to the San Joaquin River. Its watershed is roughly 1,100 square-miles in which most of the precipitation falls between November and April near the headwaters (Kondolf et al. 2001). The average unimpaired basin runoff is 1,200,000 acre-feet, which is approximately 21% of the total for the San Joaquin River basin. The confluence of the Stanislaus and San Joaquin rivers occurs at about RM 75 of the San Joaquin River. The Stanislaus River is accessible to anadromous fish for the first 58 river-miles with access terminating at Goodwin Dam. The area of suitable salmonid spawning and rearing habitats in the project area has been substantially reduced due to anthropogenic influences including dam construction, in river aggregate mining, and the conversion of floodplain habitat for agricultural uses.

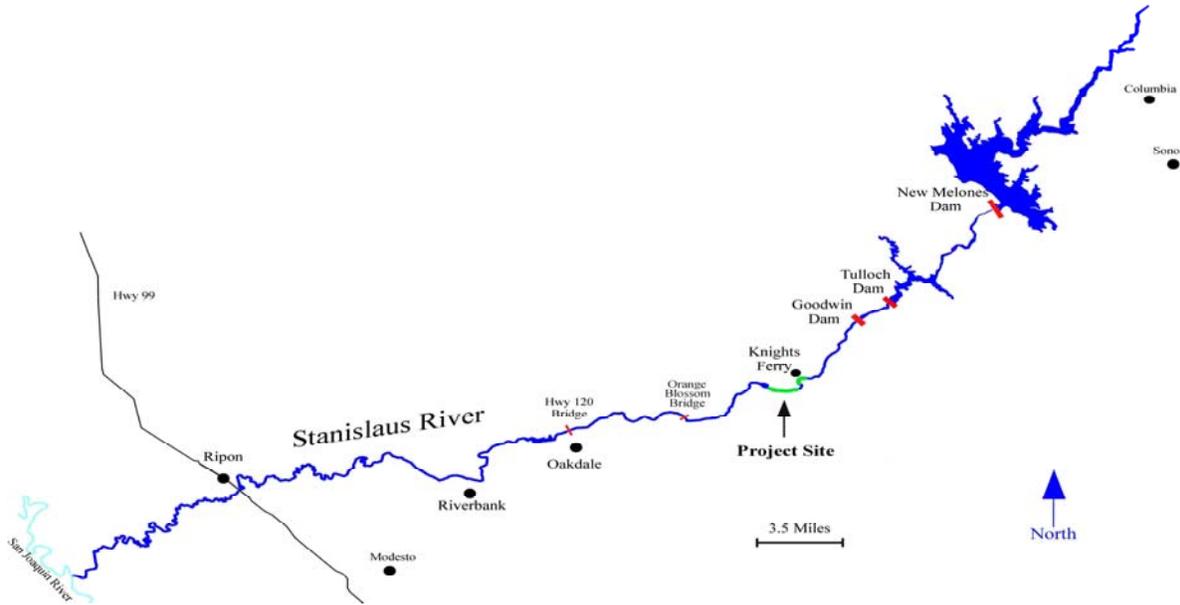


Figure 1. The Lover's Leap Restoration Project site (highlighted green) on the lower Stanislaus River.

METHODS

Gravel and site specifications

The project area falls within the Stanislaus River's 25.5 mile fall-run Chinook spawning reach (CMC 2002b). Specific gravel augmentation sites were chosen based on accessibility for gravel placement equipment on existing gravel roads, availability of naturally occurring cover and holding habitat for adult steelhead, and proximity to gravel supply. Gravel bed design and spawning gravel size recommendations were taken from the 1999 KFGRP (CMC 2002b). CMC (2002b) reported that following restoration efforts in the summer of 1999 Chinook salmon redd densities were highest in riffles constructed with washed ¼-inch screened gravel from the Stanislaus River.

Gravel extraction and processing

A licensed subcontractor was hired to harvest, process, and place cleaned gravel. A 623 paddle wheel self-loading scraper and a 966 rubber tire front-end loader were used to extract approximately 54,000 tons of gravel from Mr. Gordon Crawford's property. Gravel extraction was completed under a grading permit from Stanislaus County, issued to Mr. Crawford. All gravel was harvested from within the Lover's Leap project area (Figure 2) to avoid transporting material over county or state roads.

Gravel processing took place in the floodplain area on Mr. Crawford's property 300 - 400 feet from the Stanislaus River (red polygon, Figure 2). A loader feed raw material into a 2-deck, 6-foot by 16-foot CEC incline portable screen plant to separate spawning-sized gravels (¼ - 5 inches in diameter) (Kondolf et al. 2001, CMC 2002a) from larger cobble (5-10 inches) and fines

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(>¼ inch). Approximately 18,000 tons of spawning size gravel was obtained for construction or improvement of the 33 gravel beds. Lager cobble was obtained for construction of a base layer at most riffle sites before the addition of spawning gravel to provide increased bed stability and to prevent loss of the entire riffle in high flow events. Sediment was dry screened to conserve topsoil for replanting. Spawning-sized gravel was washed with high-pressure spray bars along the 16-foot screen. Spray bars required up to 450 gallons of water per minute, which was pumped directly from the river. Turbid wash water was prevented from entering nearby wetlands or the Stanislaus River by construction of a dirt berm around the screen plant. Dirt used to construct the berm was obtained from dry screening of local gravel. During the washing process, wash water was allowed to percolate through the underlying volcanic mud flow formation thereby removing fine sediments before the water flowed back into the river.

During gravel processing and placement activities, all Fremont cottonwood trees, oak trees, and willows on USACE property with a diameter of at least 6 inches were protected with 30-foot, 10-foot, and 10-foot buffers, respectively. Buffers were removed after the close of construction activities.

Large boulders used to create cover were obtained from within the Lover's Leap area or were trucked in from the old lumber mill site in Martell, CA. Roughly 189 boulders totaling 660 tons were added to the river within the project area.

Gravel placement

Washed ¼-inch gravel and larger cobble was transported to in-river construction sites over existing gravel roads and 0.8 miles of temporary access routes within the Lover's Leap project area with either a 20-ton end-dump hauler or a 30-ton articulated hauler. River access routes pass through a 100 ft wide strip of ACOE property which borders the river on the north bank. Temporary access routes were constructed over non-irrigated pasture areas or exposed gravel bars. With the exception of the trimming of woody vegetation to access the in-river construction site at riffle 21, existing gravel roads were not altered. A front-end loader was used to move gravel within the river to achieve gravel bed design specifications. A ramp of processed gravel was constructed over the riverbank to minimize damage caused by heavy equipment entering the river. Best Management Practices were implemented to minimize construction related discharge of sediment into the river. To minimize impacts to water quality, the hydraulic systems of all equipment used to place gravel within the river were rebuilt immediately prior to construction to minimize oil leakage, and all equipment was checked daily for leaks and routine maintenance. Biodegradable oils were used in all machinery.

All natural woody riparian or "shaded riparian aquatic" habitat was avoided or preserved to the maximum extent possible as recommended in the NOAA Fisheries guidelines. To protect valley elderberry longhorn beetle (VELB) habitat, all elderberry shrubs were mapped, fenced off with a 20 foot buffer, and avoided entirely. No elderberry shrubs were to be trimmed or removed in the project area.

Gravel bed design

Gravel beds were constructed to meet the preferences of spawning Chinook salmon and adult steelhead trout. Gravel bed design was similar to beds constructed in 1999 by Carl Mesick

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Consultants for the KFGRP (for detailed bed design information see CMC 1999). Large cobble and spawning sized gravels were placed in previously mined channels to create 50 to 75-foot long gravel beds interspersed between deep water habitat as is preferred by spawning adult steelhead and rainbow trout. As a result of past gravel mining, deep-water habitat exists adjacent to constructed steep riffle habitat and eliminated the need to excavate gravel from the streambed. To maximize the amount of cover required by adult steelhead, gravel beds were created upstream from overhanging riparian vegetation or submerged woody debris, and large boulders were placed at one side of the crest to create surface turbulence over the downstream deep-water feeding and holding habitat. Because the Stanislaus River does not have a flow schedule, the USFWS recommended gravel beds be designed to suit a range of flows from 200-500 cfs, the anticipated average flow rate in the near future (personal communication JD Wikert).

In consideration of ACOE specifications regarding recreational uses such as angling and rafting within the project area, boulders were not placed more than 1/3 of the rivers width from either bank. Additionally, notches were left in project riffles that created shallow water conditions to allow for rafter passage.

Erosion control

In order to restore vegetation disturbed during gravel bed construction and gravel processing and to reduce erosion and turbid runoff, seed mixtures and several tree species were plated within the project area. Perennial and annual rye grass mixtures in a mulch of certified weed free straw were distributed over all temporary and permanent access routes following completion of riffle construction in August 2007 (Appendix B Figures B-4 and B-5). Approximately 120 bales of straw were used in the process. To prevent erosion of river access punch through roads, straw waddles held in with stakes and reinforced by dirt berms were placed across roads within ten feet of where they meet the river (Appendix B Figure B-5 (b)). A locally obtained dry pasture seed mix was distributed over the gravel processing area at Mr. Crawford's request. All seed mixtures were obtained from Oakdale Feed and were designed for local climatic conditions.

Seventy Fremont cottonwood (*Populus fremontii*), 20 Red willow (*Salix laevigata*), 20 Sandbar willow (*S. exigua*), 10 Black oak (*Quercus kelloggii*), and 10 Big-leaf maple (*Acer macrophyllum*) were planted.

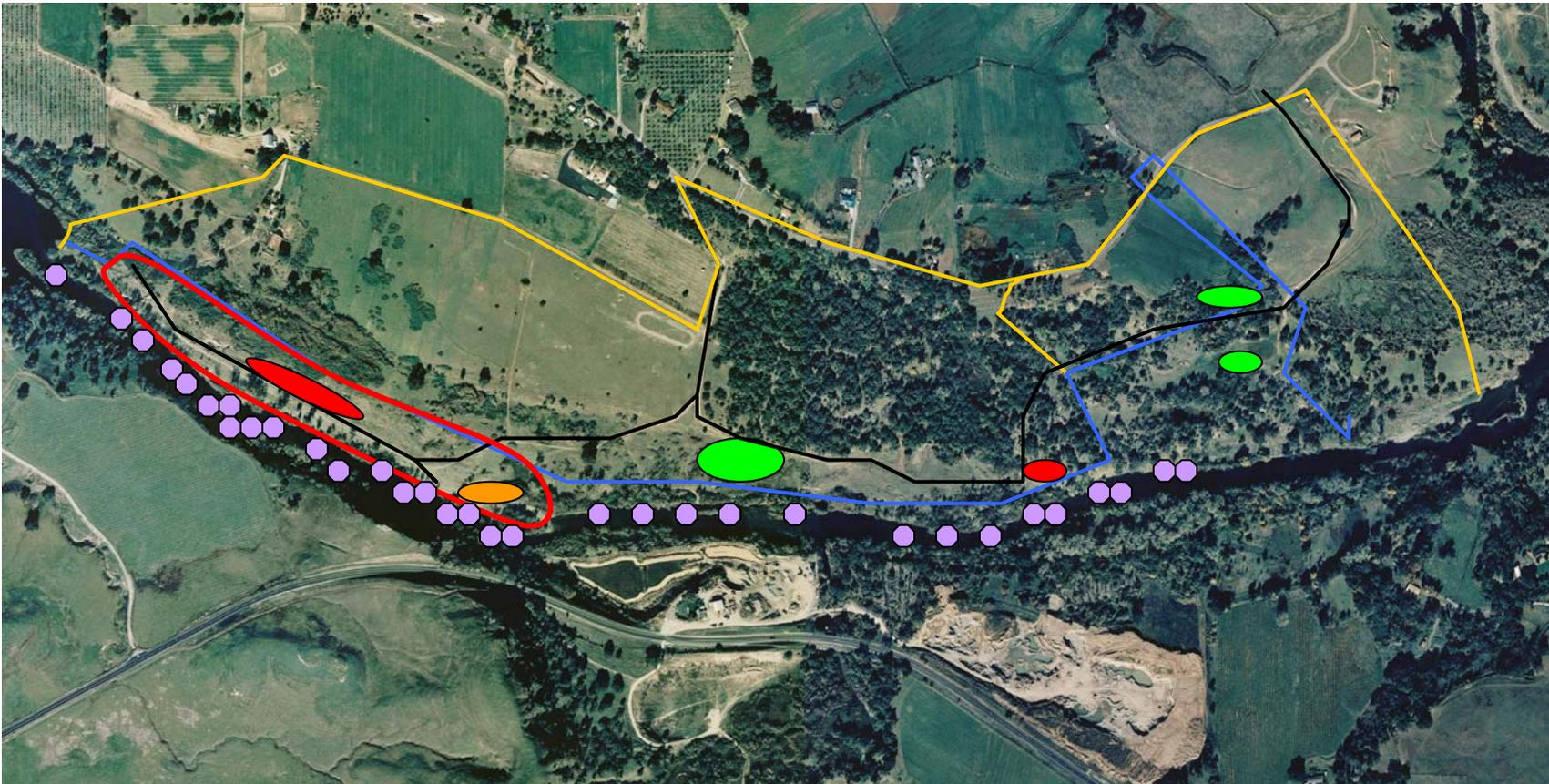


Figure 2. The Lover's Leap Restoration Project area includes: 33 sites where gravel beds (purple dots) were constructed or improved in the lower Stanislaus River; restoration of functional floodplain habitat (orange oval) near Lover's Leap; the gravel processing and stockpiling areas (red polygon and red oval respectively); and preexisting gravel roads (black lines). The areas outlined in blue are owned by USACE. The yellow polygon to the west includes two parcels owned by Western Sand and Gravel (WSG). Three artificially created wetlands are shown as green ovals.

RESULTS

Gravel bed construction was aimed at augmenting the area of available Chinook salmon and steelhead trout spawning and rearing habitat suitable for a range of river flow between roughly 200 and 500 cfs. Twenty seven gravel beds were constructed and six were reconditioned. Approximately 27,076 tons of gravel were added to the river within the Lover's Leap project area including 19,948 tons of washed spawning sized gravel and 7,128 tons of larger (>5-inch) cobble. Larger cobble was used to construct a base layer at most riffle sites before the addition of spawning gravel to provide increased bed stability and to prevent loss of the entire riffle in high flow events. Gravel beds ranged from 44 to 205 feet in width and averaged 105 feet long. Depth of gravel added to beds ranged from 1.3 to 5.8 feet and averaged 3.35 feet. The total area of spawning and rearing habitat in the project area was increased by 100,438 square feet (2.31 acres).

Two preexisting side channels were also improved in order to provide additional habitat for juvenile salmonids and contribute food and other nutrients to the river ecosystem during periods of flooding. In total, 4,550 square feet (0.10 acres) of side channel habitat was improved. Side channel one runs parallel to the north bank of the main channel between R10 and R11 (Appendix C, image c) and is functional at river flows of approximately 200-500 cfs. Side channel two runs into a restored floodplain area upstream of R13 (Appendix C image e) and is functional at flows exceeding approximately 1000 cfs. Side channel improvement required approximately 321 tons of spawning sized gravels. No large cobbles were used for side channel improvement.

A 20,567 square foot (0.47 acres) area of floodplain designed to be inundated at flow releases that exceed roughly 1000 cfs was restored on the north bank of the river near the downstream end of the project area (Figure 2, orange oval). Gravel graded from the floodplain area was used to construct gravel beds at riffles R14 and R15. Native riparian tree species including Fremont cottonwood (*Populus fremontii*), Red willow (*Salix laevigata*), Sandbar willow (*S. exigua*), Black oak (*Quercus kelloggii*), and 10 Big-leaf maple (*Acer macrophyllum*) were planted in the margin of the floodplain area.

MONITORING

A monitoring program consisting of streambed surveys to determine gravel transport rates, bed permeability, and adult steelhead habitat use was designed according to AFRP policy and DFG protocols. Budget overruns due to changes in the work order precluded post project monitoring tasks including streambed surveys and permeability measurements proposed in the original scope of work. Monitoring of adult steelhead habitat use began in 2004 and will continue until 2009. Monitoring was not completed during the 2005/2006 sampling period due to high flows.

Adult Steelhead Habitat Use

For two years following project completion, KDH Environmental will continue to monitor adult steelhead use in order to quantify the effect of pool length, pool depth, and surface turbulence and thereby maximize the effectiveness of future restoration projects for steelhead. Monitoring of steelhead habitat use at various natural and restored sites (including Lover's Leap) in the Stanislaus, Tuolumne, and Merced Rivers began in 2004 and will continue for 2 years following construction of the Lover's Leap riffles.

Two methods will be implemented to monitor adult steelhead use: (1) Hook-and-line surveys combined with the natural-tag (TNT) method, (2) snorkeling/underwater videography surveys. Both will be conducted by KDH staff and a professional fishing guide. In 2004, professional fishing guides Steve Walser and Jeff Richey were hired to conduct angling surveys. After 2004 Mr. Richey was chosen to complete angling surveys under the supervision of Mr. Dennis Hood of KDH until monitoring is completed. Surveys are conducted on each of the three rivers between January 1 and June 30 and are carried out only when water temperatures are below 60° F to minimize stress to fish. Survey periods in a particular river reach are staggered at 7-day or greater intervals to maximize the likelihood that different fish are collected or observed during each survey, and to help ensure that observed fish are behaving normally.

(1) Hook-and-line / TNT Methods

Hook-and-line methods will comply with all DFG fishing regulations including using only artificial lures with barbless hooks, a zero creel limit, and fishing only during the permitted season between January 1 and October 15. The location of each fish observed or caught will be determined with a hand held GPS unit and marked on detailed project site maps. Additional hook-and-line surveys will be conducted following storms or pulse flows when adult steelhead migrants tend to enter the river. Each fish will be weighed to the nearest ounce and its fork length measured to the nearest millimeter.

In addition, each fish caught will be recorded using the natural-tag (TNT) method. The natural-tag method involves capturing digital images of the dorsum of the head, and full lateral view of each fish caught during hook-and-line sampling. Images collected for TNT analysis help to ensure that previously caught fish are not counted more than once in population estimates. In order to capture usable images fish are placed in clear, water filled, Plexiglas box with a scalar (ruler) displayed across the back. Fish must be parallel to the ruler (lengthwise) to obtain an accurate estimation of their length. As a precaution, each fish's length will also be recorded by hand in the field. The box also helps to keep the fish as close to zero pitch, roll, and yaw as possible while images are captures, in order to expedite automated assessment of digital images. Images are sent to the Biopar (Biological Pattern Recognition) lab in Anchorage, AK where unique digital patterns and other morphometric information were recorded for each fish.

Scale samples were collected during the 2004/2005 sampling period and can be collected again if requested by the agencies. Scale samples are collected in order to assess anadromy and the river/hatchery of origin. Two scales were collected from between the fish's lateral line and dorsal fin with forceps. Scale samples were placed in a coin envelope on which the species, date, location of capture, length, and weight of the fish was recorded. Samples will be given to DFG or other resource agencies for the purpose of conducting genetic and life history studies. The fish were kept wet for the approximate 1-minute period while samples were being collected and measurements were made. Immediately after taking measurements and samples, fish were returned to the water at the capture location.

(2) Snorkel survey and Videography Methods

Snorkel surveys will be conducted when visibility is approximately 10 feet or greater. Observations will be made by two divers, one observing fish on the left half of the river and the other simultaneously observing fish on the right half of the river. Surveys may be conducted in

either a downstream or upstream direction depending on flow and water clarity. To record undisturbed fish using their habitat, a digital underwater video camera will be left unattended for approximately 1 hour at each site. The fork lengths of all fish observed will be visually estimated to the nearest inch.

CONCLUSIONS AND RECOMMENDATIONS

- 1) Placement of washed ¼ to 5-inch gravel within the spawning reach of the Stanislaus River will contribute to the CVPIA goal of at least doubling natural production of Central Valley anadromous fishes over the 1967-1991 population levels. This statement can be substantiated by the findings of CMC (2002b) that immediately following gravel bed constriction in the Lower Stanislaus River in 1999, per spawner production of juvenile Chinook salmon increased by at least 30% in all of the project gravel beds. Use of restoration riffles by Chinook salmon and adult steelhead has been monitored by KDH Environmental Services on an ongoing basis since 2004 and will continue into 2009. Dennis Hood of KDH Environmental and professional fishing guide Jeff Richey have observed steelhead trout spawning in restoration riffles during the spring 2008.
- 2) In order for placed gravel to function as spawning and rearing habitat in the long-term, a flow release schedule should be developed for the Stanislaus River to facilitate the flushing of fine particles from spawning gravels and to improve spawning and rearing conditions for Central Valley salmonids.

ACKNOWLEDGMENTS

KDH would like to thank land owner Mr. Gordon Crawford and his family for allowing access to gravel harvesting and processing areas and to restoration sites, the USFWS - Anadromous Fish Restoration Program, especially J.D. Wikert and Dr. Carl Mesick, DFG, USACE, and DWR, and the State Water Resources Board, J.D. Richey Sport Fishing for assistance with planning and placement of gravel, equipment operators Sean Smith and Warren Smith, and our field crew Chris Strazzo, Sean Bennett, Trina Nation, and Kate Milich.

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