



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

JUL 14 2015

Refer to NMFS No: WCR-2015-2703

Susan M. Fry
Area Manager
U.S. Bureau of Reclamation
Mid-Pacific Region – Bay Delta Office
801 I Street, Suite 140
Sacramento, California 95814-2536

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Lower American River Anadromous Fish Habitat Restoration Program

Dear Ms. Fry:

Thank you for your letter of March 16, 2015, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.), Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Lower American River Anadromous Fish Habitat Restoration Program.


This BO is based on the Biological Assessment provided on March 19, 2015. Based on the best available scientific and commercial information, the BO concludes that the project is not likely to jeopardize the continued existence of the federally listed endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU, threatened CCV spring-run Chinook salmon ESU, (*O. tshawytscha*) or threatened CCV steelhead DPS (*O. mykiss*) and is not likely to destroy or adversely modify their designated critical habitats. NMFS has also included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

This letter also transmits NMFS's essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 et seq.; Enclosure 2). The document concludes that the project will adversely affect the EFH of Pacific salmon in the action area and adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO as the EFH conservation recommendations.

Reclamation has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, Reclamation should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, Reclamation must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the proposed action and the measures needed to avoid, minimize, or mitigate such effects.

Please contact ENS Sean Luis in NMFS' WCR CCVAO at (916) 930-3724 or via email at Sean.M.Luis@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,


William W. Stelle, Jr.
Regional Administrator

Enclosure

Cc: Chron File – Division File Copy: 151422-WCR2015-SA00122

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation and Fish and Wildlife Coordination Act Recommendations

Lower American River Anadromous Fish Habitat Restoration Program

NMFS Consultation Number: **2015-2703**

Action Agency: U.S. Bureau of Reclamation (Reclamation)

Affected Species and NMFS' Determinations:

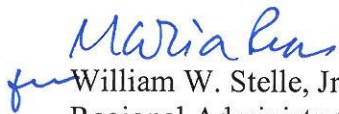
ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?*	Is Action Likely to Affect Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
California Central Valley steelhead (<i>Oncorhynchus mykiss</i>)	Threatened	Likely	No*	No	No
California Central Valley spring-run Chinook salmon (<i>O. tshawytscha</i>)	Threatened	Not Likely*	No*	No	No
Sacramento River winter-run Chinook salmon (<i>O. tshawytscha</i>)	Endangered	Not Likely*	No*	No	No

*Please refer to section 2.4 for the analysis of species or critical habitat that are not likely to be adversely affected.

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

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

Issued By:


 William W. Stelle, Jr.
 Regional Administrator

Date:

JUL 14 2015

List of Acronyms and Abbreviations

ACID – Anderson-Cottonwood Irrigation Dam
BA – Biological Assessment
BCSSRP – Battle Creek Salmon and Steelhead Restoration Program
BMPs – Best Management Practices
BO – Biological Opinion
CAMP – Comprehensive Assessment and Monitoring Program
CCV – California Central Valley
CCVAO – California Central Valley Area Office
CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Regulations
cfs – Cubic feet per second
Coleman – Coleman National Fish Hatchery
CRR – Cohort Replacement Rate
CVP – Central Valley Project
CVPIA – Central Valley Project Improvement Act
CWT – Coded Wire Tag
DNA – Deoxyribonucleic Acid
DO – Dissolved Oxygen
DPS – Distinct Population Segment
EBMUD – East Bay Municipal Utilities District
EFH – Essential Fish Habitat
EPA – Environmental Protection Agency
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FISH Group – Lower American River Fisheries and In-Stream Habitat Working Group
FL – Fork Length
FMP – Fisheries Management Plan
fps – foot per second
FR – Federal Regulations
FRFH – Feather River Fish Hatchery
FWCA – Fish and Wildlife Coordination Act
GCM – General Circulation Model
GFDL – Geophysical Fluid Dynamics Laboratory (NOAA)
ITS – Incidental Take Statement
JPE – Juvenile Production Estimate
LSNFH – Livingston Stone National Fish Hatchery
LWM – Large Woody Material
MSA – Magnussen-Stevens Act
NMFS – National Marine Fisheries Service
NTU – Nephelometric Turbidity Unit
OHWM – Ordinary High Water Mark
PAH – Polycyclic Aromatic Hydrocarbon
PCE – Primary Constituent Element
PCM – Parallel Climate Model
PSMFC – Pacific States Marine Fisheries Commission

RBDD – Red Bluff Diversion Dam
Reclamation – U.S. Bureau of Reclamation
RM – River Mile
SAFCA – Sacramento Area Flood Control Agency
SJRRP – San Joaquin River Restoration Program
SWE – Snow Water Equivalent
SWP – State Water Project
SWRCB – State Water Resources Control Board
TCP – Temperature Compliance Point
TRT – Technical Review Team (California Central Valley)
USFWS – U.S. Fish and Wildlife Service
VSP – Viable Salmonid Parameters
WRO – Water Rights Order

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

Because the Proposed Action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.).

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System <https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts>. A complete record of this consultation is on file at the NMFS California Central Valley Area Office.

1.2 Consultation History

- On March 19, 2015, the NMFS West Coast Region – California Central Valley Area Office (CCVAO) received a consultation initiation request and Biological Assessment for the Lower American River Anadromous Fish Habitat Restoration Program. Listed species and critical habitats in the Action Area include California Central Valley steelhead and their critical habitat; California Central Valley spring-run Chinook salmon and their critical habitat; and Sacramento River winter-run Chinook salmon.
- On March 24, 2015, NMFS initiated formal ESA Section 7 consultation.
- On June 3, 2015, NMFS requested additional clarification on minor aspects of the Biological Assessment including adaptive management strategy, LWD placement methods, post-project monitoring plan and concurrent restoration projects.
- On June 15, 2015, project applicant provided additional materials as requested.

1.3 Proposed Action

“Action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

An anadromous fish habitat restoration program has been proposed by Reclamation which includes several related salmonid habitat restoration activities in the Lower American River between Nimbus dam (RM 23) and the State Route 160 Bridge (RM 2). The Lower American River Fisheries and In-Stream Habitat Working Group (FISH Group), consisting of 24 different agencies including NMFS, U.S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Wildlife (CDFW), have proposed this project in conjunction with Reclamation. The purpose of the project is to restore, enhance and protect viable salmonid habitat in the Lower American River to ultimately enhance overall salmonid productivity in the Upper Sacramento River. A suite of proposed restoration activities are scheduled to occur through December 31, 2039 including gravel augmentation; side channel and flood plain modification; and placement of woody material. The proposed restoration activities include a continuation of on-going restoration projects previously authorized under the Central Valley Improvement Act of 1992 (CVPIA) Section 3604(b)(13). Since the CVPIA was passed, these restoration projects have contributed to increases in salmonid spawning and rearing habitat within the Lower American River. Eight sites have been established for continued restoration activities as well as some additional undetermined locations (Table 2).

An adaptive management strategy will be used by Reclamation to select the undetermined sites. This strategy is supported by an ongoing biological monitoring and analysis from Cramer Fish Sciences and is based on three primary variables: (1) substrate size in relation to spawning use, (2) seasonal surveying of salmonids in the Action Area and (3) characterization and quantity of benthic macro invertebrates at augmented sites. Additional parameters that inform the adaptive management strategy are hyporheic flows measured during critical life stages of salmonids in the Action Area; genetic analysis to compare fish taken from restored sites and unrestored sites; and otolith isotope analysis to determine and compare an individual's rearing stream and spawning stream.

Gravel Augmentation

Gravel restoration will occur in five of the established sites (12 acres total) as well as another 12 acres in currently unestablished locations within the Action Area between Nimbus Dam and the State Route 160 Bridge (Table 2). Gravel augmentation will generally occur once at each site pending site analysis by the FISH Group. The proposed sites may not be suitable for gravel augmentation in which case it would not occur. Also, sites may need to be replenished upon post-project site evaluation. In a given year, three proposed gravel augmentation sites will be implemented with 12,000 cubic yards of gravel per site, totaling 36,000 cubic yards placed in that year. The FISH Group will utilize the adaptive management approach as described above and will select gravel augmentation sites for a given year based on ongoing monitoring within the Lower American River.

Gravel that is placed as part of this project will be uncrushed, rounded river rock with no sharp edges and will be free of oils, clay, debris and organic material. It will be a well-graded mix designed for spawning use by salmonids and a ¼-inch screen will be placed beneath it. The median diameter (D_{50}) of the mix would be between 1 inch and 1.5 inches. Fine material would be removed on-site prior to placement to minimize sediment incursion. Materials excavated

during side channel enhancement projects may be used for gravel augmentation and would be cleaned and sorted to meet design criteria. Larger gravel and cobble that is excavated would be used to stabilize habitat features. Stockpile areas would be located near a given Project Area or within it and existing roads would be utilized for delivery of material. Stockpiles would be ½-acre or less and would occur in existing clearings to minimize disturbance to vegetation.

Gravel will be placed in the river using dump trucks and front end loaders. Bulldozers may be used to grade a gravel augmentation site prior to placement of material either to remove armoring or to meet topographic design specifications. They may also be used to distribute material in areas that cannot be accessed by front end loaders. Front end loaders will be used as practicable to place materials in the river. They will begin placement at the river access site and place subsequent loads further into the river. This will allow them to drive onto newly placed gravel and avoid disturbing fine sediment. Off-road dump trucks will transport gravel material from stockpile areas to the front end loader. This work would utilize 2-3 front end loaders and would occur for 4-6 weeks at a time depending on the project site.

Floodplain and Side Channel Enhancements

Side channel enhancements will occur in all eight of the proposed project sites for a total of approximately 43.1 acres of new or re-established floodplain or side channel habitat. An additional 7 acres of side channel or floodplain habitat will be restored or created at sites that are yet to be determined. These sites would be within the Action Area between Nimbus Dam and the State Route 160 Bridge and would include activities of similar size, type and construction method.

Side channel and floodplain habitat enhancements will consist of new or restored habitat designed to function optimally under flows within the main channel ranging between 3,250 cubic feet per second (cfs) and 7,000 cfs. Physical characteristics of the new habitat will vary depending on the project site. Average water velocities will range between 1 foot per second (fps) and 5 fps, water depths will average between one and three feet and channel widths will range between 12 feet and 50 feet. Existing channels may be expanded beyond that range. Floodplain and side channel habitats would be created, reconnected or modified by excavation using heavy construction equipment including bulldozers, front end loaders and excavators. Excavated gravel material may be sorted and placed into side channel or main channel areas for habitat enhancement so long as it meets design standards. Gravel may also be placed to facilitate flow into newly-created or restored side channel areas. Fine sediment from excavated material would be distributed over floodplain areas to assist in the establishment and growth of vegetation. Gently sloping beaches would be created along side channel areas and main channel areas to provide juvenile rearing habitat through a range of flows.

Placement of Woody Material

The third component of the restoration activities proposed in this project is placement of large woody material (LWM) in the Action Area between Nimbus Dam and the State Route 160 Bridge. Each of the eight proposed project sites will include LWM placement as well as three unspecified locations per year (Table 2). Woody material would be placed within main channel

and side channel areas to enhance habitat complexity, foraging, cover and rearing habitat for juvenile salmonids. LWM will also be used to facilitate scour by creating or expanding pool habitat. Material with rootwads will be positioned such that the rootwad faces an existing pool, maximizing scour and habitat complexity. Material will be partially buried in sediment or keyed into the river bank and no artificial materials will be used for anchoring. LWM would also facilitate accumulation of debris and reduction of flow velocities, further enhancing habitat complexity and directly benefiting salmonid fry following egg emergence. All woody material would be placed below the ordinary high water mark (OHWM) within wetted channel areas. Material will have a maximum size of 40 feet in length and 2 feet in diameter and would include the following taxa: willow (*Salix* spp.), cottonwood (*Populus* spp.), alder (*Alnus* spp.), oak (*Quercus* spp.), ash (*Fraxinus* spp.), walnut (*Juglans* spp.) and conifer (Class Pinopsida). An intact rootwad or crown and at least one trunk will be placed at each site.

LWM will be placed in existing main channel areas as well as newly created side channel areas. Using the adaptive management strategy as described above, LWM placement will be determined by the FISH group based on ongoing site monitoring. Placement sites will be accessed using existing roads. Up to 100 log structures will be placed within the Action Area per year, including unspecified site locations. LWM design will be consistent with the California Salmonid Stream Habitat Restoration Manual, 4th Edition (CDFG 2010).

1.4 Avoidance and Minimization Measures

Construction Planning

In-water construction activities will generally occur between July 1st and October 30th with consideration given to spatial and temporal distribution of spawning CCV steelhead adults, rearing CCV juvenile steelhead, rearing juvenile California Central Valley (CCV) spring-run, rearing juvenile Sacramento River winter-run and incubating CCV steelhead eggs (Table 1). This time window is designed to minimize adverse effects to listed fish in a given Project Area. There is at least one lifecycle stage of steelhead existing in the Action Area year-round. Juvenile steelhead are most likely to be present in the Action Area during construction. Construction activities will occur year-round in side channel and floodplain areas where there is no connection to any active wetted channel. Gravel berms may be constructed to divert flows from construction activities. Measures will be taken to ensure that construction equipment, supplies, excavated material, gravel and other materials associated with the project are staged and stockpiled in designated areas. In-water work would be conducted with flows of 5,000 cfs or lower to minimize construction-related impacts in active channels.

Table 1. Temporal occurrence of listed fish species in the Lower American River by life stage.
From Reclamation 2015.

	Construction Window											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
California Central Valley Steelhead												
Adult Immigration												
Adult Holding												
Spawning												
Egg Incubation												
Juvenile Rearing												
Juvenile Emigration												
Sacramento River Winter-Run Chinook Salmon												
Juvenile Non-Natal Rearing												
Juvenile Emigration												
Central Valley Spring-Run Chinook Salmon												
Juvenile Non-Natal Rearing												
Juvenile Emigration												
		= Presence in the Action Area										
		= Absence in the Action Area										

Source: SWRI 2001; PSMFC 2014 a,b; Snider et al. 1998; Snider and Titus 2000b, 2001b, 2002.

Sedimentation and Turbidity

Best management practices (BMPs) and strategic construction planning will be put in place to avoid and minimize turbidity and sedimentation effects to listed fish species and their critical habitat. BMPs for erosion and sediment control will be implemented at all project sites where a risk of sediment incursion exists. BMPs include placement of straw bales, straw wattles and silt fences at source sites for potential sedimentation including stockpiles, eroded soil and/or substrate and sediment-laden runoff. Operation of construction equipment within active wetted channels will be minimized. When operation of heavy machinery within active wetted channels is required for gravel or LWM placement, a gravel pad will be placed within the stream as practicable to avoid disturbance of substrates. Turbidity and settleable solids will be monitored and measured according to water quality permits that will be issued for each Project Area. If acceptable levels are exceeded, work will be suspended to allow turbidity to subside. In-water work that may cause turbidity within 200 feet upstream of active redds will be avoided. Gravel mobilization, sorting and loading will be done in areas that are outside the wetted channel or are disconnected from any wetted channel. This will avoid incursion of sediment, gravel or other debris into any stream habitat. Gravel that is used in augmentation projects will be uncrushed, rounded “natural river rock” with no sharp edges. Fine sediments will be removed from gravel material and it will be free of oils, clay, debris and organic material. Gravel that is sorted and used from excavated material will meet these same standards. Disturbed areas adjacent to the river deemed to be unstable will be either covered with river rock, vegetated with native plant

species and/or mulched with certified weed-free hay following project completion.

Pollution and Hazardous Materials

Pollution and incursion of hazardous materials into the aquatic environment will be minimized through implementation of BMPs, careful construction planning and compliance with local, state and federal regulations on the use of hazardous materials. Equipment working within or near an active channel will be thoroughly cleaned and inspected to prevent hazardous materials from entering the American River. Heavy equipment will also use biodegradable hydraulic fluid. All equipment and machinery will be inspected daily for leaks and all leaks will be repaired prior to commencement of activities in sensitive areas. Equipment refueling and maintenance will be restricted to designated areas away from the American River and associated environmentally sensitive areas. Reclamation and other personnel will regularly monitor equipment use for environmental compliance within the Action Area. Spill response kits will be staged adjacent to locations of equipment operation and hazardous materials storage sites. Work crews will be trained on the use of the kits and of proper spill response procedures.

Effects to Riparian Vegetation

Through careful construction planning, crew training and targeted post-project restoration efforts, effects to riparian vegetation within the Action Area will be minimized to the maximum extent practicable. Equipment used for the project will be thoroughly cleaned off-site to remove any invasive plant material prior to construction activities within the Action Area. They will also be inspected and cleaned to prevent the transport of invasive aquatic biota prior to entering the Action Area. Environmentally sensitive areas, sensitive plant species and wetland areas will be avoided during project activities to the extent practicable. High-visibility fencing will be placed around these areas to minimize construction-related disturbance. Material will be stockpiled in existing clearings and will occupy an area no larger than one half acre to minimize disturbance to plant biota.

Interrelated or Interdependent Actions

“Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interdependent or interrelated activities associated with the proposed action.

1.5 Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

Eight sites along the Lower American River have been selected between Nimbus Dam (RM 23) and the State Route 160 Bridge (RM 2) for habitat restoration activities including gravel augmentation, placement of LWM and side channel/floodplain habitat enhancement. The Action Area for the restoration program as a whole is defined by the segment of the Lower American

River bounded by Nimbus Dam and the State Route 160 Bridge, including side channel and floodplain areas that are to be impacted by construction activities, sedimentation or other construction-related disturbance. The eastern extent of the Action Area lies at 38.636190°N, -121.219783°. The western extent lies at 38.596166°, -121 476304°. Each of the eight sites will be defined as an individual Project Site. In addition to the eight Project Sites selected, the following restoration activities are planned at locations that are yet to be determined: gravel augmentation (additional 10 sites with 12 acres per site), LWM placement (100 log structures per year at 3 additional sites) and side channel/floodplain enhancement (additional 10 sites with 4 new/modified side channels per site). Undetermined sites will be selected using the adaptive management plan described above. The total area to be impacted throughout the course of the activities is 257.1 acres.

Project Site Descriptions:

Site 1: Upper Sunrise (RM 21.5)

This site includes a 3/4-mile reach of the Lower American River between the upper Sunrise side channel and the 2012 gravel placement and side channel enhancement project (Figure 1). The adjacent floodplain area along the south side of the river is also included in the Project Area. Previous restoration projects were implemented within the Project Area from 2010-2012 including side channel connection at the downstream end of the Project Area, riffle and island creation midway through the Project Area and additional side channel creation and gravel augmentation at the upstream end of the Project Area. Woody material was also placed in restored areas of the reach during that time. Additional side channel creation and flood plain modification will occur at this site. Additional gravel will be placed at the 2010-2011 placement site to enhance riffle habitat. Side channel connectivity at the downstream end of the Project Area will be monitored and maintained. A total of approximately 3.5 acres will be impacted by gravel augmentation operations over a 4-week timeline; 12,000 cubic yards of material will be added. A total of approximately 3 acres will be impacted by side channel creation and floodplain modification operations over a 4-week timeline and a total of 25,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.

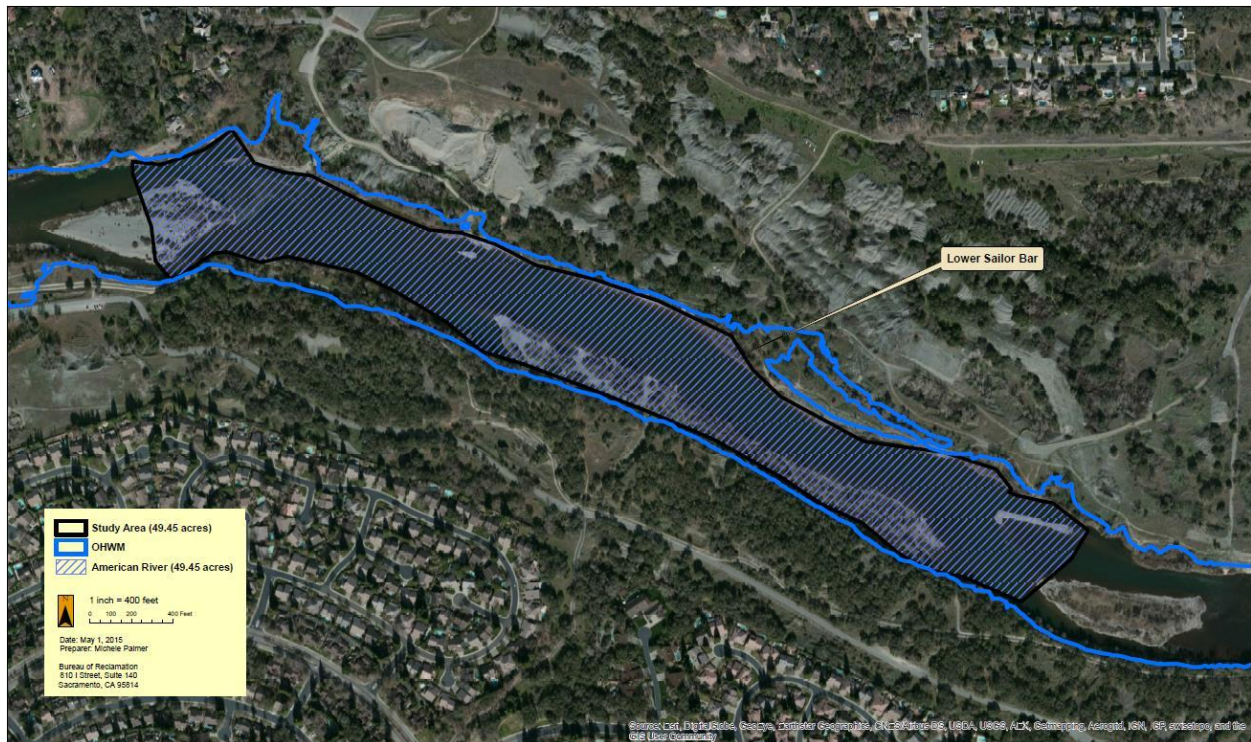


Figure 1. Upper Sunrise site (Site 1).

Site 2: Sunrise (RM 20.4)

This site includes the reach of the Lower American River between Sunrise Boulevard Bridge and the old Fair Oaks Bridge (Figure 2). The site includes riffle habitat that experiences heavy spawning activity, pool habitat upstream of the riffle and low-elevation floodplain habitat along the south side of the river. A juvenile isolation area occurs within the floodplain. This isolation area will be eliminated through side channel creation and flood plain modification. Gravel will be placed upstream of the existing riffle and woody material will be placed along the south side of the river. A total of approximately 1.5 acres will be impacted by gravel augmentation operations over a 4-week timeline; 7,000 cubic yards of material will be added. A total of approximately 1.5 acres will be impacted by side channel creation and floodplain modification operations over a 4-week timeline and a total of 10,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.



Figure 2. Sunrise site (Site 2).

Site 3: Sacramento Bar (RM 18.6)

This site includes the Sacramento Bar and the adjacent reach of the Lower American River (Figure 3). Spawning currently occurs primarily along the edges of the channel in the upstream end of the Project Area. Side channel creation and flood plain modification will occur on the existing gravel bar. Gravel from the bar will be sorted and placed in the main channel along the east side of the bar. Existing armored substrate will be pushed into deeper water. A total of approximately 1.5 acres will be impacted by gravel augmentation operations over a 4-week timeline; 10,000 cubic yards of material will be added. A total of approximately 10 acres will be impacted by side channel creation and floodplain modification operations over an 8-week timeline and a total of 50,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.



Figure 3. Sacramento Bar (Site 3).

Site 4: El Manto (RM 17.9)

This site includes extensive floodplain habitat along the left side of the Lower American River upstream and downstream of the San Juan Rapids (Figure 3). Spawning currently occurs at various riffle habitats throughout this Project Area. Side channel creation and floodplain modification will occur along the left bank of the river. An isolation area at the downstream end of the project site will be modified and permanently connected to the main channel. Armored

substrate downstream of the San Juan rapids will be replaced with spawning gravel. Woody material will be placed in side channel areas. A total of approximately 1.8 acres will be impacted by gravel augmentation operations over a 4-week timeline; 10,000 cubic yards of material will be added. A total of approximately 7 acres will be impacted by side channel creation and floodplain modification operations over an 8-week timeline and a total of 35,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.



Figure 4. El Manto (Site 4).

Site 5: Ancil Hoffman (RM 15.8)

This site includes a large floodplain area along the right side of the river. Riffle habitat occurs in the main channel and spawning occurs mostly along the left side of the channel adjacent to the island at the upstream end of the Project Area. Side channel creation and floodplain modification will occur along the right bank and gravel augmentation will occur in the main channel. Oversized substrate material at the upstream end of the Project Area will be relocated to deeper water or on to the island and replaced with spawning gravel. The newly created side channel will be deeper than the existing one and woody material will be placed in side channel areas. A total of approximately 1.7 acres will be impacted by gravel augmentation operations over a 4-week timeline; 9,000 cubic yards of material will be added. A total of approximately 5 acres will be impacted by side channel creation and floodplain modification operations over a 6-week timeline and a total of 30,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.

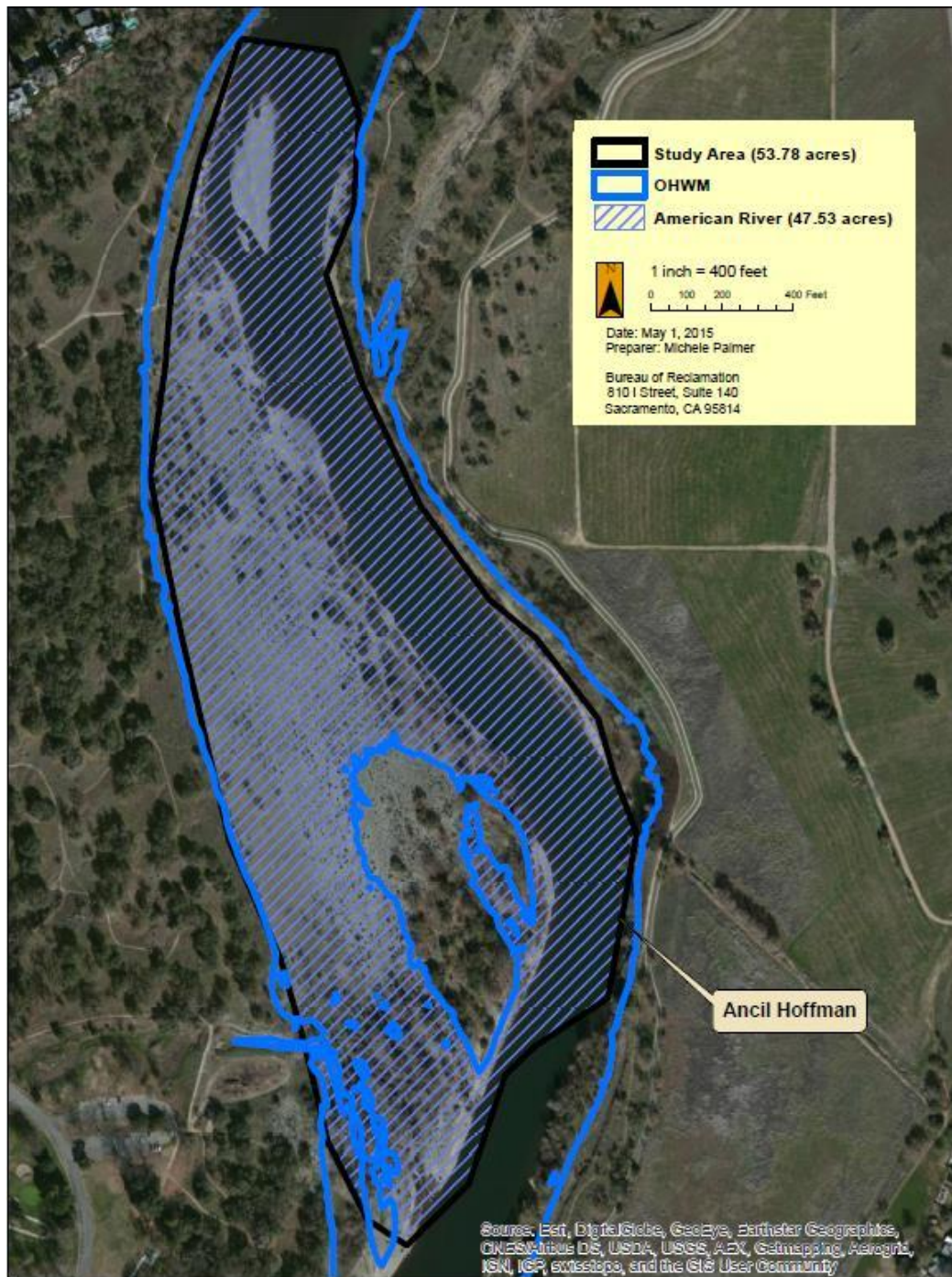


Figure 5. Ancil Hoffman (Site 5).

Site 6: Upper River Bend (RM 14.5)

This site includes a one mile reach of the Lower American River with floodplain habitat occurring on both sides. Low density spawning occurs at riffle areas throughout the Project Area. Side channel creation and floodplain modification will occur on both sides of the river. Gravel augmentation will occur in the main channel and LWM will be placed in side channel habitat areas. This Project Area contains the confluence of Cordova Creek where a locally

managed restoration project has been implemented to remove a drainage ditch and restore stream habitat (see ‘Cumulative Effects’ section 2.5). A total of approximately 2 acres will be impacted by gravel augmentation operations over a 4-week timeline; 10,000 cubic yards of material will be added. A total of approximately 7 acres will be impacted by side channel creation and floodplain modification operations over an 8-week timeline and a total of 35,000 cubic yards of material will be removed. Restoration activities will occur once at this site and replenishment will occur as needed.

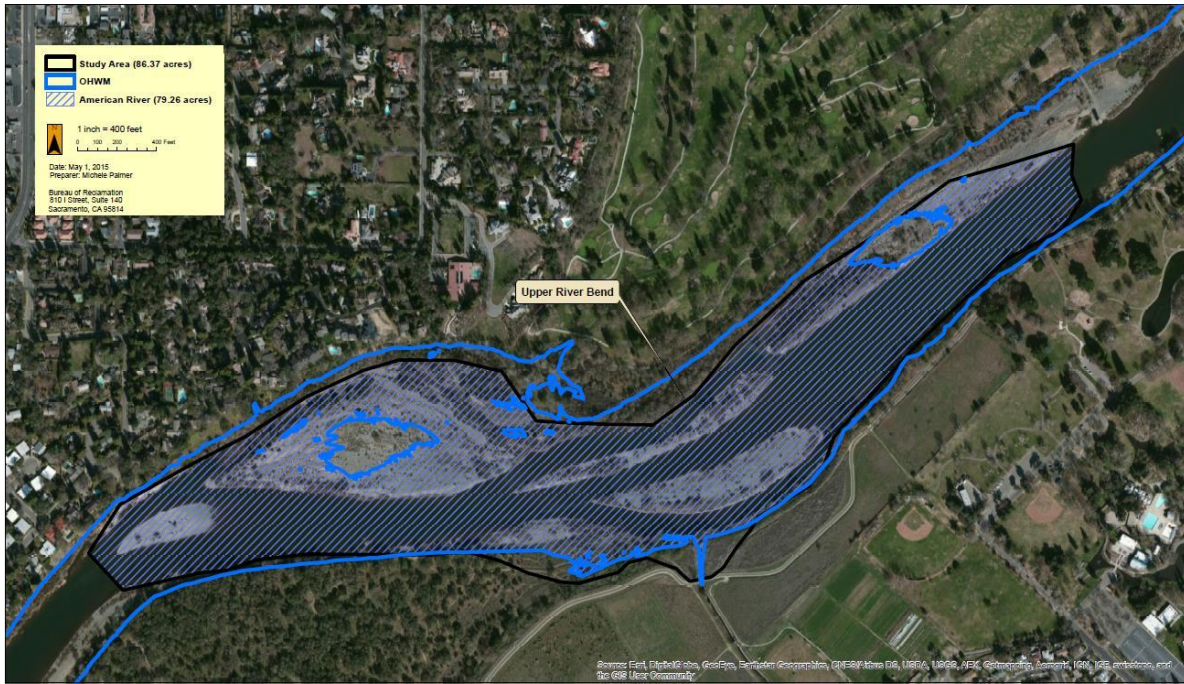


Figure 6. Upper River Bend (Site 6).

Site 7: Howe to Watt (RM 8.5 – 9.2)

This site includes a low elevation area along the left side of the river with existing side channel and backwater areas that become disconnected during low flow conditions. Connectivity will be increased between backwater areas and the main channel. Isolation areas will be modified to increase connectivity. No work will occur in the main channel. Woody material will be placed in the side channel habitat. A total of approximately 2.6 acres will be impacted by side channel creation and floodplain modification operations over a 4-week timeline and a total of 10,000 cubic yards of material will be removed. Restoration activities will occur once at this site.

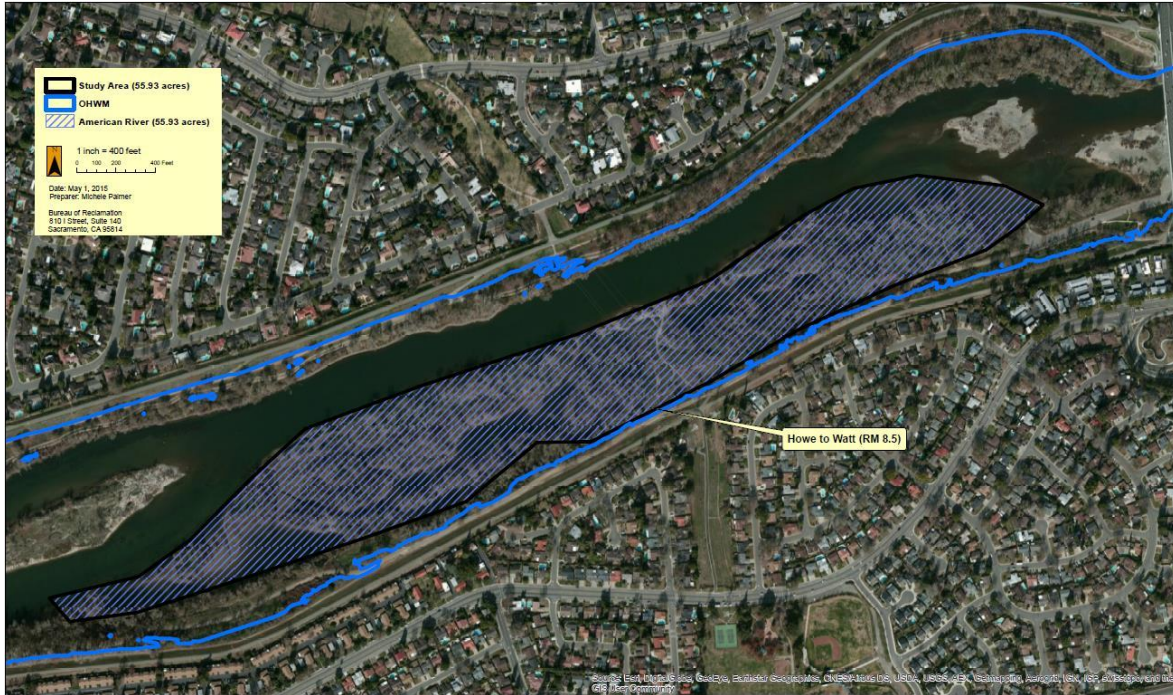


Figure 7. Howe to Watt (Site 7).

Site 8: Paradise Beach (RM 5)

This site includes a large floodplain area along the left bank of the river. Side channels will be created and the floodplain will be modified so that it becomes inundated under a range of flows. Isolation ponds that presently occur in the floodplain will be connected to the main channel during most flows. No work will occur in the main channel within this Project Area. This reach of the Lower American River becomes inundated when flows in the Sacramento River exceed 30,000 cfs measured at Freeport. A total of approximately 7 acres will be impacted by side channel creation and floodplain modification operations over a 7-week timeline and a total of 35,000 cubic yards of material will be removed. Restoration activities will occur once at this site.



Figure 8. Paradise Beach (Site 8).

Unspecified Locations:

Additional side channel creation, flood plain modification/enhancement and placement of woody material will occur within the Action Area (see Table 2). 10 gravel augmentation sites, 10 side channel creation and floodplain enhancement sites and 3 LWM placement sites will be selected based on the adaptive management strategy described in Section 1.3. A total of approximately 12 acres per site will be impacted by gravel augmentation operations and each project will require approximately 5 weeks. 10,000 cubic yards of gravel will be added to each site and projects will occur at a frequency of up to one per year as needed. A total of approximately 7 acres per site will be impacted by side channel creation and floodplain modification operations and each project will require 2-6 weeks to complete. 4 new side channels will be created at each site and restoration actions will occur only once per site. Volume of material removed for each site has yet to be determined and will be based on the adaptive management strategy. A total of approximately 4 acres per site will be impacted by LWM placement and each project will require 1-3 weeks to complete. A total of 100 log structures will be placed per year and restoration actions will occur only once per site.

Table 2. – Summary of proposed Project Areas and respective restoration actions within each Project Area. *From Reclamation (2015)*

Site	RM	Restoration Type	Method ^a	Approximate Maximum Dimensions ^b	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 1 - Upper Sunrise ^d	21.5	Gravel Augmentation; Woody Material	RS, WM	3.5 acres	12,000 yd ³	Once, replenish as needed	4 weeks
		Side Channel/Floodplain Habitat	EX, WM	3 acres	25,000 yd ³	Once, revisit as needed	4 weeks ^e
Site 2 - Sunrise	20.4	Gravel Augmentation; Woody Material	RS, WM	1.5 acres	7,000 yd ³	Once, revisit as needed	4 weeks
		Side Channel/Floodplain Habitat	EX, WM	1.5 acres	10,000 yd ³	Once, revisit as needed	4 weeks ^e
Site 3 - Sacramento Bar	18.6	Side Channel Creation; Floodplain Modification	EX, WM	10 acres	50,000 yd ³	Once, revisit as needed	8 weeks ^e
		Gravel Augmentation; Woody Material	RS, WM	1.5 acres	10,000 yd ³	Once, revisit as needed	4 weeks
Site 4 - El Manto	17.9	Side Channel Creation; Floodplain Modification	EX, WM	7 acres	35,000 yd ³	Once, revisit as needed	8 weeks ^e
		Gravel Augmentation; Woody Material	WM, RS	1.8 acres	10,000 yd ³	Once, revisit as needed	4 weeks
Site 5 - Ancil Hoffman	15.8	Side Channel Creation; Floodplain Modification	EX, WM	5 acres	30,000 yd ³	Once, revisit as needed	8 weeks ^e
		Gravel Augmentation; Woody Material	WM, RS	1.7 acres	9,000 yd ³	Once, revisit as needed	4 weeks
Site 6 - Upper River Bend	14.5	Side Channel Creation; Floodplain Modification	EX, WM	7 acres	35,000 yd ³	Once, revisit as needed	8 weeks ^e
		Gravel Augmentation; Woody Material	WM, RS	2 acres	10,000 yd ³	Once, revisit as needed	4 weeks
Site 7 - Howe to Watt	8.5-9.2	Side Channel Reconnection; Woody Material	EX, WM	2.6 acres	10,000 yd ³	Once	4 weeks ^e
		Side Channel Creation; Floodplain Modification; Woody Material	EX, WM	7 acres	35,000 yd ³	Once	7 weeks ^e
Unspecified Locations ^e	2-23	Gravel Augmentation	RS, WM	Per site: 12 acres	12,000 yd ³ per site; 10 sites	Up to once a year, as needed	5 weeks
		Side Channel Creation/Modification; Floodplain Modification	EX, WM	Per site: 7 acres	4 new/modified side channels per site; 10 sites	Once per site	2-6 weeks ^e
		Woody Material	WM	Per site: 4 acres	Per Year: 10 log structures; 3 sites	Once	1-3 weeks ^e

^a Method codes are: RS = Riffle Supplementation; EX = Excavation; WM = Woody Material Placement

^b Number represents potential Action Area; the actual project footprint location within the action area is unknown but will be smaller.

^c Values represent overall construction timeframe, actual duration of instream work will be less than half of this timeframe (i.e. less than 2-4 weeks dependent on the project type and site).

^d This restoration site encompasses three locations where some previous restoration work has occurred.

^e Three previously restored sites (Nimbus, Upper Sailor Bar, and River Bend; Reclamation 2008) may also need future maintenance consistent with the characteristics identified under specified locations.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

The proposed action is not likely to adversely affect CCV spring-run Chinook or their critical habitat, Sacramento River winter-run or CCV steelhead critical habitat. The analysis is found in the "Not Likely to Adversely Affect" Determinations section (2.11).

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.¹

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using best available information and an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.

¹ Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions using best available information.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the Proposed Action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species’ likelihood of both survival and recovery. The species status section also helps to inform the description of the species’ current “reproduction, numbers, or distribution” as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

The following Federally listed species evolutionarily significant units (ESU), distinct population segment (DPS) and designated critical habitat occur in the action area and have the potential to be affected by the action (Table 3):

Table 3. ESA Listing History.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Chinook salmon (<i>Oncorhynchus tshawytscha</i>)	Central Valley spring-run ESU	9/16/1999 64 FR 50394 Threatened	6/28/2005 70 FR 37160 Threatened	9/2/2005 70 FR 52488
Chinook salmon (<i>O. tshawytscha</i>)	Sacramento River winter-run ESU	1/4/1994 59 FR 440 Endangered	6/28/2005 70 FR 37160 Endangered	6/16/1993 58 FR 33212
Steelhead (<i>O. mykiss</i>)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488

2.2.1 California Central Valley Steelhead distinct population segment (DPS)

- Originally listed as threatened on March 19, 1998 (63 FR 13347)
- Reaffirmed as threatened August 15, 2011 (76 FR 157)
- Critical habitat designated September 2, 2005 (70 FR 52488)

The Federally listed DPS of CCV steelhead and designated critical habitat occurs in the action area and may be affected by the proposed Project.

A. Species Listing and Critical Habitat Designation History

CCV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, NMFS reaffirmed its status as threatened and also listed the Feather River Hatchery and Coleman National Fish Hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid evolutionarily significant units (ESUs) and DPSs, NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011a). Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488).

B. Critical Habitat and Primary Constituent Elements (PCEs) for CCV Steelhead

Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta (Figure I). Currently the CCV steelhead DPS and critical habitat extends up the San Joaquin River up to the confluence with the Merced River. 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). Critical habitat for CCV steelhead is defined as specific areas that contain the primary constituent elements (PCEs) and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CCV steelhead.

1. Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, egg incubation, and larval development. Most of the available spawning habitat for steelhead in the Central Valley is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing below the dams. 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 survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams, 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 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 and downstream passage of adults, and the emigration of smolts. 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 this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

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. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

C. Description of Viable Salmonid Population (VSP) Parameters

As an approach to determining the conservation status of salmonids, NMFS has developed a framework for identifying attributes of a viable salmonid population (VSP). The intent of this framework is to provide parties with the ability to assess the effects of management and conservation actions and ensure their actions promote the listed species' survival and recovery. This framework is known as the VSP concept (McElhany et al. 2000). The VSP concept measures population performance in term of four key parameters: abundance, population growth rate, spatial structure, and diversity.

1. Abundance

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s the steelhead run size had declined to about 40,000 adults (McEwan 2001). 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 the Red Bluff Diversion Dam (RBDD) declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990's, 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, and comprehensive steelhead population monitoring has not taken place in the Central Valley since then, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being planned (Eilers et al. 2010).

Current abundance data is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Coleman National Fish Hatchery (Coleman) operates a weir on Battle Creek, where all upstream fish movement is blocked August through February, during the hatchery spawning season. Counts of steelhead captured at and passed above this weir represent one of the better data sources for the Central Valley DPS. However, changes in hatchery policies and transfer of fish complicate the interpretation of these data. In 2005, per NMFS request, Coleman stopped transferring all adipose-fin clipped steelhead above the weir, resulting in a large decrease in the overall numbers of steelhead above the weir in recent years (Figure 10). In addition, in 2003, Coleman transferred about 1,000 clipped adult steelhead to Keswick Reservoir, and these fish are not included in the data. The result is that the only unbiased time series for Battle Creek is the number of unclipped (wild) steelhead since 2001, which have declined slightly since that time, mostly because of the high returns observed in 2002 and 2003.

Prior to 2002, hatchery and natural-origin steelhead in Battle Creek were not differentiable, and all steelhead were managed as a single, homogeneous stock, although USFWS believes the majority of returning fish in years prior to 2002 were hatchery-origin. Abundance estimates of

natural-origin steelhead in Battle Creek began in 2001. These estimates of steelhead abundance include all *O. mykiss*, including resident and anadromous fish (Figure 9).

Steelhead returns to Coleman NFH have fluctuated greatly over the years. From 2003 to 2012, the number of hatchery origin adults has ranged from 624 to 2,968. Since 2003, adults returning to the hatchery have been classified as wild (unclipped) or hatchery produced (adipose clipped). Wild adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200-500 fish each year (Figure 10).

Redd counts are conducted in the American River and in Clear Creek (Shasta County). An average of 151 redds have been counted in Clear Creek from 2001 to 2010 (Figure IV; data from USFWS), and an average of 154 redds have been counted on the American River from 2002-2010 (figure V; data from Hannon and Deason 2008, Hannon et al. 2003, Chase 2010).

The East Bay Municipal Utilities District (EBMUD) has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season, and the overall trend is a slight increase. However, it is generally believed that most of the *O. mykiss* spawning in the Mokelumne River are resident fish (Satterthwaite et al. 2010), which are not part of the CCV steelhead DPS.

The returns of steelhead to the Feather River Hatchery have decreased greatly over time, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively (Figure 13). This is despite the fact that almost all of these fish are hatchery fish, and stocking levels have remained fairly constant, suggesting that smolt and/or ocean survival was poor for these smolt classes. The average return in 2006-2010 was 649, while the average from 2001 to 2005 was 1,963. However, preliminary return data for 2011(CDFG) shows a slight rebound in numbers, with 712 adults returning to the hatchery through April 5th, 2011.

The Clear Creek steelhead population appears to have increased in abundance since Saeltzer Dam was removed in 2000, as the number of redds observed in surveys conducted by the USFWS has steadily increased since 2001 (Figure 12). The average redd index from 2001 to 2011 is 157, representing somewhere between 128 and 255 spawning adult steelhead on average each year. The vast majority of these steelhead are wild fish, as no hatchery steelhead are stocked in Clear Creek.

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the proportion of wild steelhead relative to hatchery steelhead (CDFG; <ftp://delta.dfg.ca.gov/salvage>). The overall catch of steelhead at these facilities has been highly variable since 1993 (Figure VIII). The percentage of unclipped steelhead in salvage has also fluctuated, but has generally declined since 100 percent clipping started in 1998. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated.

The years 2009 and 2010 showed poor returns of steelhead to the Feather River Hatchery and Coleman Hatchery, probably due to three consecutive drought years in 2007-2009, which would

have impacted parr and smolt growth and survival in the rivers, and possibly due to poor coastal upwelling conditions in 2005 and 2006, which strongly impacted fall-run Chinook salmon post-smolt survival (Lindley et al. 2009). Wild (unclipped) adult counts appear not to have decreased as greatly in those same years, based on returns to the hatcheries and redd counts conducted on Clear Creek, and the American and Mokelumne Rivers. This may reflect greater fitness of naturally produced steelhead relative to hatchery fish, and certainly merits further study.

Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2011 that no clear trend is present, other than the fact that the numbers are still far below those seen in the 1960's and 1970's, and only a tiny fraction of the historical estimate. Returns of natural origin fish are very poorly monitored, but the little data available suggest that the numbers are very small, though perhaps not as variable from year to year as the hatchery returns.

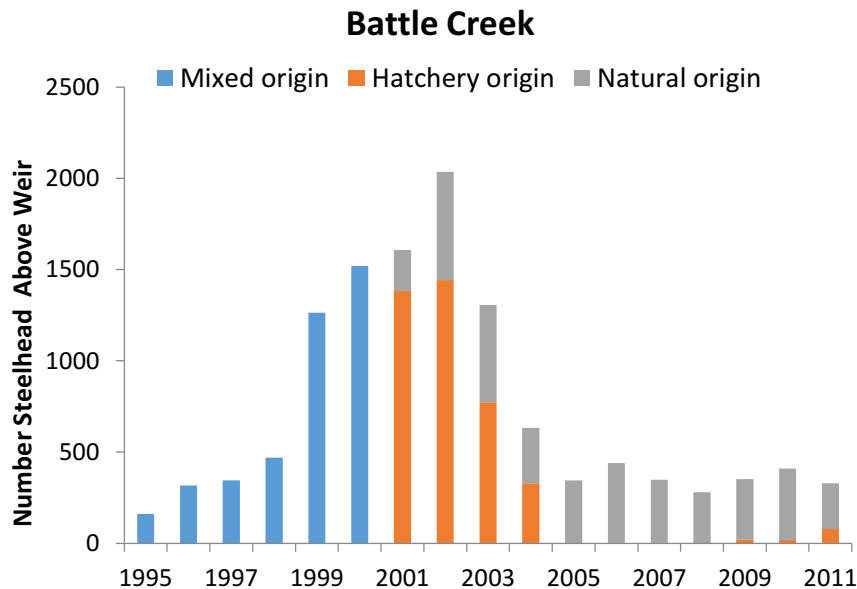


Figure 9. Steelhead returns to Battle Creek from 1995-2009. Starting in 2001, *O. mykiss* were classified as either wild (unclipped) or hatchery produced (clipped). Includes fish passed above the weir during broodstock collection and fish passing through the fish ladder March 1 to August 31. Data are from USFWS.

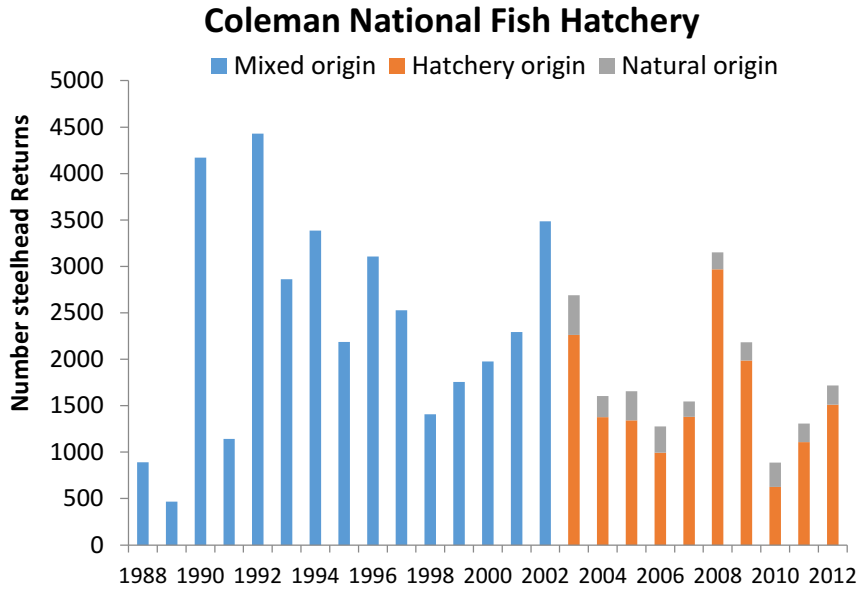


Figure 10. Annual steelhead returns to Coleman National Fish Hatchery. Adipose fin-clipping of hatchery smolts started in 1998 and since 2003 all returns have been categorized either natural or hatchery origin.

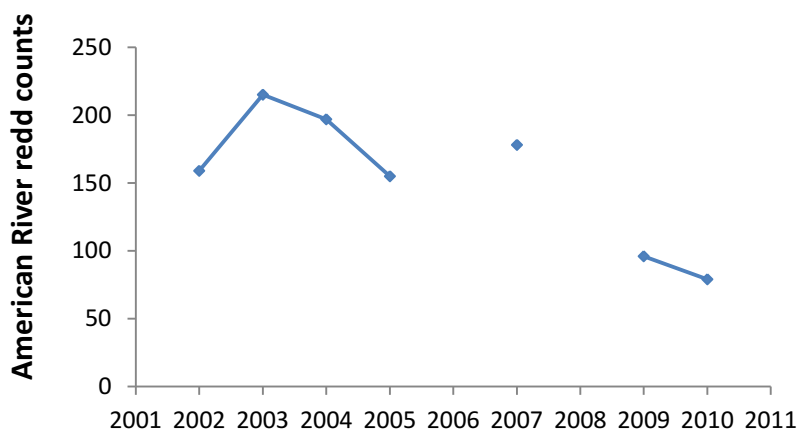


Figure 11. American River steelhead redd counts from USBR surveys 2002–2010. Surveys could not be conducted in some years due to high flows and low visibility.

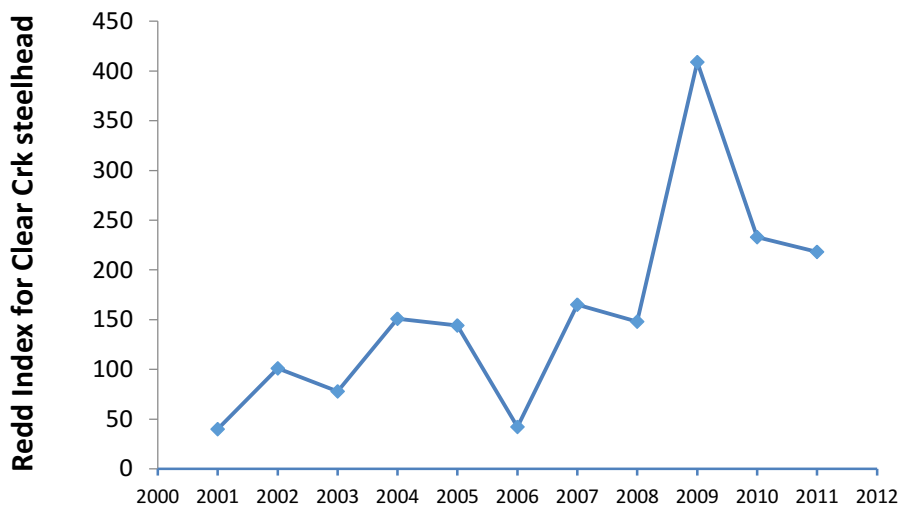


Figure 12. Clear Creek steelhead redd counts from USFWS surveys 2001–2011.

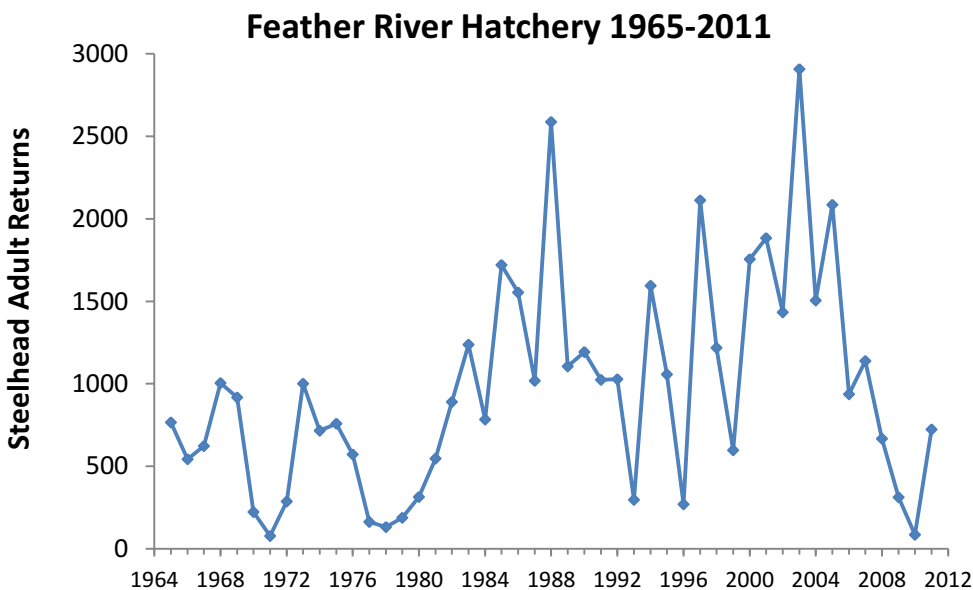


Figure 13. Feather River Hatchery steelhead returns 1965–2011. Almost all fish are hatchery origin.

2. Productivity

100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and

USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams et al. 2011).

Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Good et al. (2005) made the following conclusion based on the Chipps Island data:

"If we make the fairly generous assumptions (in the sense of generating large estimates of spawners) that average fecundity is 5,000 eggs per female, 1 percent of eggs survive to reach Chipps Island, and 181,000 smolts are produced (the 1998-2000 average), about 3,628 female steelhead spawn naturally in the entire Central Valley. This can be compared with McEwan's (2001) estimate of 1 million to 2 million spawners before 1850, and 40,000 spawners in the 1960s".

In the Mokelumne River, EBMUD has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season (NMFS 2011a). Based on data from these surveys, the overall trend suggests that redd numbers have slightly increased over the years (2000-2010). However, according to Satterthwaite et al. (2010), it is likely that most of the *O. mykiss* spawning in the Mokelumne River are non-anadromous (or resident) fish rather than steelhead. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production. In the past, this hatchery received fish imported from the Feather River and Nimbus hatcheries (Merz 2002). However, this practice was discontinued for Nimbus stock after 1991, and discontinued for Feather River stock after 2008. Recent genetic studies show that the Mokelumne River Hatchery steelhead are closely related to Feather River fish, suggesting that there has been little carry-over of genes from the Nimbus stock.

Analysis of data from the Chipps Island midwater trawl conducted by the USFWS 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. Beginning in 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-clipped steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. The proportion of hatchery fish exceeded 90 percent in 2007, 2010, and 2011 (Figure 14). 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.

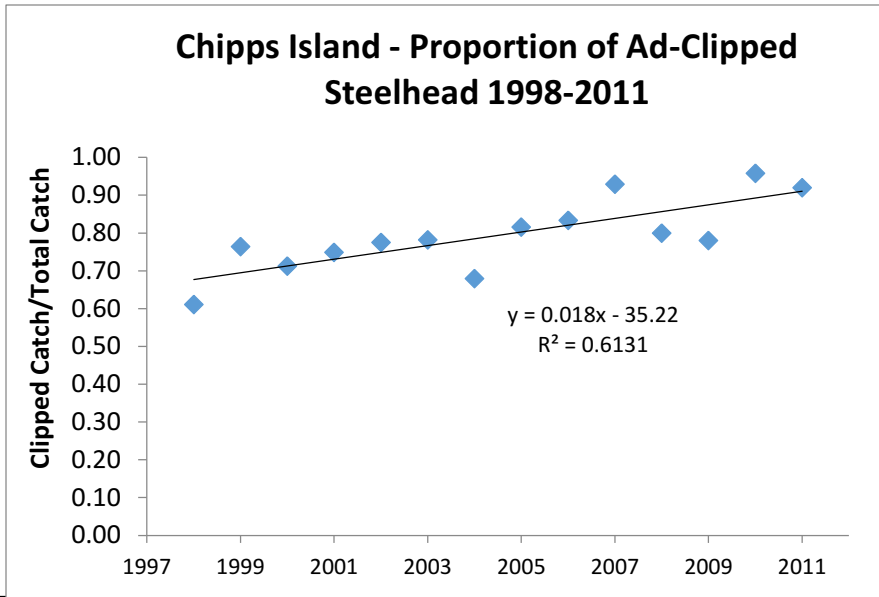


Figure 14. Catch of steelhead at Chippis Island in the USFWS midwater trawl survey 1998–2011. Fraction of the catch bearing an adipose fin clip. All hatchery steelhead have been marked starting in 1998.

Salvage of juvenile steelhead at the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities also indicates a reduction in the natural production of steelhead (figure 15). The percentage of unclipped juvenile steelhead collected at these facilities declined from 55 percent to 22 percent over the years 1998 to 2010 (NMFS 2011a).

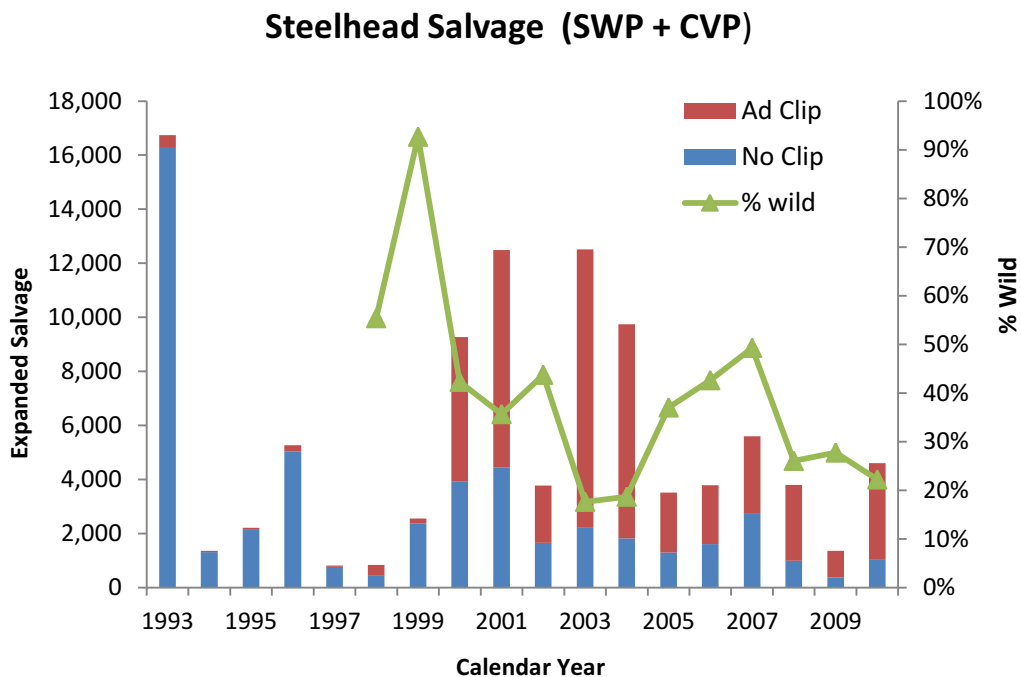


Figure 15. Steelhead salvaged in the Delta fish collection facilities from 1993 to 2010. All hatchery steelhead have been adipose fin-clipped since 1998. Data are from CDFG, at: <ftp.delta.dfg.ca.gov/salvage>.

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV 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 2011a). Since 2003, fish returning to the Coleman National Fish Hatchery have been identified as wild (adipose fin intact) or hatchery produced (ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 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.

3. Spatial Structure

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the Central Valley is now upstream of impassible dams (Lindley et al. 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed. Due to their superior jumping ability, the timing of their upstream migration which coincided with the winter rainy season, and their less restrictive preferences for spawning gravels, steelhead could have utilized at least hundreds of miles of smaller tributaries not accessible to the earlier-spawning salmon (Yoshiyama et al. 1996). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead were found as far south as the Kings River (and possibly Kern River systems in wet years) (McEwan 2001). Native American groups such as the Chunut people have had accounts of steelhead in the Tulare Basin (Latta 1977).

Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005; NMFS 2011a). Zimmerman et al. (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries.

Monitoring has detected small numbers 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 Fish Sciences 2000). A counting weir has been in place in the Stanislaus River since 2002 and in the Tuolumne River since 2009 to detect adult salmon; these weirs have also detected *O. mykiss* passage. In 2012, 15 adult *O. mykiss* were detected passing the Tuolumne River weir and 82 adult *O. mykiss* were detected at the Stanislaus River weir (FISHBIO 2012, 2013a). In addition, rotary screw trap sampling has occurred since 1995 in the Tuolumne River, but only one juvenile *O. mykiss* was caught during the 2012 season (FISHBIO 2013b). Rotary screw traps are well known to be very inefficient at catching steelhead smolts, so the actual numbers of smolts produced in these rivers

could be much higher. Rotary screw trapping on the Merced River has occurred since 1999. A fish counting weir was installed on this river in 2012. Since installation, one adult *O. mykiss* has been reported passing the weir. Juvenile *O. mykiss* were not reported captured in the rotary screw traps on the Merced River until 2012, when a total of 381 were caught (FISHBIO 2013c). The unusually high number of *O. mykiss* captured may be attributed to a flashy storm event that rapidly increased flows over a 24 hour period. Annual Kodiak trawl surveys are conducted on the San Joaquin River at Mossdale by CDFW. A total of 17 *O. mykiss* were caught during the 2012 season (CDFW 2013a).

The low adult returns to the San Joaquin tributaries and the low numbers of juvenile emigrants typically captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

Efforts to provide passage of salmonids over impassable dams have the potential to increase the spatial diversity of Central Valley steelhead populations if the passage programs are implemented for steelhead. In addition, the San Joaquin River Restoration Program (SJRRP) calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011a).

4. Diversity

Genetic Diversity:

California Central Valley steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al. 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen et al. 2003). Garza and Pearse (2008) analyzed the genetic relationships among Central Valley steelhead populations and found that unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers.

The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley et al. 2007). There are four hatcheries (Coleman National Fish Hatchery, Feather River Fish Hatchery, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the Central Valley which combined release approximately 1.6 million yearling steelhead smolts each year. These programs are intended to mitigate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (primarily from the Eel and Mad

rivers) and are not presently considered part of the DPS.

Life-History Diversity:

Steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning.

Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish. After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and perished in the warm water downstream of Old Folsom Dam (Gerstung 1971).

Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of suitable holding and staging habitat, such as cold-water pools in the headwaters of Central Valley streams, presently located above impassible dams (Lindley et al. 2006).

Juvenile steelhead (parr) rear in freshwater for one to three years before migrating to the ocean as smolts (Moyle 2002). The time that parr spend in freshwater is inversely related to their growth rate, with faster-growing members of a cohort smolting at an earlier age but a smaller size (Peven et al. 1994, Seelbach 1993). Hallock et al. (1961) aged 100 adult steelhead caught in the Sacramento River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the Central Valley, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock et al. 1961, McEwan and Jackson 1996).

Deer and Mill creeks were monitored from 1994 to 2010 by the CDFW using rotary screw traps to capture emigrating juvenile steelhead (Johnson and Merrick 2012). Fish in the fry stage averaged 34 and 41 mm FL in Deer and Mill, respectively, while those in the parr stage averaged 115 mm FL in both streams. Silvery parr averaged 180 and 181 mm in Deer and Mill creeks, while smolts averaged 210 mm and 204 mm. Most silvery parr and smolts were caught in the spring months from March through May, while fry and parr peaked later in the spring (May and June) and were fairly common in the fall (October through December) as well.

In contrast to the upper Sacramento River tributaries, Lower American River juvenile steelhead have been shown to smolt at a very large size (270 to 350 mm FL), and nearly all smolt at age-1 (Sogard et al. 2012).

5. Summary of ESU Viability

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al. 2005; NMFS 2011a); the long-

term trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The most recent status review of the CCV 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.

2.2.2 Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU)

- First listed as threatened (August 4, 1989, 54 FR 32085), reclassified as endangered (January 4, 1994, 59 FR 440), reaffirmed as endangered (June 28, 2005, 70 FR 37160 and August 15, 2011, 76 FR 50447)
- Designated critical habitat (June 16, 1993, 58 FR 33212)

A. Species Listing and Critical Habitat History

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

classes (1991 and 1993); and (3) continued threats to the “take” of winter-run (August 15, 2011, 76 FR 50447).

On June 28, 2005, NMFS concluded that the winter-run ESU was “in danger of extinction” due to risks to the ESU’s diversity and spatial structure and, therefore, continues to warrant listing as an endangered species under the ESA (70 FR 37160). In August 2011, NMFS completed a 5-year status review of five Pacific salmon ESUs, including the winter-run ESU, and determined that the species’ status should again remain as “endangered” (August 15, 2011, 76 FR 50447). The 2011 review concluded that although the listing remained unchanged since the 2005 review, the status of the population had declined over the past five years (2005–2010).

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

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown’s Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the Sacramento River, critical habitat includes the river water, river bottom, and the adjacent riparian zone.

B. Critical Habitat: Essential Features for Sacramento River Winter-run Chinook Salmon

Critical habitat for winter-run is defined as specific areas (listed below) that contain the physical and biological features considered essential to the conservation of the species (Figure 16). This designation includes the river water, river bottom (including those areas and associated gravel used by winter-run as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (June 16, 1993, 58 FR 33212). NMFS limits “adjacent riparian zones” to only those areas above a stream bank that provide cover and shade to the near shore aquatic areas. Although the bypasses (*e.g.*, Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing. Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile outmigration or adult spawning migration.

Central Valley Winter-run Chinook Habitat and Distribution

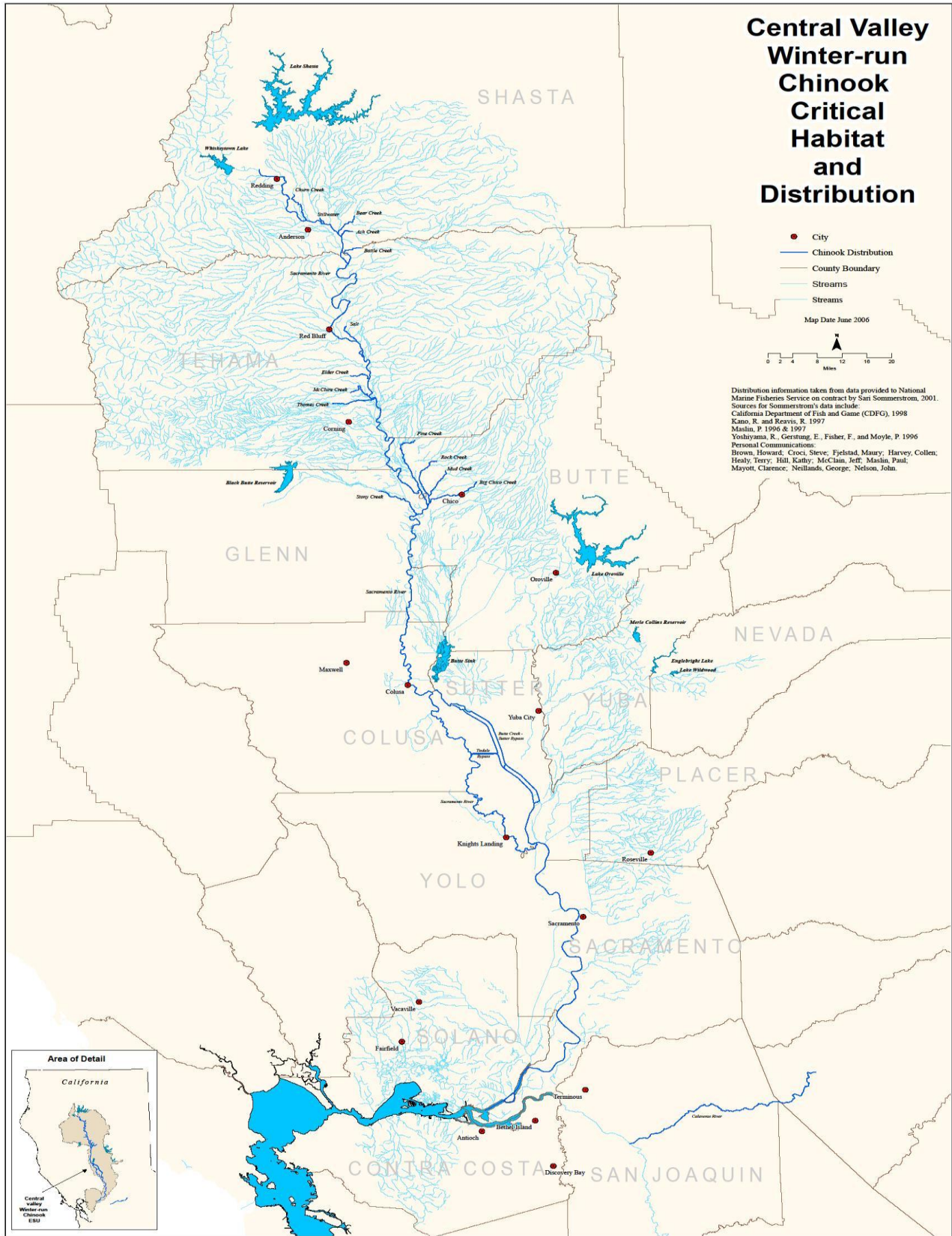


Figure 16. Winter-run Chinook salmon distribution and critical habitat in the Central Valley.

The following is the status of the physical and biological habitat features that are considered to be essential for the conservation of winter-run (June 16, 1993, 58 FR 33212):

1. Adult Migration Corridors

Adult migration corridors are defined as providing “access from the Pacific Ocean to appropriate spawning areas.” provide access from the Pacific Ocean to appropriate spawning areas, providing satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter, and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate to spawning areas during the winter and spring. At that time of year, the migration route is accessible to the appropriate spawning grounds on the upper 60 miles of the Sacramento River, however much of this migratory habitat is degraded and they must pass through a fish ladder at the Anderson-Cottonwood Irrigation Dam (ACID). In addition, the many flood bypasses are known to strand adults in agricultural drains due to inadequate screening (Vincik and Johnson 2013). Since the primary migration corridors 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.

2. Spawning Habitat

Spawning habitat is defined as “the availability of clean gravel for spawning substrate.” Suitable spawning habitat for winter-run exists in the upper 60 miles of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). However, the majority of spawning habitat currently being used occurs in the first 10 miles below Keswick Dam. The available spawning habitat is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, Reclamation annually injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the upper Sacramento River reach continues to support a small naturally-spawning winter-run Chinook salmon population. 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.

3. Adequate River Flows

Adequate River flows are defined as providing “adequate river flows for successful spawning, incubation of eggs, fry development and emergence, and downstream transport of juveniles.” An April 5, 1960, Memorandum of Agreement between Reclamation and the California Department of Fish and Wildlife (CDFW, formerly California Department of Fish and Game) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the 1990 flow releases required in State Water Resource Control Board (SWRCB) Water Rights Order (WRO) 90-05 for the protection of Chinook salmon. This order includes a minimum flow release of 3,250 cubic feet per second (cfs) from Keswick Dam downstream to RBDD from September through February during all water year types, except critically dry.

4. Water Temperatures

Water temperatures are defined as “water temperatures at 5.8–14.1°C (42.5–57.5°F) for successful spawning, egg incubation, and fry development.” Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dam water releases during the period of winter-run migration, spawning, egg incubation, fry development, and emergence. This pattern, the opposite of the pre-dam hydrograph, benefits winter-run by providing cold water for miles downstream during the hottest part of the year. The extent to which winter-run habitat needs are met depends on Reclamation’s other operational commitments, including those to water contractors, Delta requirements pursuant to State Water Rights Decision 1641 (D-1641), and Shasta Reservoir end of September storage levels required in the NMFS 2009 biological opinion on the long-term operations of the Central Valley Project and State Water Project (CVP/SWP, NMFS 2009a). WRO 90-05 and 91-1 require Reclamation to operate Shasta, Keswick, and Spring Creek Powerhouse to meet a daily average water temperature of 13.3°C (56°F) at RBDD. They also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. Based on these requirements, Reclamation models monthly forecasts and determines how far downstream 13.3°C (56°F) can be maintained throughout the winter-run spawning, egg incubation, and fry development stages.

In every year since WRO 90-05 and 91-1 were issued, operation plans have included modifying the TCP to make the best use of the cold water available based on water temperature modeling and current spawning distribution. Once a TCP has been identified and established in May, it generally does not change, and therefore, water temperatures are typically adequate through the summer for successful winter-run egg incubation and fry development for those redds constructed upstream of the TCP (except for in some critically dry and drought years). However, by continually moving the TCP upstream, the value of that habitat is degraded by reducing the spawning area in size and imprinting upon the next generation to return further upstream.

5. Habitat and Adequate Prey Free of Contaminants

Water quality conditions have improved since the 1980s due to stricter standards and Environmental Protection Agency (EPA) Superfund site cleanups (see Iron Mountain Mine remediation under Factors). No longer are there fish kills in the Sacramento River caused by the heavy metals (*e.g.*, lead, zinc and copper) found in the Spring Creek runoff. However, legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls, heavy metals and persistent organochlorine pesticides continue to be found in watersheds throughout the Central Valley. In 2010, the EPA, listed the Sacramento River as impaired under the Clean Water Act, section 303(d), due to high levels of pesticides, herbicides, and heavy metals (http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml). Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column.

Adequate prey for juvenile salmon to survive and grow consists of abundant aquatic and

terrestrial invertebrates that make up the majority of their diet before entering the ocean. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz et al. 2009). Contaminants are typically associated with areas of urban development, agriculture, or other anthropogenic activities (e.g., mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system. Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

6. Riparian and Floodplain Habitat

Riparian and floodplain habitat is defined as providing “for successful juvenile development and survival.” The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Ideal habitat contains natural cover, such as riparian canopy structure, submerged and overhanging LWM, aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Riparian recruitment is prevented from becoming established due to the reversed hydrology (i.e., high summer time flows and low winter flows prevent tree seedlings from establishing). However, there are some complex, productive habitats within historical floodplains [e.g., Sacramento River reaches with setback levees (i.e., primarily located upstream of the City of Colusa)] and flood bypasses (i.e., fish in Yolo and Sutter bypasses experience rapid growth and higher survival due to abundant food resources) seasonally available that remain in the system. Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010, Michel et al. 2012).

7. Juvenile Emigration Corridors

Juvenile emigration corridors are defined as providing “access downstream so that juveniles can migrate from the spawning grounds to San Francisco Bay and the Pacific Ocean.” Freshwater emigration corridors should be free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. Migratory corridors are downstream of the Keswick Dam spawning areas and include the mainstem of the Sacramento River to the Delta, as well as non-natal rearing areas near the confluence of some tributary streams.

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. Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River and in the Delta. Predators such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to concentrate immediately downstream of diversions, resulting in increased mortality of juvenile Chinook salmon.

Water pumping at the CVP/SWP export facilities in the South Delta at times causes the flow in the river to move back upstream (reverse flow), further disrupting the emigration of juvenile winter-run by attracting and diverting them to the interior Delta, where they are exposed to increased rates of predation, other stressors in the Delta, and entrainment at pumping stations. NMFS' biological opinion on the long-term operations of the CVP/SWP (NMFS 2009b) sets limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to as rearing habitat and as an area of transition to the ocean environment.

8. Summary of the Essential Features of Winter-run Chinook Salmon Critical Habitat

Critical habitat for winter-run is composed of physical and biological features that are essential for the conservation of winter-run, including upstream and downstream access, and the availability of certain habitat conditions necessary to meet the biological requirements of the species. Currently, many of these physical and biological features are degraded, and provide limited high quality habitat. Additional features that lessen the quality of the migratory corridor for juveniles include unscreened diversions, altered flows in the Delta, and the lack of floodplain habitat.

In addition, water operations that limit the extent of cold water below Shasta Dam have reduced the available spawning habitat (based on water temperature). Although the habitat for winter-run has been highly degraded, the importance of the reduced spawning habitat, migratory corridors, and rearing habitat that remains is of high conservation value.

C. Description of Viable Salmonid Population (VSP) Parameters

1. Abundance

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (NMFS 2011a). In recent years, since carcass surveys began in 2001 (Figure 17), the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2013, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (Figure 17). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley et al. 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2011a). In 2014, the population was 3,015 adults, slightly above the 2007–2012 average, but below the high (17,296) for the last ten years.

Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, less ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala et al. 2012), the winter-run conservation program at LSNFH is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001–2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002–2010

average, (Poytress and Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile production in any given year.

2014 was the third year of a drought which increased water temperatures in the upper Sacramento River. This caused significantly higher mortality (95-97%) in the upper spawning area. Due to the anticipated lower than average survival in 2014, hatchery production from LSNFH was tripled to offset the impact of the drought. In 2014, hatchery production represented 50-60% of the total in-river juvenile production. Drought conditions are likely to persist into 2015 and hatchery production will again be increased.

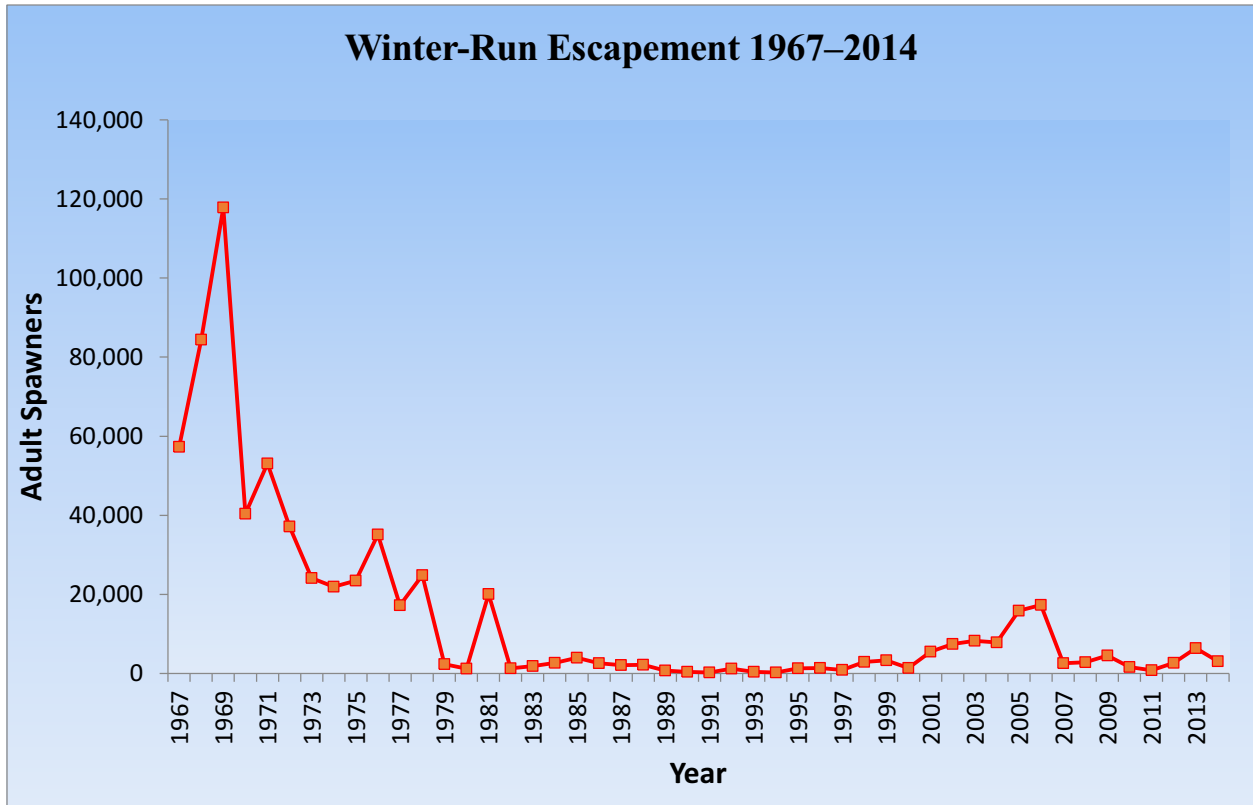


Figure 17. Winter-run Chinook salmon escapement numbers 1970-2014, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD ladder counts used pre-2000, carcass surveys post 2001 (CDFG 2012).

2. Productivity

ESU productivity was positive over the period 1998–2006, and adult escapement and juvenile production had been increasing annually until 2007, when productivity became negative (Figure 18) with declining escapement estimates. The long-term trend for the ESU, therefore, remains negative, as the productivity is subject to impacts from environmental and artificial conditions. The population growth rate based on cohort replacement rate (CRR) for the period 2007–2012 suggested a reduction in productivity (Figure 18), and indicated that the winter-run population was not replacing itself. In 2013, and 2014, winter-run experienced a positive CRR, possibly due to favorable in-river conditions in 2011, and 2012 (wet years), which increased juvenile

survival to the ocean.

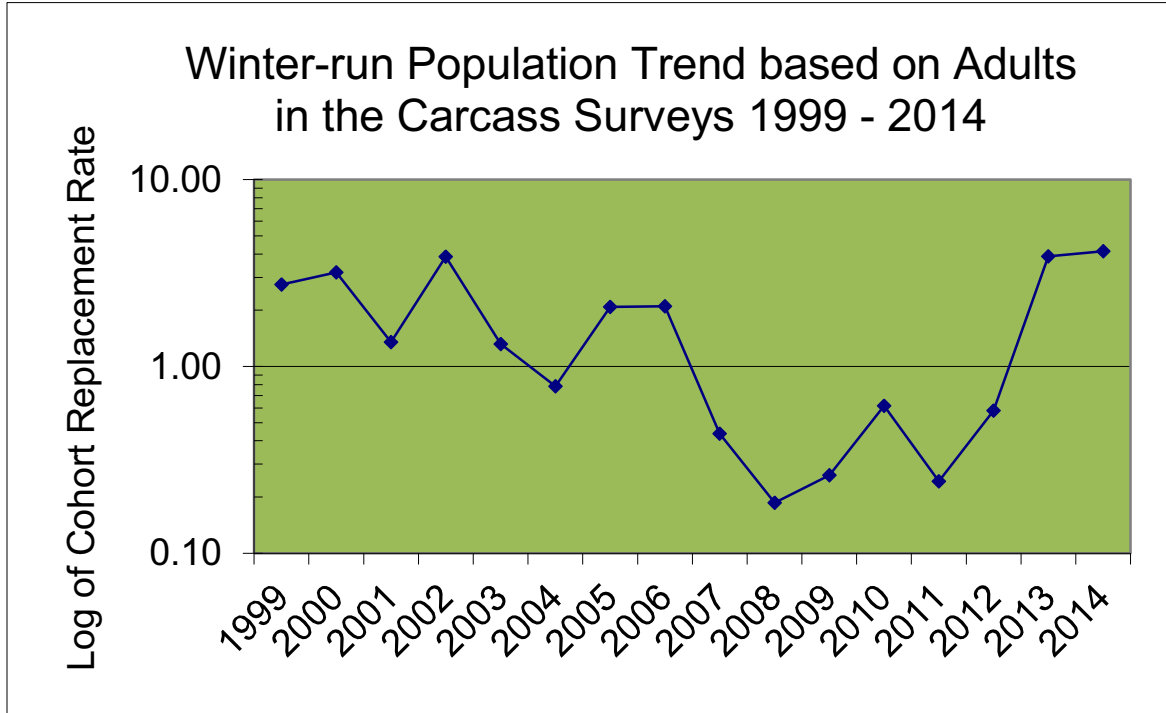


Figure 18. Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1999–2014.

An age-structured density-independent model of spawning escapement by (Botsford and Brittnacher 1998) assessing the viability of winter-run found the species was certain to fall below the quasi-extinction threshold of three consecutive spawning runs with fewer than 50 females (Good et al. 2005). Lindley and Mohr (2003) assessed the viability of the population using a Bayesian model based on spawning escapement that allowed for density dependence and a change in population growth rate in response to conservation measures found a biologically significant expected quasi-extinction probability of 28 percent. Although the growth rate for the winter-run population improved up until 2006, it exhibits the typical variability found in most endangered species populations. The fact that there is only one population, dependent upon cold-water releases from Shasta Dam, makes it vulnerable to periods of prolonged drought (NMFS 2011a). Productivity, as measured by the number of juveniles entering the Delta, or juvenile production estimate (JPE), has declined in recent years from a high of 3.8 million in 2007 to 124,521 in 2014 (Table 4). Due to uncertainties in the various JPE factors, it was updated in 2010 with the addition of confidence intervals (Cramer Fish Sciences model), and again in 2013, and 2014 with a change in survival based on acoustic tag data (NMFS 2014b). However, juvenile winter-run productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

Table 4. Winter-run adult and juvenile population estimates based on RBDD counts (1986–2001) and carcass counts (2001–2014), with corresponding 3-year-cohort replacement rates.

Return Year	Adult Population Estimate^a	Cohort Replacement Rate^b	Juvenile Production Estimate (JPE)^c
1986	2596		
1987	2185		
1988	2878		
1989	696	0.27	
1990	430	0.20	
1991	211	0.07	
1992	1240	1.78	40,100
1993	387	0.90	273,100
1994	186	0.88	90,500
1995	1297	1.05	74,500
1996	1337	3.45	338,107
1997	880	4.73	165,069
1998	2992	2.31	138,316
1999	3288	2.46	454,792
2000	1352	1.54	289,724
2001	8224	2.75	370,221
2002	7441	2.26	1,864,802
2003	8218	6.08	2,136,747
2004	7869	0.96	1,896,649
2005	15839	2.13	881,719
2006	17296	2.10	3,556,995
2007	2542	0.32	3,890,534
2008	2830	0.18	1,100,067
2009	4537	0.26	1,152,043
2010	1,596	0.63	1,144,860
2011	827	0.29	332,012
2012	2,674	0.59	162,051
2013	6,075	3.88	1,196,387
2014	3,015	4.13	124,521
median	3,709	0.95	874,931

^a Population estimates include hatchery returns based on RBDD ladder counts until 2001, after which the methodology changed to carcass surveys (California Department of Fish and Game 2012).

^b Assumes all adults return after three years. CRR is calculated using the adult spawning population, divided by the spawning population three years prior. Two year old returns were not used.

^c Includes survival estimates from spawning to Delta (*i.e.*, Sacramento at I St Bridge) entrance, but does not include through-Delta survival.

3. Spatial Structure

The distribution of winter-run spawning and initial rearing historically was limited to the upper Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963) *op. cit.* (Yoshiyama et al.

1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project (BCSSRP) is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in the future. Approximately 299 miles of former tributary spawning habitat above Shasta Dam is inaccessible to winter-run. Yoshiyama et al. (2001) estimated that in 1938, the upper Sacramento River had a “potential spawning capacity” of approximately 14,000 redds equal to 28,000 spawners. Since 2001, the majority of winter-run redds have occurred in the first 10 miles downstream of Keswick Dam. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for winter-run lies within its spatial structure (NMFS 2011a). The remnant and remaining population cannot access 95 percent of their historical spawning habitat, and must therefore be artificially maintained in the Sacramento River by: (1) spawning gravel augmentation, (2) hatchery supplementation, and, (3) regulating the finite cold-water pool behind Shasta Dam to reduce water temperatures. Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2017. The Central Valley Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2014a). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program above Shasta Dam.

4. Diversity

The current winter-run population is the result of the introgression of several stocks (*e.g.*, spring-run and fall-run Chinook) that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam which blocked access and did not allow spatial separation of the different runs (Good et al. 2005). Lindley et al. (2007) recommended reclassifying the winter-run population extinction risk from low to moderate, if the proportion of hatchery origin fish from the LSNFH exceeded 15 percent due to the impacts of hatchery fish over multiple generations of spawners. Since 2005, the percentage of hatchery winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012 (Figure 19).

Concern over genetic introgression within the winter-run population led to a conservation program at LSNFH that encompasses best management practices such as: (1) genetic confirmation of each adult prior to spawning, (2) a limited number of spawners based on the effective population size, and (3) use of only natural-origin spawners since 2009. These practices reduce the risk of hatchery impacts on the wild population. Hatchery-origin winter-run have made up more than 5 percent of the natural spawning run in recent years and in 2012, it exceeded 30 percent of the natural run (Figure 19). However, the average over the last 16 years (approximately 5 generations) has been 8 percent, still below the low-risk threshold (15 percent) used for hatchery influence (Lindley et al. 2007).

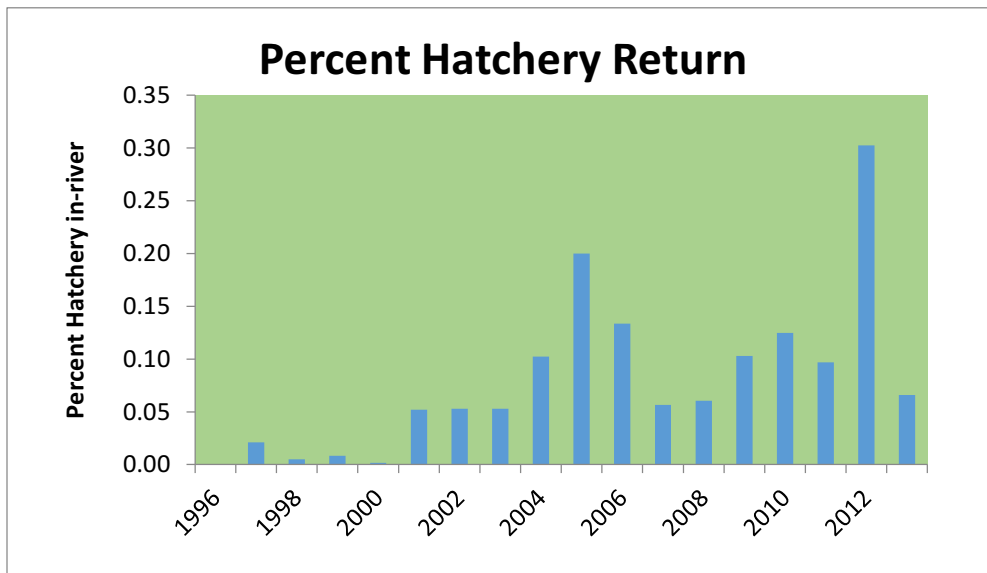


Figure 19. Percentage of hatchery-origin winter-run Chinook salmon naturally spawning in the Sacramento River (1996–2013). Source: CDFW carcass surveys, 2013.

5. Summary of ESU Viability

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns below Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in (Lindley et al. 2007). Recent trends in those criteria are: (1) continued low abundance (Figure 17); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 18); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought (climate change). The most recent 5-year status review (NMFS 2011a) on winter-run concluded that the ESU had increased to a high risk of extinction. In summary, the most recent biological information suggests that the extinction risk for the winter-run ESU has increased from moderate risk to high risk of extinction since 2005 (last review), and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (NMFS 2011a).

2.2.3 California Central Valley spring-run Chinook salmon Evolutionarily Significant Unit (ESU)

- listed as threatened (September 16, 1999, 64 FR 50394)
- designated critical habitat (September 2, 2005, 70 FR 52488)

A. Species Listing and Critical Habitat History

CCV spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CCV spring-run Chinook salmon ESU in the most recent CCV spring-run

Chinook salmon listing decision (70 FR 37160, June 28, 2005). Although FRFH spring-run Chinook salmon production is included in the ESU, these fish do not have a section 9 take prohibition. Critical habitat was designated for CCV spring-run Chinook salmon on September 2, 2005 (70 FR 52488).

In August 2011, NMFS completed an updated status review of five Pacific Salmon ESUs, including CCV spring-run Chinook salmon, and concluded that the species' status should remain as previously listed (76 FR 50447). The 2011 Status Review (NMFS 2011a) additionally stated that although the listings will remain unchanged since the 2005 review, and the original 1999 listing (64 FR 50394), the status of these populations has worsened over the past five years and recommended that the status be reassessed in two to three years as opposed to waiting another five years.

B. Critical Habitat and Primary Constituent Elements (PCEs) for CCV Spring-run Chinook Salmon

Critical habitat for the CCV spring-run Chinook salmon includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, and the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches (70 FR 52488). Critical habitat for CCV spring-run Chinook salmon is defined as specific areas that contain the primary constituent elements (PCEs) and physical habitat elements essential to the conservation of the species. Following are the PCEs for CCV spring-run Chinook salmon.

1. Spawning Habitat

Freshwater spawning sites are those with sufficient water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the Central Valley for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CCV spring-run Chinook salmon occurs on the mainstem Sacramento River between the Red Bluff Diversion Dam (RBDD) and Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks, as well as the Feather and Yuba rivers, Big Chico, Battle, Antelope, and Clear creeks. 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 that support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material, 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 piscivorous fish and birds. Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

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 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. The stranding of adults has been known to occur in flood bypasses and associated weir structures (Vincik and Johnson 2013) and a number of challenges 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, such as the San Francisco Bay and the downstream portions of the Sacramento-San Joaquin Delta, 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 large woody material, 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.

C. Description of Viable Salmonid Population (VSP) Parameters

As an approach to evaluate the likelihood of viability of the CCV spring-run Chinook salmon ESU, and determine the extinction risk of the ESU, NMFS uses the VSP concept. In this section, we evaluate the VSP parameters of abundance, productivity, 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)

1. Abundance

Historically spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 1990). These fish occupied the upper and middle elevation 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 1872, 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). The San Joaquin River historically supported a large run of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam on the San Joaquin River began in 1939, and when completed in 1942, blocked access to all upstream habitat.

The FRFH spring-run Chinook salmon population represents the only remaining evolutionary legacy of the spring-run Chinook salmon populations that once spawned above Oroville Dam, and has been included in the ESU based on its genetic linkage to the natural spawning population, and the potential development of a conservation strategy, for the hatchery program. On the Feather River, significant numbers of spring-run Chinook salmon, as identified by run timing, return to the FRFH. Since 1954, spawning escapement has been estimated using combinations of in-river estimates and hatchery counts, with estimates ranging from 2,908 in 1964 to 2 fish in 1978 (California Department of Water Resources 2001). However, after 1981, CDFG (now California Department of Fish and Wildlife (CDFW)) ceased to estimate in-river spawning spring-run Chinook salmon because spatial and temporal overlap with fall-run Chinook salmon spawners made it impossible to distinguish between the two races. Spring-run Chinook salmon estimates after 1981 have been based solely on salmon entering the hatchery during the month of September. The 5-year moving averages from 1997 to 2006 had been more than 4,000 fish, but from 2007 to 2011, the 5-year moving averages have declined each year to a low of 1,783 fish in 2011 (CDFG Grandtab 2013). Genetic testing has indicated that substantial introgression has occurred between fall-run and spring-run Chinook salmon populations within the Feather River system due to temporal overlap and hatchery practices (CDWR 2001). Because Chinook salmon have not always been spatially separated in the FRFH, spring-run and fall-run Chinook salmon have been spawned together, thus compromising the genetic integrity of the spring-run Chinook salmon stock (CDFG and CDWR 2012, Good et al. 2005). In addition, coded-wire tag (CWT) information from these hatchery returns has indicated that fall-run and spring-run Chinook salmon have overlapped (CDWR 2001). For the reasons discussed above, the FRFH spring-run Chinook salmon numbers are not included in the following discussion of

ESU abundance trends.

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of 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 in the Sacramento River downstream of Keswick Dam. Although the physical habitat conditions downstream of Keswick Dam are capable of supporting spring-run Chinook salmon, higher than normal water temperatures in some years have led to substantial levels of egg mortality. Less than 15 Chinook salmon 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 Chinook salmon redds from Keswick Dam downstream to the RBDD, ranging from 3 to 105 redds; 2012 observed zero redds, and 2013, 57 redds in September (CDFG, unpublished data, 2013). This is typically when spring-run Chinook salmon spawn, however, these redds also could be early spawning fall-run Chinook salmon. Therefore, even though physical habitat conditions may be suitable for spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely extensive introgression between the populations has occurred (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CCV spring-run Chinook salmon ESU as a whole because these streams contain the majority of the abundance, and are currently the only independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998 (Table 5). Escapement numbers are dominated by Butte Creek returns, which averaged over 7,000 fish from 1995 to 2005, but then declined in years 2006 through 2011 with an average of just over 3,000 (although 2008 was nearly 15,000 fish). During this same period, adult returns on Mill and Deer creeks have averaged over 2,000 fish total and just over 1,000 fish total, respectively. From 2001 to 2005, the CCV spring-run Chinook salmon ESU experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good et al. 2005). Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CCV spring-run Chinook salmon remained well below estimates of historic abundance.

Additionally, 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 (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiliis*) diseases in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to a 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 due to the diseases.

From 2005 through 2011, abundance numbers in most of the tributaries declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin is declining from the peaks seen in the five years prior to 2006. Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011a). Butte Creek has sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include, Butte, Deer and Mill creeks (NMFS 2011a). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 escapement numbers increased, in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. However, 2014 appears to be lower, just over 5,000 fish, which indicates a highly fluctuating and unstable ESU abundance.

2. 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 criteria for 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. CRR are indications of whether a cohort is replacing itself in the next generation.

From 1993 to 2007 the 5-year moving average of the tributary population CRR remained over 1.0, but then declined to a low of 0.47 in years 2007 through 2011. The productivity of the Feather River and Yuba River populations and contribution to the CCV spring-run Chinook salmon ESU currently is unknown, however the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.84, and 8.68 in 2013, due to increases in abundance for most populations. Although 2014 returns were lower than the previous two years, the CRR was still positive.

Table 5. California Central Valley Spring-run Chinook salmon population estimates from CDFW Grand Tab (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	1,658	5.24		4,948	2.30	
1991	5,101	4,303	798	1,376	0.36		5,240	0.56	
1992	2,673	1,497	1,176	1,551	0.60		5,471	0.38	
1993	5,685	4,672	1,013	1,307	0.64	1.54	4,795	1.63	1.36
1994	5,325	3,641	1,684	1,253	2.11	1.79	4,454	1.04	1.18
1995	14,812	5,414	9,398	2,814	7.99	2.34	6,719	5.54	1.83
1996	8,705	6,381	2,324	3,119	2.29	2.73	7,440	1.53	2.03
1997	5,065	3,653	1,412	3,166	0.84	2.77	7,918	0.95	2.14
1998	30,534	6,746	23,788	7,721	2.53	3.15	12,888	2.06	2.23
1999	9,838	3,731	6,107	8,606	2.63	3.26	13,791	1.13	2.24
2000	9,201	3,657	5,544	7,835	3.93	2.44	12,669	1.82	1.50
2001	16,869	4,135	12,734	9,917	0.54	2.09	14,301	0.55	1.30
2002	17,224	4,189	13,035	12,242	2.13	2.35	16,733	1.75	1.46
2003	17,691	8,662	9,029	9,290	1.63	2.17	14,165	1.92	1.43
2004	13,612	4,212	9,400	9,948	0.74	1.79	14,919	0.81	1.37
2005	16,096	1,774	14,322	11,704	1.10	1.23	16,298	0.93	1.19
2006	10,948	2,181	8,767	10,911	0.97	1.31	15,114	0.62	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,615	0.71	1.00
2008	6,368	1,624	4,744	8,857	0.33	0.78	11,350	0.40	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,388	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.54	6,927	0.39	0.49
2011	4,967	1,969	3,067	3,961	0.65	0.47	5,731	0.78	0.53
2012	18,275	3,738	10,810	4,713	3.84	1.09	7,441	0.79	0.54
2013	38,556	4,294	18,499	7,464	8.68	2.76	13,878	2.00	0.86
2014									
Median	10,962	3,734	6,508	6,324	2.08	1.83	10,258	1.00	1.29

^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

3. Spatial Structure

The California Central Valley Technical Review Team (TRT) estimated that historically there were 18 or 19 independent populations of CCV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Figure 20) (Lindley et al. 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and Butte creeks tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks, and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998). All historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated, although Battle Creek in the basalt and porous lava diversity group has had a small persistent population in Battle Creek since 1995, and the upper Sacramento River may have a small persisting population spawning in the mainstem river as well. The northwestern California diversity group did not historically contain independent populations, and currently contains two small persisting populations, in Clear Creek, and Beegum Creek (tributary to Cottonwood Creek) that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence.

Construction of low elevation dams in the foothills of the Sierras on the San Joaquin, Mokelumne, Stanislaus, Tuolumne, and Merced rivers, has thought to have extirpated CCV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American River of the Sacramento River basin. However, observations in the last decade suggest that perhaps spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2013 unpublished data).

Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (*e.g.*, a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genotypic (DNA) characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genotypic diversity, on the other hand, provides populations with the ability to survive long-term changes in the environment. To meet the objective of representation and redundancy, diversity groups need to contain multiple populations to survive in a dynamic ecosystem subject to unpredictable stochastic events, such as pyroclastic events or wild fires.

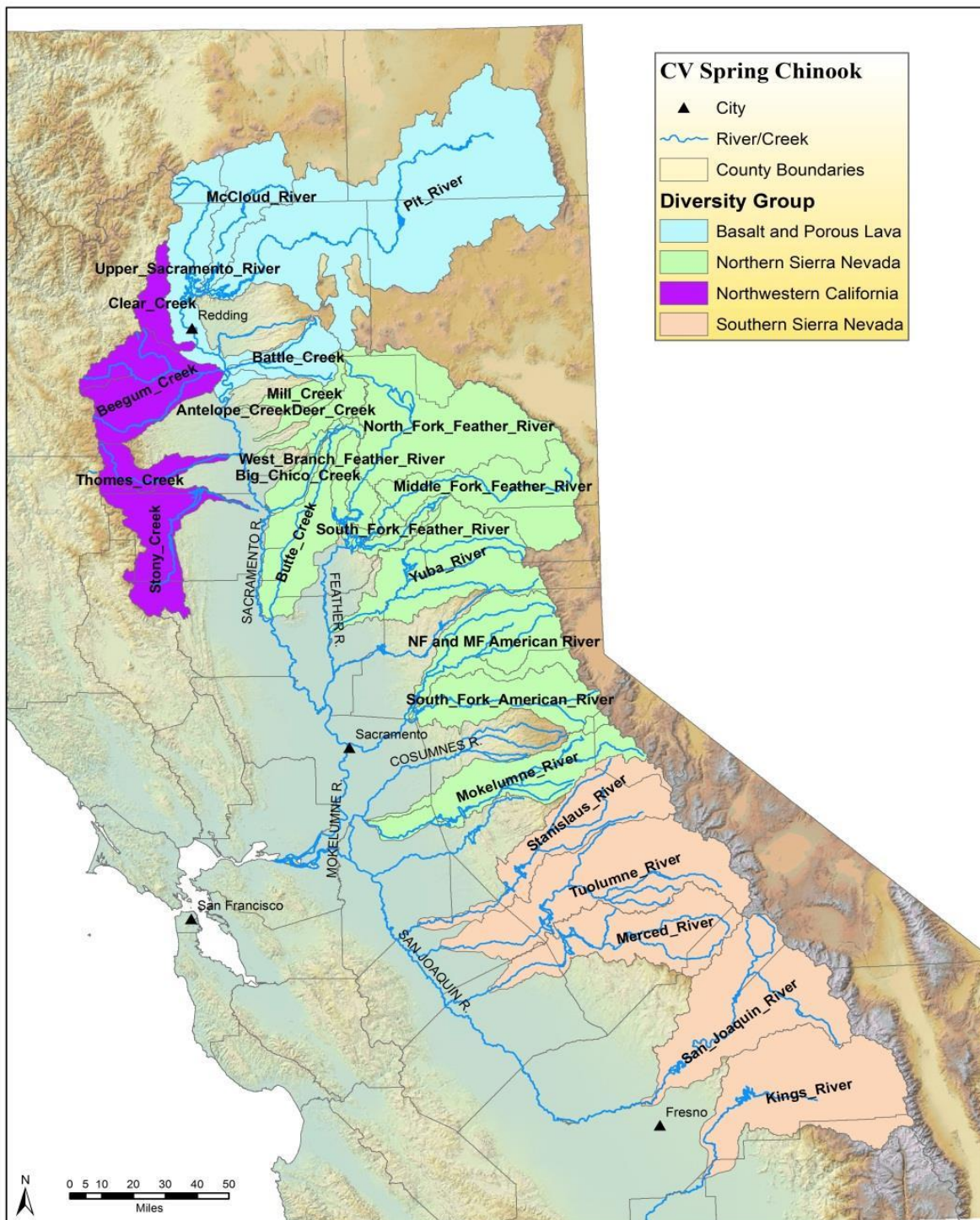


Figure 20. Diversity Groups for the California Central Valley spring-run Chinook salmon ESU.

With only one of four diversity groups currently containing viable independent populations, the spatial structure of CCV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon adult returns are currently utilizing all available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent

populations in Clear Creek and Battle Creek, with habitat restoration projects completed and more underway, are anticipated to add to the spatial structure of the CCV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the spring-run Chinook salmon ESU would still be lacking due to the extirpation of all San Joaquin River basin spring-run Chinook salmon populations, however recent information suggests that perhaps a self-sustaining population of spring-run Chinook salmon is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne rivers.

A final rule was published to designate a nonessential experimental population of CCV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the SJRRP (78 FR 251; December 31, 2013). Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. However, the rule includes proposed protective regulations under ESA section 4(d) that would provide specific exceptions to prohibitions under ESA section 9 for taking CCV spring-run Chinook salmon within the experimental population area, and in specific instances elsewhere. The first release of CCV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April, 2014. A second release occurred in 2015, and future releases are planned to continue annually during the spring. The SJRRP's future long-term contribution to the CCV spring-run Chinook salmon ESU has yet to be determined.

Snorkel surveys (Kennedy and Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and 2004, as well as observed Chinook fry in December of 2003, which would indicate spring-run Chinook salmon spawning timing. In addition, monitoring on the Stanislaus since 2003 and on the Tuolumne since 2009, has indicated upstream migration of adult spring-run Chinook salmon (Anderson et al. 2007). Genetic testing is needed to confirm that these fish are spring-run Chinook salmon, to determine which strain they are. Finally, rotary screw trap data provided by Stockton U.S. Fish and Wildlife Service (USFWS) corroborates the spring-run Chinook salmon adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Franks 2013 unpublished data). Plans are underway to re-establish a spring-run Chinook salmon population in the San Joaquin River downstream of Friant Dam, as part of the San Joaquin River Restoration Program. Interim flows for this began and spring-run Chinook salmon are expected to be released in 2013. The San Joaquin River Restoration Programs' future long-term contribution to the CCV spring-run Chinook salmon ESU is uncertain.

Lindley et al. (2007) described a general criteria for "representation and redundancy" of spatial structure, which was for each diversity group to have at least two viable populations. More specific recovery criteria for the spatial structure of each diversity group have been laid out in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a). According to the criteria, 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, in addition to maintaining dependent populations are needed for recovery. It is

clear that further efforts will need to involve more than restoration of currently accessible watersheds to make the ESU viable. The NMFS 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 2014a).

4. 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 (including rate of gene-flow among populations). Criteria for the diversity parameter are that human-caused factors should not alter variation of traits. 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 CCV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the California Central Valley indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retains genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the Feather River fall-run Chinook salmon, and it appears that the Yuba River spring-run Chinook salmon population may have been impacted by FRFH fish straying into the Yuba River (and likely introgression with wild Yuba River fall-run has occurred). Additionally, the diversity of the spring-run Chinook salmon ESU has been further reduced with the loss of the majority if not all of the San Joaquin River basin spring-run Chinook salmon populations. Efforts underway like the San Joaquin River Restoration Project (to reintroduce a spring-run population below Friant Dam), are needed to improve the diversity of CCV spring-run Chinook salmon.

5. Summary of ESU Viability

Since the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based on VSP parameters in these watersheds. 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 population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). 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 CCV spring-run

Chinook salmon ESU 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, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Over the long term, these three 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.

Until 2012, the status of CCV spring-run Chinook salmon ESU had deteriorated on balance since the 2005 status review and the Lindley *et al.* (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. Additionally, Butte Creek remained at low risk, although it was 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 had increased in abundance since 1998, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have likely increased at least in part due to extensive habitat restoration. The Southwest Fisheries Science Center concluded in their viability report that the status of CCV 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.

The most recent viability assessment of CCV spring-run Chinook salmon was conducted during NMFS’ 2011 status review (NMFS 2011a). This review found that the biological status of the ESU had worsened since the last status review (2005) and recommend that its status be reassessed in two to three years as opposed to waiting another five years, if the decreasing trend continues and the ESU does not respond positively to improvements in environmental conditions and management actions. In 2012 and 2013, tributary populations have had an increase in returning adults, averaging over 13,000, in contrast to returns in 2006 through 2011 averaging less than 5,000; however with 2014 returns of just over 5,000 fish, indicates the ESU remains highly fluctuating. A status review is currently underway and expected to be completed before the end of 2015.

2.2.4 Climate Change Impacts to ESA-Listed Species

One factor affecting the range-wide status of CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook and aquatic habitat at large is climate change. In the last six decades, Earth has experienced a significant increase in average surface temperatures. This increase is likely a result of increased anthropogenic greenhouse gas emissions resulting from increasing populations, industrial activity and fossil fuel consumption, among other sources. A warming climate has profound implications for stream ecosystems as hydrologic conditions are likely to become highly altered from their current and historical states (20th century). Other physical factors such as air temperature and changes to terrestrial ecosystems will likely play a role as well.

Cayan et al 2008, using the Parallel Climate Model (PCM) (Washington et al. 2000) and the NOAA Geophysical Fluid Dynamics Laboratory model (GFDL) (Stouffer et al 2006) found California's temperatures to rise by 1.7 to 3.0°C in the lower range of projections, 3.1 to 4.3°C in the medium range, and 4.4 to 5.8°C in the high range between 2000 and 2100. One consequence that will result even in the lower range of projections is a decrease in the Snow Water Equivalent (SWE) in the region. SWE is a measurement of stored water that is available from snowpack. In the low and medium-level projections, SWE is expected to decrease in the Sacramento, San Joaquin and Trinity drainages between -32 and -79% of historical averages (1961 – 1990). Using the PCM model, Dettinger et al. (2003) also projected a decrease in SWE, increased winter flood events and low flows in summer months in the Merced, Carson and American River basins by the end of the 21st century. Similar results were found by Miller et al. (2003) using two General Circulation Models (GCM).

Stream flow is a highly important variable and driving mechanism in fluvial ecosystems and climate has been identified as a landscape-scale driver of flow rates (Minshall 1988). Multiple climatological and hydrologic model predictions indicate that flows in the CCV will decrease throughout the 21st century as warming trends continue. Salmonids in the American River will likely face a decrease in flows, resulting in potentially lethal or sub-lethal water temperatures in summer months, impaired migration and decreased egg to fry recruitment. In addition to altered flow regimes, some other aspects of stream systems that are particularly sensitive to changes in climate are sediment transport/channel alterations, nutrient loading and rates of nutrient cycling, fragmentation and isolation of cold water habitats, altered exchanges with the riparian zone and life history characteristics of many aquatic insects (Meyer et al. 1999). Current warming trends and model predictions indicate that it is likely that climate change will result in some direct and indirect adverse effects to salmonids in the Lower American River in the 21st century.

2.3 Environmental Baseline

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).

The Action Area occurs on the Lower American River between Nimbus Dam and the State Route 160 Bridge and contains eight restoration sites (referred to as Project Areas), these sites are defined in section 1.5 of this document (Table 2). Undetermined sites within the Action Area are also described in Section 1.5 and will be selected at a later date according to the adaptive management strategy described in Section 1.3. Project Areas are defined by the area which could potentially be impacted by increased suspended sediments, contaminants, disturbance to riparian vegetation or other construction related impacts. Suspended sediments are expected to impact an area less than 40% of the width of the wetted channel, 200 feet downstream of each Project Area.

Status of Listed Species in the Action Area

The Action Area provides potential spawning and rearing habitat for CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook. Due to observed life history patterns and known spawning behavior for these species, one or more of the following life stages may be present in the Action Area year-round: spawning adult, migrating adult, rearing eggs or rearing and emigrating juveniles. Table 6 shows USFWS rotary screw trap data for fish captured on the Lower American River from 2013 – 2015. It should be noted that during this sampling effort, Chinook runs were identified by length-at-date criteria (PSFMC 2014b). Abundance estimates (especially for spring-run) may not be accurate but the data does indicate presence of each run within the Lower American River.

Table 6. Rotary screw trap data from sampling seasons in years 2013-2015. Run identification prior to genetic analysis. (From USFWS CAMP Program)

	Year		
Taxon	2013	2014	2015
Fall-run Chinook salmon	262,523	377,693	282,469
Late-fall-run Chinook salmon	35	2	3
Spring-run Chinook salmon	93	1,856	703
Winter-run Chinook salmon	26	10	30
Steelhead	2,205	586	9

CCV steelhead

CCV steelhead are known to spawn consistently in the Lower American River and naturally spawning fish are primarily hatchery-produced (Lindley et al. 2007). Although Hannon (2013) observed some returning adults with adipose fins (indicating wild origin) in the Lower American River, the in-river population is thought to be composed entirely of individuals raised in Nimbus Hatchery or their descendants (NMFS 2009b). Juveniles are known to rear in the Lower American River throughout the year. All other life stages occur in the winter and spring months. In river-wide surveys conducted throughout the Lower American River, juvenile CCV steelhead have been observed exclusively in riffle and fast water habitat areas (Reclamation 2015).

CCV spring-run Chinook

Historically, spring-run Chinook occupied the Lower American River. However, the CCV spring-run Chinook ESU as it exists today is primarily composed of three self-sustaining populations which spawn in Deer Creek, Mill Creek and Battle Creek. Smaller populations currently persist in Antelope and Big Chico creeks, and the Feather and Yuba. The loss of the spawning population in the Lower American River is likely due to habitat loss and loss of access to spawning habitat upstream of Nimbus and Folsom dams. USFWS rotary screw trap surveys have observed small numbers of spring-run the Lower American River, suggesting that they

exhibit non-natal rearing there during winter and spring months. USFWS has shown through genetic analysis in past surveys that many individuals identified initially as spring-run were later identified as fall-run, leading to an initial overestimate of spring-run abundance.

Sacramento River winter-run Chinook

Unlike the CCV spring-run Chinook ESU, historically, there was never a Sacramento River winter-run population that spawned in the American River. Currently, winter-run spawning is confined to the upper Sacramento River. USFWS rotary screw traps have captured small numbers of juvenile winter run in the Lower American River suggesting that they exhibit non-natal rearing there during winter and spring months.

Status of Critical Habitat in the Action Area

CCV steelhead and CCV spring-run Chinook

The Action Area includes critical habitat that has been designated for CCV steelhead and CCV spring-run Chinook. Critical habitat was designated under the same federal ruling for these two species as their habitat requirements are very similar. PCEs within the Action Area for these two species include (1) freshwater spawning sites (currently CCV steelhead only) (2) freshwater rearing sites (3) freshwater migration corridors. All three of these PCEs have been degraded from their historical condition due to human activity on and near the American River. The construction of Nimbus and Folsom dams has restricted access to historical spawning and rearing habitat for both species. Degradation of these PCEs has contributed to significant population declines within the American River. Drought conditions have also had detrimental effects to PCEs through reduced flows and increased water temperatures. These effects have led to reduced quality of spawning and rearing habitat and has likely limited migration corridors in summer months due to thermal barriers.

Sacramento River winter-run Chinook

Critical habitat features for Sacramento River winter-run Chinook do not exist within the Action Area. They exist in the main stem of the Sacramento River, which is two miles downstream of the western extent of the Action Area.

Factors Affecting Listed Species and Critical Habitat in the Action Area

Range-wide factors that affect listed fish species are described in section 2.2. This section will focus on factors that are specific to the Action Area.

The Lower American River has been degraded from its historic condition and many anthropomorphic and naturally occurring factors have led to the decline of anadromous fish in the system. Due to the construction of Nimbus and Folsom dams, flows and temperatures have been altered from their natural and historic regimes. Altered flow regimes can influence migratory cues, water quality (including contaminants, dissolved oxygen and nutrients for primary productivity) and temperature. Construction of the dams has also restricted access to historic spawning and rearing habitat, leading to the decline of anadromous fish abundance in the

Lower American River. Spawning site, rearing site and migration corridor PCEs have been degraded as a result of dam construction.

Drought conditions have played a significant role in the past 4 years as flows have decreased and temperatures have increased, leading to unfavorable environmental conditions in the river. This has resulted in direct and indirect impacts to listed fish as well as impacts to critical habitat. Heat stress, heat shock and disruption of migration due to thermal barriers have resulted from decreased flows in the river. Increased temperatures also have the potential to disrupt aquatic macroinvertebrate production, leading to declines in food availability (Ward and Stanford 1982).

It is likely that the in-river population of CCV steelhead is composed entirely of individuals raised in Nimbus Hatchery or their descendants (NMFS 2009b, NMFS 2011b). Hatchery production in recent years has been responsible for sustaining the CCV steelhead population in the American River, though there are likely hatchery-related genetic effects that have occurred within the population. Early broodstock used at Nimbus Hatchery contained steelhead from many different populations and geographic regions. There is also some concern that rainbow trout were introduced to the in-river population. Garza and Pierce (2008), using highly variable microsatellite markers from adults returning to the hatchery, identified over one third of the fish as hatchery rainbow trout. Reduced wild population size and altered selection regimes have likely led to the current genetic assemblage of CCV steelhead in the Lower American River (Waples 1991).

The areas surrounding the Lower American River have been heavily urbanized. This has likely increased the amount of contaminant loading in the aquatic ecosystem. Heavy metals, Polycyclic Aromatic Hydrocarbons (PAHs), petroleum products, plastics, fertilizer and many other contaminants can enter the river via urban runoff. Shoreline areas along the Lower American River have also been highly developed over time. Shore side development leads to decreased recruitment of LWM and results in a loss of habitat complexity which is a critical component of the freshwater rearing site PCE.

Importance of the Action Area to the Survival and Recovery of Listed Species

The Lower American River contains viable spawning and rearing habitat for CCV steelhead and rearing habitat for CCV spring-run Chinook and Sacramento River winter-run Chinook. The portion of the Lower American River within the Action Area is designated critical habitat for CCV spring-run Chinook and CCV steelhead. It contains spawning sites for CCV steelhead and rearing habitat and migration corridor for both species. Sacramento River winter-run Chinook have been observed in the Lower American River, presumably exhibiting non-natal rearing behavior, though it has not been designated as critical habitat for that run.

Based on the current status, range and estimated abundance of CCV steelhead, the Action Area is a highly important portion of the Lower American River. Due to the presence of Nimbus Dam, spawning habitat for CCV steelhead is confined to those areas below the dam. The current in-river population depends on spawning areas contained primarily within the Action Area. Rearing habitat within the Action Area is also highly critical for the viability of the in-river CCV steelhead population. Juveniles rear in the Action Area primarily in the winter and spring but

may be present year-round. For this reason, the flow and temperature regimes in the river can potentially have important implications for juvenile recruitment. Habitat complexity and food availability are also important components within the Action Area as they facilitate juvenile rearing and growth.

The portion of the Lower American River contained in the Action Area is important for CCV spring-run Chinook and Sacramento River winter-run Chinook because juveniles are known to exhibit non-natal rearing. However, they do not spawn in the Action Area. Therefore it is important primarily because it increases the carrying capacity of total range of each run, providing additional rearing habitat. Habitat complexity and food availability within the Action Area contributes to the growth and survival of these runs.

The restoration plans that are outlined in the Proposed Action will ultimately be highly beneficial for all three ESUs and the critical habitat PCEs that are present in the Action Area. Gravel augmentation, side channel creation and floodplain enhancement will improve the quality and quantity of spawning and rearing habitat in the Action Area. Placement of LWM will increase habitat complexity and macroinvertebrate food production, enhancing the growth and survival of rearing juveniles. As juveniles sampled in the Lower American River were found exclusively in riffle and fast water habitat areas, gravel augmentation will enhance migration corridors by expanding these areas (Reclamation 2015). LWM placement will enhance migration corridors as well by providing additional cover and in-stream shelter.

The Recovery Plan for Central Valley Chinook Salmon and Steelhead (NMFS 2014a) outlines several recommended recovery actions for the Lower American River that are consistent with the Proposed Action:

- Implement a long-term gravel management program in the Lower American River to provide suitable spawning habitat per CVPIA.
- Implement a long-term wood management program to provide habitat complexity and predator refuge habitat.
- Develop and Implement programs and projects that focus on retaining, restoring and creating river riparian corridors within their jurisdiction in the American River watershed.
- Inventory locations on the American River for creating shallow, inundated floodplain habitat for multi-species benefits and implement where suitable opportunities are available.

Implementation of these recovery actions will contribute to the overall recovery and survival of these ESUs. They will have direct and indirect long-term effects to listed species and their critical habitat.

2.4 Effects of the Action

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline (50 CFR

402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The Proposed Action includes activities that may directly or indirectly impact CCV steelhead and/or their critical habitat, CCV spring-run Chinook salmon and/or their critical habitat or Sacramento River winter-run Chinook salmon. Winter-run Chinook critical habitat essential physical and biological features are not present in the Action Area, however, juvenile winter-run are known to rear in the Action Area during winter and spring months (Table 1). The following is an analysis of the potential direct and indirect effects to listed fish species and/or their critical habitat that may occur as a result of implementing the Lower American River Anadromous Fish Habitat Restoration Program.

2.4.1 Effects of the Proposed Action to Listed Fish Species

1) Gravel Augmentation, Side Channel Creation and Flood Plain Enhancement

Increased Sedimentation and Turbidity

Increased sedimentation and turbidity may result from gravel augmentation as new gravel is transported in to the Action Area and placed in the wetted channel. Sediment may be sourced from the gravel itself, it may be transported into the river via equipment operation or disturbed sediment may be suspended in the river as a result of the placement process. Similarly, sediment will likely become disturbed and enter the river during side channel creation and flood plain enhancement projects due to displacement and construction operations. Sedimentation and turbidity are expected to have varying effects to fish at different life stages. Because juvenile CCV steelhead are the only species/life stage likely to be present in the Action Area during construction activities, some adverse effects are expected to impact that particular life stage (Table 1).

Juvenile CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook are known to rear in the Action Area, particularly in riffle habitat areas. Juvenile salmonids are not likely to avoid increased levels of turbidity below a level of 70 NTU (Bash et al. 2001). As a result, they may be at greater risk to turbidity and sediment-related effects than adults. One effect of turbidity that has important implications for juvenile salmonids is that predator avoidance behavior has been shown to decrease at increased levels of turbidity (Gregory 1992). Growth and survival amidst increased sediment and turbidity levels has also been shown to decrease resulting from reduced prey detection and availability and physical injury due to increased activity, aggression and gill fouling (Suttle et al. 2004, Kemp et al 2011). Sedimentation effects are expected to impact sections of the Lower American River 200 feet downstream of a given project area (see section 1.5) and less than 40% of the width of the active channel (Reclamation 2015). Because rearing juvenile steelhead are likely to be present in the Action Area, during construction, injury or death are expected to occur as a result of direct or indirect sedimentation-related effects. Juvenile CCV spring-run Chinook and Sacramento River winter-run Chinook are not expected to be rearing in the Action Area during construction, therefore adverse effects are not expected to impact juveniles of those ESUs.

Adult CCV steelhead are known to return and spawn in the Action Area in winter and spring months. Increased sedimentation and turbidity could potentially have direct and indirect adverse effects to adult CCV steelhead through gill fouling, reduced foraging ability and reduced predator avoidance (Kemp et al. 2011). Due to the planned work schedule of the Proposed Action, adult CCV steelhead are not likely to be present in the Action Area during construction activities. Therefore adverse effects are not expected to impact adults.

CCV steelhead eggs are potentially present during winter and spring months throughout the Action Area where there is suitable spawning habitat. Reclamation (2015) indicates that known spawning habitat occurs in multiple proposed Project Areas. Sedimentation is known to have lethal and sublethal effects to incubating salmonids eggs by decreasing dissolved oxygen (DO) transport between spawning gravel. Sediment also blocks micropores on the surface of incubating eggs, inhibiting oxygen transport and creates an additional oxygen demand through the chemical and biological oxidation of organic material (Kemp et al. 2011, Greig et al. 2005, Suttle et al. 2004). CCV steelhead eggs in the Lower American River are expected to hatch prior to the onset of construction activities in the Action Area. As a result, adverse effects to incubating CCV steelhead eggs are not expected to occur.

Avoidance and minimization techniques as well as BMPs pertaining to sedimentation and turbidity for these projects are described in Section 1.4. These actions will avoid and minimize the extent of adverse effects associated with the Proposed Action.

Construction-related effects

As side channel creation and flood plain enhancement projects are implemented as a part of the proposed restoration program, construction-related activities have the potential to result in injury or death to listed fish species. Construction-related effects may include debris falling into the active channel, tools and/or equipment falling into the active channel or noise generated by displaced rock and sediment and the operation of construction machinery. Because juvenile CCV steelhead are the only species/life stage likely to be present in the Action Area during construction activities, some adverse effects are expected to impact that particular life stage (Table 1).

Juvenile CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook rear in riffle habitat areas within the Action Area and may be susceptible to construction-related effects resulting from construction operations. Juvenile salmonids in the Lower American River are known to prefer shallow, riffle habitats with fast moving water (Reclamation 2015). As machinery is brought out onto gravel bars to place spawning gravel into the river, to create side channel habitats or to modify flood plain areas, fish occupying riffle habitat close to shore may be vulnerable. BMPs, avoidance and minimization measures described in Section 1.4 such as the use of techniques to alert and disperse juveniles prior to the commencement of activity will minimize injury or death to CCV steelhead that may be present in the Action Area during construction. CCV spring-run Chinook and Sacramento River winter-run Chinook are not likely to be present in the Action Area during construction, therefore adverse effects are not expected to impact juveniles of these ESUs.

Construction-related effects have the potential for direct or indirect adverse effects to adult CCV steelhead that may be present in the Action Area during construction. Adults could potentially encounter falling debris, which could cause physical injury or death, or construction-related noise, which may alter spawning behavior. Adult CCV steelhead are not expected to be present in the Action Area during construction activities, therefore injury or death are not expected to occur. Likewise, incubating CCV steelhead eggs could potentially be affected by falling debris, causing physical injury or death. Eggs are expected to hatch prior to the onset of construction activities; therefore, adverse effects are not expected to impact this life stage.

Contaminants and Pollution-related Effects

Side channel creation, floodplain enhancement and gravel augmentation as described in the Proposed Action will involve heavy construction equipment and many potential sources of hazardous material contamination in the Action Area. Potential sources of pollutants include hazardous material spills, petroleum product leaks in construction equipment, introduction of metals from the operation of equipment and vehicles and the disturbance of sediments that may contain hazardous suspended particulates. BMPs, avoidance and minimization techniques will be implemented, minimizing the probability of pollutant incursion into the Lower American River. However, unlike sedimentation, turbidity and construction-related effects, potential pollution-related effects would be persistent in the Action Area and may affect multiple life stages if they were to occur.

Incursion of contaminants into the Action Area has the potential to directly or indirectly effect juvenile CCV steelhead, CCV spring-run Chinook and/or Sacramento River winter run that may be rearing in the Action Area at the time of a pollution event or possibly afterwards. Construction equipment and heavy machinery will be present in the action area and metals may be deposited through their use and operation (Paul and Meyer 2001). These materials have been shown to alter juvenile salmonid behavior through disruptions to various physiological mechanisms including sensory disruption, endocrine disruption, neurological dysfunction and metabolic disruption (Scott and Sloman 2004). Oil-based products used in combustion engines are known to contain Polycyclic Aromatic Hydrocarbons (PAHs) which have been known to bioaccumulate in other fish taxa such as Pleuronectiformes and have carcinogenic, mutagenic and cytotoxic effects (Johnson et al 2002). The exact toxicological effects of PAHs in juvenile salmonids not well understood, although studies have shown that increased exposure of salmonids to PAHs, reduced immunosuppression, increasing their susceptibility to pathogens (Arkoosh et al. 1998, Arkoosh and Collier 2002). Juvenile CCV steelhead are expected to be present in the Action Area during construction activities and would potentially be directly affected by a pollution event. Juvenile CCV spring-run Chinook and Sacramento River winter-run Chinook are expected to be present in the Lower American River during winter and spring months and could be indirectly effected by a pollution event if contaminants were to settle within substrate in the active channel that may become disturbed at a later time.

CCV steelhead adults and incubating eggs are not expected to be present in the Action Area during construction activity and thus are not likely to be directly affected by a pollution-related event. However, similar to CCV spring-run and Sacramento river winter run Chinook, they may be indirectly affected should contaminants become suspended in sediments within the active

channel that are disturbed at a later time. Salmonid eggs are particularly susceptible to heavy metals which may easily come into contact with them via suspended sediments and particles. Dissolved metal ions can impair the formation of the vertebral column as well as impair growth, yolk resorption and the activity of ion pumps in the gill or yolk sac epithelia (Finn 2007).

BMPs, avoidance and minimization measures are described in Section 1.4 and will aid in minimizing potential direct or indirect adverse effects to listed fish species.

2) Placement of Large Woody Material

LWM will be placed in restored habitat areas to enhance habitat complexity, benefiting salmonids that utilize the Lower American River and improving the habitat conservation value within the Action Area. The installation of habitat structures has the potential to physically injure or kill rearing juvenile CCV steelhead that are likely to be present in the Action Area during construction activities. Placement of woody material may cause disturbance to substrates in the active channel along channel margins, causing minor and transient sedimentation events. Such events are likely to be negligible and are not expected to cause injury or death to juvenile CCV steelhead.

Measures will be taken to alert fish to the presence of construction equipment and the commencement of operations (see Section 1.4). Additionally, placement of such materials will generally occur along non-vegetated channel margins where presence of rearing juvenile CCV steelhead is expected to be minimal. Due to construction timing, incubating eggs and adult CCV steelhead are not likely to be present in the Action Area and therefore adverse effects are not expected to impact these life stages. Juvenile CCV spring-run Chinook and Sacramento River winter-run Chinook are not likely to be present during construction activities, therefore adverse effects are not expected to impact these ESUs.

2.4.2 Effects of the Proposed Action to Critical Habitat PCEs

Critical habitat has been designated in the Action Area for CCV steelhead and CCV spring-run Chinook. Sacramento River winter-run Chinook critical habitat exists two miles downstream of the Action Area but does not occur within it. Therefore the analysis of the direct and indirect potential effects of the Proposed Action to critical habitat will focus on CCV steelhead and CCV spring-run Chinook. The PCEs for these species that exist within the Action Area are 1) freshwater spawning habitat 2) freshwater rearing habitat and 3) a migration corridor.

1) Gravel Augmentation, Side Channel Creation and Flood Plain Enhancement

Removal of riparian vegetation will occur in the process of operating heavy construction machinery and creating access roads for the creation of side channel habitat, flood plain enhancement and gravel augmentation. Also, sediments will likely become suspended and transported as a result of these activities. Disturbance to riparian vegetation and sedimentation may have direct or indirect adverse effects to one or more PCEs that occurs in the Action Area. The following are potential adverse effects that may impact each PCE.

Freshwater Spawning Habitat

Kemp et al. (2011) describe a suite of physiochemical effects to lotic aquatic systems resulting from increased sedimentation and sediment-related events (Figure 21). Spawning habitat requires adequate substrate material, adequate delivery of oxygen-rich water and access for spawning adults and many landscape attributes that occur on multiple spatial scales (Feist et al. 2003). Furthermore, Isaak et al. (2007) demonstrated that spawning patch size and connectivity may be just as important as the quality of the habitat itself in terms of population viability. Sedimentation resulting from the Proposed Action has the potential to reduce the quality and quantity of available spawning habitat in the Lower American River by filling interstitial spaces between existing spawning gravel, releasing toxic particulate matter and reducing oxygen delivery to interstitial spaces.

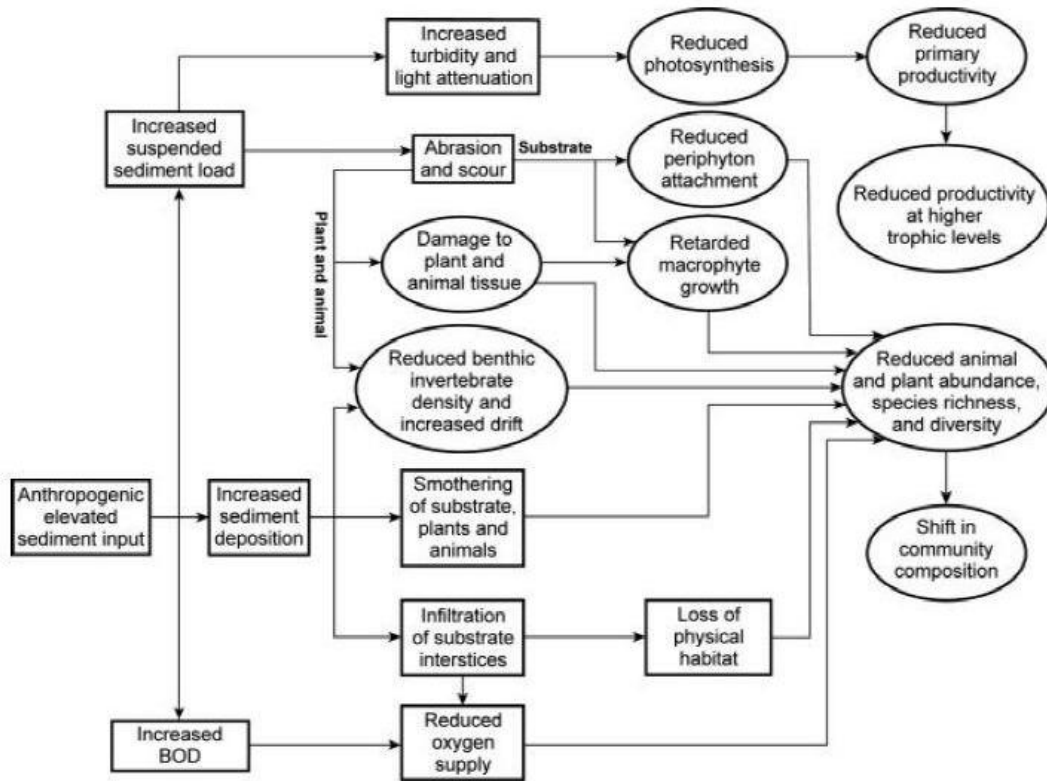


Figure 21. Negative impacts of anthropogenically enhanced sediment input to lotic aquatic systems at lower trophic levels. Rectangles and ovals respectively denote physiochemical effects and direct and long-term biological and ecological responses. *From: Kemp et al. (2011)*

Construction of side channel habitats, flood plain enhancement and gravel augmentation operations will require the removal of riparian vegetation in the Action Area which has the potential to have direct or indirect adverse effects on spawning habitat in the Action Area. It has been suggested by Dosskey et al. (2010) that presence and abundance of riparian vegetation can be directly correlated with water quality in riverine systems through biogeochemical cycling, soil and channel chemistry, water movement and erosion. Riparian vegetation also plays a role in maintaining adequate temperature for incubating eggs by shading. Removal of riparian vegetation has the potential to directly and indirectly adversely affect spawning habitat in the

Action Area. Minimization techniques, BMPs and replanting efforts will be implemented to ensure that these effects are minimized.

Table 2 indicates proposed Project Areas where gravel augmentation efforts will be implemented. Ultimately, additional gravel will improve the spawning habitat PCE by increasing the quality, quantity and connectivity of available spawning habitat in the Lower American River.

Freshwater Rearing Habitat

Sedimentation and scouring may have direct or indirect adverse effects to the freshwater rearing habitat PCE by reducing the quality and quantity of available rearing habitat. Reclamation (2015) demonstrated that juvenile CCV steelhead prefer riffle habitat areas when rearing in the Lower American River. Scouring and sediment transport may reduce available riffle habitat by filling interstitial spaces in existing substrate or by creating deep pools.

Riparian vegetation plays a key role in the conservation value of rearing habitat for all salmonid life stages. It provides shading to lower stream temperatures; increases the recruitment of large woody material into the river, increasing habitat complexity; provides shelter from predators and; enhances the productivity of aquatic macro invertebrates (Pusey and Arthington 2003, Anderson and Sedell 1979). It has also been shown to directly influence channel morphology and may be directly correlated with improved water quality in aquatic systems (Dosskey et al. 2010, Schlosser and Karr 1981).

Migration Corridor

The existing migration corridor in the Lower American River is essential for spawning adult access to viable spawning habitat as well as access to the estuary for emigrating juveniles. Sedimentation could potentially result in the loss of riffle habitat, resulting in adverse effects to the migration corridor PCE for the juvenile life stage as juveniles have been shown to prefer riffle habitat. Sedimentation and increased turbidity could also impact shallow and deep pools, reducing habitat quality in those areas.

Similar to its importance for freshwater rearing habitat, riparian vegetation is also an important component of migration corridors. It provides shading to lower water temperature and provides shelter from predators for emigrating juveniles. Food availability is also important for emigrating juveniles and the presence of riparian vegetation is known to increase macro invertebrate food production.

Losses of riparian vegetation due to the implementation of the Proposed Action will be minimized and effects will be mitigated through the use of BMPs, minimization and avoidance measures described in Section 1.4.

2) Placement of Large Woody Material

Placement of LWM is expected to have mostly beneficial effects to critical habitat PCEs within

the Action Area. There is a potential for loss of spawning habitat resulting from placement of large woody structures and from sedimentation that may occur during installation. However, the beneficial effects to PCEs in the Action Area resulting from the addition of woody material are expected to far outweigh the adverse effects. Roni and Quinn (2001) have demonstrated that the addition of woody material leads to higher densities of juvenile salmonids by improving habitat complexity. Increased habitat complexity through the addition of woody material into the Lower American River will ultimately improve the habitat conservation value of the three critical habitat PCEs that occur in the Action Area.

2.5 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). 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.

Concurrent habitat restoration programs will likely occur along the Lower American River throughout the duration of the proposed restoration program. A restoration project is currently underway at Cordova Creek (Sacramento County 2008), and is co-managed by a number of local agencies including Sacramento County Department of Regional Parks, Sacramento Area Water Forum, City of Rancho Cordova, CA Native Plant Society, Soil Born Farms, and Sacramento Area Flood Control Agency (SAFCA). This project aims to remove a 2,600 foot concrete drainage ditch and naturalize 4,000 linear feet of stream and riparian habitat. The confluence of this stream is located within a proposed Project Area (“Upper River Bend – Site 6”) and could result in cumulative effects to listed species and their critical habitat through sedimentation and increased turbidity downstream of the project area.

The NMFS West Coast Region Recovery Plan for CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook summarizes sources of habitat loss and population decline for these salmonid ESUs (NMFS 2014a). A significant factor for loss of abundance and available habitat is the installation of dams along major rivers and tributaries in the California Central Valley. The American River is a primary example of this phenomenon. However, one of the core goals of the Recovery Plan is to implement recovery actions that create, restore and enhance PCEs of these listed salmonid species. The Proposed Action is consistent with this goal. Through the implementation of restoration actions outlined in the Proposed Action, the conservation value of salmonid habitat in the Lower American River will be improved, contributing to the range-wide recovery of these ESUs.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency’s biological opinion as to whether the proposed action is

likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species.

CCV steelhead, CCV spring-run Chinook and Sacramento River winter-run Chinook ESUs have experienced significant declines in abundance and available habitat in the California Central Valley relative to historical conditions. The status of the species and critical habitat and environmental baseline sections (2.2 and 2.3) detail the current range-wide status of these ESUs and also the current baseline conditions found in the Lower American River, where the Proposed Action is to occur. Section 2.2.4 discusses the vulnerability of listed species and critical habitat to climate change projections in the California Central Valley and specifically in the Lower American River. Reduced summer flows and increased water temperatures will likely be exacerbated by increasing surface temperatures in the American River basin. The Lower American River is a highly manipulated system with flow and temperature regimes that differ drastically from their historical condition. Additionally, Nimbus and Folsom Dams have restricted access to historical spawning habitat for CCV steelhead and CCV spring-run Chinook. Currently, the Lower American River contains a spawning population of CCV steelhead, however, it is believed that this population is composed entirely of fish produced at Nimbus Hatchery or their descendants. CCV spring-run Chinook no longer spawn in the Lower American River, although juveniles are known to exhibit non-natal rearing behavior. Sacramento River winter-run likely never spawned in the American River historically, although juveniles of this ESU are known to exhibit non-natal rearing as well. Cumulative effects are likely to include sedimentation and turbidity events resulting from concurrent state and local habitat restoration projects in the Action Area. The Proposed Action contains restoration actions that are consistent with the NMFS recovery plan for these three ESUs, and are intended to aid in their long-term recovery and survival.

Effects of the Proposed Action to Listed Species

The Proposed Action has the potential to affect various life stages of CCV steelhead and rearing juvenile CCV spring-run Chinook and Sacramento River winter-run Chinook. However, the only life stage that is expected to be present in the Action Area during construction are juvenile CCV steelhead (Table 1). Construction of side channel habitats, flood plain modification and gravel augmentation are likely to result in sediment and turbidity pulse events which may result in adverse effects to juvenile CCV steelhead due to increased activity, gill fouling and reduced foraging capability. Incubating eggs are also susceptible to a multitude of adverse effects resulting from sedimentation, although eggs are expected to be hatched prior to the commencement of activity in the Action Area. Cumulative sediment and turbidity effects may result from the implementation of concurrent restoration programs in the Action Area such as the Cordova Creek project. Construction-related effects may also occur as a result of equipment operation in riparian habitats. Juvenile CCV steelhead are the only life stage that will likely be impacted by adverse construction-related effects. Contaminants and pollution events have the potential to occur in the Action Area and may impact all species and life stages considered in this consultation. BMPs, minimization and avoidance measures will be implemented for each project described in the proposed restoration program and will aid in minimizing direct impacts to listed fish in the Lower American River.

Effects of the Proposed Action to Critical Habitat

Critical habitat has been designated for CCV steelhead and CCV spring-run Chinook within the Action Area. Critical Habitat for Sacramento River winter-run Chinook occurs two miles downstream of the Action Area but not within it. Therefore it is excluded from the effects analysis associated with this consultation. PCEs contained within the Action Area are: 1) freshwater spawning habitat 2) freshwater rearing habitat and 3) a migration corridor. Spawning and rearing habitat PCEs have the potential to be adversely affected by sedimentation and loss of riparian vegetation through a variety of physical and biological mechanisms. The migration corridor PCE also has the potential to be adversely effected in the course of the proposed construction operations. However, the beneficial effects to critical habitat PCEs far outweigh the adverse effects. The results of the Proposed Action will ultimately enhance all three PCEs contained in the Action Area.

Survival and Recovery

The Lower American River contains a spawning population of CCV steelhead, making it an important tributary of the Sacramento River watershed in terms of range-wide recovery for this species. The Lower American River population of CCV steelhead is thought to be composed entirely of hatchery-produced fish. This population may aid in the range-wide recovery of CCV steelhead by increasing range-wide abundance, though they may introduce hatchery-related genetic effects if there is range-wide genetic introgression within this ESU. CCV spring-run Chinook and Sacramento River winter-run Chinook utilize the Lower American River for non-natal rearing, making it an important tributary for increasing the range-wide carrying capacity for rearing juveniles of these runs.

Restoration Goals outlined in the Proposed Action are consistent with specific recommended recovery actions for the Lower American River outlined in the NMFS Recovery Plan for these ESUs (see section 2.3). Implementation of the proposed restoration program is consistent with the NMFS recovery plan and is expected to aid in the range-wide recovery of these ESUs.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead, CCV spring-run Chinook salmon and Sacramento River winter-run Chinook salmon or destroy or adversely modify its designated critical habitat (Table 7).

Table 7. Summary of ESA Section 7 Determinations.

Species	Is the Proposed Action likely to result in adverse effects to the species?	Is the Proposed Action likely to result in Jeopardy for the species?	Is the Proposed Action likely to result in destruction or adverse modification of critical habitat?
CCV steelhead (<i>O. mykiss</i>)	Likely	No	No
CCV spring-run Chinook (<i>O. tshawytscha</i>)	Not Likely	No	No
Sacramento River winter-run Chinook (<i>O. tshawytscha</i>)	Not Likely	No	N/A

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a 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 regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). “Incidental take” is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take would occur as follows:

NMFS anticipates incidental take of CCV steelhead to occur in the course of the Lower American River Anadromous Fish Habitat Restoration Project. Specifically, NMFS anticipates that juvenile CCV steelhead may be killed, wounded or harassed as a result of project implementation as they will likely be present in the Action Area during the scheduled work period each year.

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 take is an ecological surrogate of temporary habitat disturbance during gravel placement, instream excavation activities for floodplain and side channel enhancements, and instream placement of habitat structures (LWM). It is

important to note that the Project Area dimensions listed in Table 2 indicate the maximum area that may be impacted at each site. Actual project footprints are yet to be determined but will be smaller. Numbers of fish are based on fish density and a description of ecological surrogates associated with the Proposed Action are used to describe the extent and form of anticipated take. For the reasons described in Sections 1.4 and 2.4, the actual amount of take is expected to be low.

Fish density assumptions are based on seining and snorkel surveys conducted by Reclamation in the Lower American River between the months of July and September. Species and life stage presence is indicated in Table 1. Juvenile CCV steelhead are the only species/life stage expected to be in the Action Area during the scheduled work period and they are expected to occupy riffle habitats based on information provided to NMFS in the Biological Assessment prepared for this consultation (Reclamation 2015). Juvenile CCV steelhead density in Lower American River riffle habitats during the scheduled work period is estimated to be 0.00125 fish per square foot.

NMFS anticipates annual take will be limited to:

1. Take in the form of harm to juvenile CCV steelhead resulting from temporary disruption of up to 500 ft X 300 ft per site of main riffle habitat resulting from gravel augmentation projects (up to 3 per year) that will affect the behavior of up to 198 fish and increase predation risk, decrease feeding and increase competition resulting in the injury or death of up to 10 fish per year.
2. Take in the form of harm to juvenile CCV steelhead resulting from temporary disruption of up to 100 ft X 50 ft per site of main riffle habitat resulting from side channel creation and floodplain enhancement/modification projects (up to 3 per year) that will affect the behavior of up to 57 fish and increase predation risk, decrease feeding and increase competition resulting in the injury or death of up to 3 fish per year.
3. Take in the form of harm to juvenile CCV steelhead resulting from temporary disruption of up to 500 ft X 300 ft per site of main riffle habitat resulting from gravel augmentation projects (up to 3 per year) that will affect the behavior of up to 198 fish and increase predation risk, decrease feeding and increase competition resulting in the injury or death of up to 10 fish per year.
4. Take in the form of harassment may occur as a result of displacement due to construction operations.

Take resulting from the four activities listed above may include injury or death of a small number of juvenile CCV steelhead (see “amount and extent of take for each action” in Table 8 below). Injury or death may also occur as a result of these activities as described above in Section 2.4.1.

In addition, take from these activities is expected to harass and/or harm the species by temporarily impacting freshwater rearing habitat and migration habitat which are designated as a critical habitat PCEs. Juvenile CCV steelhead will be affected because they will temporarily lose access to and use of this habitat for rearing and migration. Disruption of habitat utilization

may result in increased predation risk, decreased feeding, and increased competition. The behavioral modifications that are expected to result from disruption of habitat use are the ecological surrogates for take. There is not a stronger ecological surrogate based on the information available at this time. It is not possible to quantify the exact numbers of individuals that may be affected however, an estimate has been generated using expected fish densities provided by Reclamation (Reclamation 2015).

Table 8. Ecological surrogates describing the amount and extent of take.

Species and life stage	Restoration Action	Life Stage Presence	Habitat Disturbance Amount	Amount and Extent of Take for each action (Wound, Kill or Harass)
California Central Valley steelhead (<i>O. mykiss</i>) (Juveniles)	Gravel Augmentation (via front end loader)	Juveniles likely rearing in the Action Area during the planned in-stream work period of July 1 st and October 30 th . Expected to occupy riffle habitats (Reclamation 2015).	6 predetermined sites; 12 total acres (Project Areas), 58,000 yd ³ material added. 10 undetermined sites; 120 total acres (Project Areas), 120,000 yd ³ material added. Temporary loss of up to 500ft X 300 ft sections of main channel riffle habitat.	The Proposed Action will expose fish to temporary habitat disturbance that will affect the behavior of 198 fish per year (66 fish per site, up to 3 sites per year). Of this potential level of take, mortality is likely for no more than 10 fish (5.1% of total take).
	Side channel modification and flood plain habitat enhancement (Excavation)		8 predetermined sites; 43.1 total acres (Project Areas), 230,000 yd ³ material removed. 10 undetermined sites 70 total acres (Project Sites), 4 new side channels per site (volume of material to be removed TBD). Temporary loss of up to 100 ft X 50 ft sections of main channel riffle habitat.	The Proposed Action will expose fish to temporary habitat disturbance that will affect the behavior of 57 fish per year (19 fish per site, up to 3 sites per year.) Of this potential level of take, mortality is likely for no more than 3 fish (5.3% of total take).
	Large Woody Material placement (partial burying)		LWM placement will occur at each project site; 257 total acres (Project Sites). 100 log structures per year. Temporary loss of up to 500 ft X 300 ft sections of main channel riffle habitat.	The Proposed Action will expose fish to temporary habitat disturbance that will affect the behavior of 198 fish per year (66 fish per site, up to 3 sites per year). Of this potential level of take, mortality is likely for no more than 10 fish (5.1% of total take).

2.8.2 Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

“Reasonable and prudent measures” are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to minimize sedimentation events and turbidity plumes in the Action Area and their direct and indirect effects to listed species and their critical habitat.
2. Measures shall be taken to minimize impacts to riparian vegetation in the Action Area and its direct and indirect effects to critical habitat.
3. Prepare and provide NMFS with a plan and a report describing how listed species in the Action Area would be protected and/or monitored and to document the observed effects of the action on listed species and critical habitat PCEs in the action area.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and Reclamation or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). Reclamation or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
 - a. BMPs shall be implemented to prevent soil erosion and sediment incursion into the active channel. Straw bales, straw wattles and silt fences will be installed at source sites for each project.
 - b. Operation of heavy machinery in the active channel shall be minimized and will occur over previously placed gravel beds to avoid disturbance of substrates.

- c. Turbidity and settleable solids shall be monitored according to water quality permits. If acceptable limits are exceeded, work shall be suspended until acceptable measured levels are achieved.
 - d. In-water work that may cause turbidity and/or sedimentation events less than 200 feet upstream of any active redds shall be avoided.
 - e. Gravel mobilization, sorting and loading shall occur outside of the active channel. Fine sediments, oils, clay, organic material and any other debris shall be removed from gravel prior to placement.
 - f. Disturbed areas adjacent to the active channel that are deemed unstable shall be covered with river rock, vegetated with native plant species and/or mulched with certified weed-free hay upon project completion.
2. The following terms and conditions implement reasonable and prudent measure 2:
- a. Equipment used for the project shall be thoroughly cleaned off-site to remove any invasive plant material or invasive aquatic biota prior to use in the Action Area.
 - b. Environmentally sensitive areas, sensitive plant species and wetland areas shall be avoided during project activities to the maximum extent practicable. High visibility fencing shall be placed around these areas to minimize disturbance.
 - c. Gravel, soil, excavated material and/or fill material shall be stockpiled in existing clearings and will occupy an area no larger than one half acre.

NMFS Requests that Reclamation submits an annual report each year for the duration of the Lower American River Anadromous Fish Habitat Restoration Program beginning July 2016 including project schedules, project completions and details regarding project implementation for each given year. Details shall include predetermined project site descriptions, project site descriptions for previously undetermined site locations, project durations, a synthesis of the adaptive management strategy used for site selection and any concurrent restoration projects that are scheduled to occur in the Action Area (similar to the project described in Section 2.5 of this Biological Opinion). NMFS also requests that Reclamation hold an annual meeting each year for the duration of the Lower American River Anadromous Fish Habitat Restoration Program beginning July 2016. This meeting shall include all stake holders involved with the Proposed Action and shall serve to enhance communication among stake holders to ensure that project plans are adhered to and that project goals are being met.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and

endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

- (1) Reclamation should provide a NMFS-approved Worker Environmental Awareness Training Program for construction personnel to be conducted by a NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections under the ESA, and an explanation of terms and conditions identified in this Biological Opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training. Completion of this training is consistent with agency requirements set forth in section 7(a)(1).
- (2) Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and sturgeon habitat restoration projects within the Sacramento River Basin. Implementation of future restoration projects is consistent with agency requirements set forth in section 7(a)(1).

2.10 Reinitiation of Consultation

This concludes formal consultation for The Lower American River Anadromous Fish Habitat Restoration Program.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 “Not Likely to Adversely Affect” Determinations

NMFS does not anticipate the proposed action will take CCV spring-run Chinook salmon or Sacramento River winter-run Chinook salmon (Table 7). Based on best available information, only the juvenile life stage of each of these species is known occur in the Action Area and is not expected to be present in the Action Area during the planned in-water work window. NMFS has also determined that the Proposed Action will NLAA critical habitat designated for CCV steelhead and CCV spring-run Chinook salmon. Details regarding the potential for direct or indirect adverse effects to these species and/or their critical habitats are included in Section 2.4.

3. MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT ACT

ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by Reclamation and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH designated under the Pacific Coast Salmon Fisheries Management Plan (FMP) may be affected by the Proposed Action. Additional species that utilize EFH designated under this FMP within the Action Area include fall-run/late fall-run Chinook salmon. Habitat Areas of Particular Concern (HAPCs) that may be either directly or indirectly adversely affected include **(1)** complex channels and floodplain habitats, **(2)** thermal refugia and **(3)** spawning habitat.

3.2 Adverse Effects on Essential Fish Habitat

Effects to the HAPCs listed in section 3.1 above are discussed in context of effects to critical habitat PCEs as designated under the ESA in section 2.4.2. Effects to ESA-listed critical habitat and EFH HAPCs are appreciably similar, therefore no additional discussion is included. A list of adverse effects to EFH HAPCs is included in this EFH consultation. Affected HAPCs are indicated by number corresponding to the list in section 3.1:

Sedimentation and turbidity

- Reduced habitat complexity **(1)**
- Reduced quality and availability of spawning substrate **(3)**
- Reduced delivery of oxygenated water to incubating eggs **(3)**
- Reduced size and connectivity of spawning patches **(1, 3)**
- Increased scouring **(1, 3)**
- Reduced riffle habitat **(1, 3)**

Removal of riparian vegetation

- Degraded water quality (1, 3)
- Reduced shading (2)
- Reduction in LWM recruitment (1)
- Reduced shelter from predators (1)
- Reduction in aquatic macroinvertebrate production (1)

3.3 Essential Fish Habitat Conservation Recommendations

The following are EFH conservation recommendations for the proposed project:

- (1) Reclamation should provide a NMFS-approved Worker Environmental Awareness Training Program for construction personnel to be conducted by a NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections under the ESA, and an explanation of terms and conditions identified in this Biological Opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training. HAPCs that would benefit from implementation of this training include (1) complex channels and floodplain habitats, (2) thermal refugia and (3) spawning habitat.
- (2) Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid and sturgeon habitat restoration projects within the Sacramento River Basin. HAPCs that would benefit from implementation of additional restoration projects include (1) complex channels and floodplain habitats, (2) thermal refugia and (3) spawning habitat.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 257.1 acres of designated EFH for Pacific coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, Reclamation must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any

disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

Reclamation must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

The following recommendation applies to the proposed action:

- (1) Reclamation should post interpretive signs within the Action Area describing the presence of listed fish and/or critical habitat as well as highlighting their ecological and cultural value.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA.

This concludes the FWCA portion of this consultation.

5. 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.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Bureau of Reclamation. Other interested users could include the Sacramento Area Water Forum, U.S. Fish and Wildlife, California Department of Fish and Wildlife and the Lower American River Fisheries and Instream Habitat (FISH) Working Group. Individual copies of this opinion were provided to the U.S. Bureau of 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.

5.2 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.

5.3 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 MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion EFH consultation 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 MSA implementation and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

6. REFERENCES

A. Literature Cited

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