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

OCT - 9 2015

Refer to NMFS No: WCR-2015-2725

Ms. Sue Fry
Area Manager
U.S. Department of the Interior
Bureau of Reclamation
801 I Street, Suite 140
Sacramento, California 95814-2536

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic, in Shasta and Tehama counties

Dear Ms. Fry:

Thank you for your letter of February 3, 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.*) for the Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic, in Shasta and Tehama counties, California. This letter transmits NMFS' biological opinion based on information provided in the biological assessment provided on February 6, 2015, and email discussions between NMFS and U.S. Bureau of Reclamation clarifying project description and effects of the project. A complete administrative record of this consultation is on file at the NMFS California Central Valley Area Office.

Based on the best available scientific and commercial information, the biological opinion concludes that the Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic is not likely to jeopardize the continued existence of the federally listed as endangered Sacramento River winter-run Chinook salmon *(Oncorhynchus tshawytscha)* evolutionarily significant unit (ESU), the threatened Central Valley spring-run Chinook salmon (0. *tshawytscha)* ESU, the threatened California Central Valley steelhead Distinct Population Segment (DPS) (*O. mykiss*), or the threatened Southern DPS of North American green sturgeon *(Acipenser medirostris)*, and is not likely to destroy or adversely modify designated critical habitat. Additionally, NMFS has 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 review of potential effects of the proposed action on essential fish habitat (EFH) for Pacific Coast Salmon, designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), including conservation recommendations. This review was pursuant to section 305(b) of the MSA, implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. The document concludes that the project will adversely affect the EFH of Pacific Coast Salmon in the action area and has included recommendations

Because the proposed action will modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources under the Fish and Wildlife Coordination Act (16 U.S.C. 662(a)).

Please contact Naseem Alston at the California Central Valley Office: 916-930-3655, or Naseem.Alston@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Maria Rea
for William W. Stelle, Jr.
Regional Administrator

Enclosure

CC: CHRON File: 151422-WCR2015-SA00123

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

Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic

NMFS Consultation Number: WCR-2015-2725

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

Affected Species and NMFS' Determinations:

ESA-Listed Species	**Status**	**Is Action Likely to Adversely Affect Species or Critical Habitat?**	**Is Action Likely To Jeopardize the Species?**	**Is Action Likely To Destroy or Adversely Modify Critical Habitat?**
Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	No
Central Valley Spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley Steelhead (*O. mykiss*)	Threatened	Yes	No	No
Green Sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No

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:

for Maria Rea
William W. Stelle, Jr.
Regional Administrator

Date: OCT - 9 2015

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Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic

NMFS Consultation Number: WCR-2015-2725

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

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Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	No
Central Valley Spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley Steelhead (*O. mykiss*)	Threatened	Yes	No	No
Green Sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No

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:

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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 California Central Valley Area Office.

The upper Sacramento River between Keswick Dam and the Red Bluff Diversion Dam (RBDD) presents several opportunities for improving and restoring salmonid spawning and rearing habitats. As of 2014, an interagency group of experts has identified 13 specific restoration sites that are intended to maintain flexibility for providing salmonid spawning and rearing habitat enhancement through long-term gravel replenishment, in-channel gravel placements, and side channel and floodplain enhancements to meet the goals of the Central Valley Project Improvement Act of 1992 (CVPIA) Section 3604(b)(13) Habitat Restoration Program. The criteria used to select sites and develop conceptual designs include: biological need, site suitability and access, engineering feasibility, environmental compliance and permitting, gravel availability and transportation, and cost-benefit. The proposed action includes 13 known sites and several unknown future sites.

Reclamation has been designated as the lead action agency for this project by the U.S. Army Corps of Engineers (Corps). The Corps will be issuing Reclamation a permit (or permits) for the projects under this programmatic. This biological opinion will therefore satisfy the requirements for the Corps to consult with NMFS under section 7 of the ESA of 1973, as amended (16 U.S.C 1531 et seq.).

1.2 Consultation History

February 3, 2015, Reclamation sent NMFS a request for formal consultation on the proposed project.

April 13, 2015, NMFS sent an email request to Reclamation for additional information on several sections of the BA, including project description and effects of the project. April 23, Reclamation emailed responses.

April 29, and May 19, 2015, NMFS sent additional clarifying questions to Reclamation, and received final responses on June 1, 2015. June 1, 205, NMFS initiated consultation.

Throughout June, communication exchange occurred between NMFS and Reclamation regarding habitat impacts.

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). Reclamation proposes to implement an Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic (proposed action), which includes several related habitat restoration activities in the Upper Sacramento River watershed. The proposed action will implement projects in the Upper Sacramento River between Keswick Dam (river mile [RM] 302) and RBDD (RM 243), in Shasta and Tehama Counties, California. The proposed activities are described as occurring in three zones (Table 1), and are a continuation of ongoing anadromous fish habitat restoration efforts in the Upper Sacramento River authorized under CVPIA Section 3604(b)(13). Activities include three types (Table 2): (1) spawning gravel augmentation; (2) floodplain and side channel habitat enhancements; and (3) placement of instream habitat structures (*e.g.*, woody material and boulders).

The CVPIA (b)(13) Sacramento River Restoration Team (SRRT) is an interagency group with members including Reclamation, National Marine Fisheries Service (NMFS), California Department of Water Resources (CDWR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW), and State Water Resources Control Board (SWRCB). The group was formed to provide technical support in the development of future salmonid habitat restoration projects in the upper Sacramento River.

Reclamation, in collaboration with the SRRT, has identified a need to combine several restoration and management activities into one long-term proposed action that will allow managers some flexibility to tailor habitat restoration projects (within pre-established limitations), and to reprioritize and schedule activities based on the most current monitoring results. This flexibility will allow Reclamation to use fishery and physical habitat monitoring information and available funding levels to meet established restoration goals and objectives, respond to any environmental changes, and optimize overall performance of the CVPIA (b)(13) Habitat Restoration Program. The objectives of the proposed action are to: improve adult spawning and juvenile rearing habitat conditions for anadromous fish species.

Table 1. Work Zone Locations and In-River Work Windows.

Zone	Location	In-River Work Window
Zone 1	Keswick Dam (RM 302) to approximately 1.5 miles downstream	Year-round (anytime flows are <15,000 cfs**)
Zone 2	Approximately 1.5 mile downstream of Keswick Dam (RM 300.5) to Cow Creek (RM 280)	October 1 to May 15* (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)
Zone 3	Cow Creek (RM 280) to Red Bluff Diversion Dam (RM 243)	October 1 to March 1* (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)

*Construction may be conducted year-round in areas, such as floodplains and side channels, when flowing water is absent due to separation from the main channel by gravel berms that are either naturally present or artificially created.

**cfs = cubic feet per second

Table 2. Upper Sacramento River Anadromous Fish Habitat Restoration Sites.

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 1-Keswick	Zone 1: 302	Gravel Augmentation	EDTC	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 2-Salt Creek	300.7	Gravel Augmentation	LB	0.5 acres	20,000 yd^3	As needed	4 weeks
Site 3-Market Street	Zone 2: 298.3	Gravel Augmentation	RS	3.5 acres	15,000 yd^3	As needed	4 weeks
Site 4-Turtle Bay Island	297	Side Channel Creation; Instream Habitat Structure	EX, HS	Each: 1.1 acres	4 new side channels	Once	8 weeks***
Site 5-Kutras Lake	296	Instream Habitat Structure	HS	40 acres**	20 structures	Pilot-once, then as needed	3 weeks
Site 6-Cypress	295	Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	2 modified side channels	Once	6 weeks***
Site 7-Cypress Avenue Bridge South		Side Channel Creation; Instream Habitat Structure	EX; HS	4 acres	1 new side channel with possible small branches	Once	5 weeks****
		Gravel Augmentation	RS	8 acres**	15,000 yd^3***	As needed	5 weeks
Site 8-Tobiasson Island	291.6	Side Channel Creation; Instream Habitat Structure	EX, RS, HS	Each: 1.7 acres**	3 new side channels	Once	8 weeks***
		Gravel Augmentation in West Side Channel	EX, RS, HS	1.5 acres	6,000 yd^3	Once	3 weeks
		Gravel Augmentation in Main	RS	6 acres	12,000 yd^3	As needed	5 weeks
Site 9- Shea Island	289.6	Gravel Augmentation	RS	12 acres**	12,000yd^3	As needed	5 weeks
		Side Channel Reconnection; Instream Habitat Structure	EX, HS	3 acres	3 reconnected side channels	Once	8 weeks***
Site 10- South Shea Levee	289	Gravel Augmentation	RS	3.3 acres**	10,000 yd^3	Once	4 weeks
Site 11-Kapusta Island	288	Side Channel Creation/Modification; Instream Habitat Structure	EX, HS	1.4 acres	1 new & 3 modified side channels	Once	8 weeks***
		Gravel Augmentation	RS	4 acres	12,000 yd^3	Once	6 weeks

Site	RM	Restoration Type	Method*	Approximate Maximum Dimensions	Approximate Maximum Quantity	Frequency	Approximate Duration of Activity
Site 12- Anderson River Park	282	Side Channel Reconnection	EX, HS	11.5 acres	1 side channel reconnected	Once	6 weeks***
Site 13- Reading	Zone 3: 275	Side Channel Reconnection	EX, HS	7.4 acres	1 side channel reconnected	Once	6 weeks***
Unspecified Locations	243-300.5	Gravel Augmentation	EDTC	Per site: 0.5	20,000 yd^3 per sites	As needed	4 weeks
			LB	Per site: 0.5	20,000 yd^3 per site;	As needed	4 weeks
			RS	Per site: 12	12,000yd^3 per site;	As needed	5 weeks
		Side Channel Creation/ Modification	EX, HS	Per site: 4 acres	4 new/ modified side channels per site; 10 sites	Once per site	2-6 weeks***
		Instream Habitat Structure	HS	Per site: 4 acres**	Per Year: 30 boulder clusters, 100 log structures; 3 sites	As needed	3-8 weeks***

*Method codes are: EDTC = End Dump Talus Cone; LB = Lateral Berm; RS = Riffle Supplementation; EX = Excavation; HS =Habitat Structure Placement
**Number represents potential action area; the actual project footprint location within the area is unknown but will be smaller.
***Values represent overall construction timeframe; actual duration of instream work will be less than half of this timeframe (i.e., less than 1.5-4 weeks dependent on project type and site).

1.3.1 Gravel

The gravel placed will be uncrushed, rounded "natural river rock" with no sharp edges. It will be a reasonably well-graded mix, designed for spawning use by salmonids, made using an approximately ¼ inch screen on the bottom. The D_{50} (median diameter of sample) of the mix will be around 1 inch to 1-1/2 inch. The gravel will be processed prior to delivery to the sites to remove excessive fine materials and minimize introduction of excessive fine sediments into the river. The gravel will be free of oils, clay, debris, and organic material. Materials excavated from side-channel work may be used for onsite gravel placement and sorted as needed to meet design criteria. The larger gravel and cobble resulting from sorting operations will be used as needed to enhance stability of habitat features.

Up to 20,000 cubic yards of cleaned and sorted gravel will be placed at individual sites each year with up to a combined total of 60,000 cubic yards (up to three sites per year) within the project action area annually. Some augmentation sites (*e.g.* Salt Creek, Market Street, Cypress and Tobiasson) may include floodplain modification and recontouring of the channel, and up to approximately 25,000 cubic yards of material at each site may be excavated, sorted, and redeposited in the nearby channel as part of the habitat improvement project. Where additional instream grading of gravel is required, an excavator or bulldozer will be used. Existing access routes (roads or trails) will be used wherever possible. Clearing or grading to create up to six temporary access routes per year (up to two per site) from existing roads or trails may be necessary to provide equipment access to the gravel augmentation sites. Instream work will be conducted during seasons of the year that are least likely to impact winter-run and spring-run Chinook salmon, steelhead, and green sturgeon incubating eggs.

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

- **Lateral Berm** – A recruitment-pile of gravel is placed as a steeply sloping bar parallel to the channel to provide a long-term supply of spawning gravel and is mobilized into the river channel during high flows;
- **Riffle Supplementation** – Gravel is placed, contoured within the channel (partial or entire channel width), and graded to appropriate depths to provide immediate spawning habitat;
- **End Dump Talus Cone** – A large pile of gravel is placed on the riverbank for recruitment into the river during high flows.

For riffle supplementation, gravel will be placed in the river using dump trucks and front end loaders. At some sites the substrate will be graded with a bulldozer prior to gravel additions to remove armoring (surface layer of larger rock) or to meet topographic design specifications. A bulldozer will be used to distribute the materials in areas unworkable for loaders. For the gravel placement, front end loaders will pick up a bucket of gravel from the stockpile and drive from the stockpile into the river and carefully dump the gravel in a manner as to distribute it across the river bottom according to design parameters. Placement will proceed starting from the river access site and working out into the river. This will allow the loaders to drive on the newly placed gravel, thereby avoiding driving in overly deep water and distributing fines from the existing substrate. Off-road dump trucks will haul the material into the river in areas where the travel distance to an onshore stockpile is excessively long for multiple loader trips. The loaders will distribute the gravel along the river bottom to create the hydraulic conditions necessary for salmonid spawning. This work will use two or three front end loaders for 4-6 weeks at a location, dependent on project site. A tracked bulldozer or excavator will be used for grading the existing substrate and larger placed rock as needed.

For Talus Cone and Lateral Berm sites, gravel will be dumped directly onto the riverbank from dump trucks or dumped using front end loaders. The trucks will originate from a stockpile area or an off-site processing plant.

1.3.2 Floodplain and Side Channel Habitat Enhancement

There are six specified floodplain and side channel enhancement projects included under the proposed action (Table 2) that will create approximately 37 acres of new or re-established floodplain and side channel habitat. In addition to specifically identified restoration projects, the proposed action includes potential implementation of similar habitat restoration activities (*i.e.*, similar types, sizes, and construction methods) at currently unspecified locations between RM 300.5 (*i.e.*, 1.5 miles downstream of Keswick Dam) and RBDD.

Floodplain and side channel habitat enhancements may consist of new or reconnected side channels and floodplain modifications that are designed to function under flows within the main channel ranging between 3,250 cfs to 7,000 cfs. Physical characteristics will be variable with average water velocities ranging between 1.5 feet per second (fps) to 4.0 fps, water depths averaging between one to three feet deep, and channel widths ranging between 12 to 50 feet wide for new channels and potentially larger for existing channels. Water velocities will be designed to be variable and range up to about 5.0 fps at design flows. Floodplain and side channel habitats will be created, reconnected, or modified by excavation using heavy equipment (i.e., bulldozer, front end loader, excavator). Where the excavated material is of the appropriate size distribution it will be sorted and placed into side channel or main channel areas to enhance habitat features. The fines will be distributed over the floodplain to assist in vegetating the area. Gravel placed into the main channel may be used to help back water up into side channels. Low elevation gently sloping benches will be created along channels in opportune areas to provide juvenile rearing habitat through a range of flows.

Instream habitat structures (*e.g*., woody material such as, trees, trunks, rootwads, and willows; and variable sized large rocks) will be incorporated into the side channels to enhance habitat quality. The woody material will be held in place by partially burying it in the existing substrate or banks or keying into existing material to provide some stability under higher flows.
Up to five acres of floodplain and side channel enhancements may occur at individual sites each year with up to a combined total of 15 acres (up to three sites per year) within the project action area annually. Enhancement activities will require heavy construction equipment (*e.g*., front end loaders, bulldozers, and excavators), as well as hand tools. During the majority of construction, a gravel berm will be left at both the upstream and downstream ends of each site to isolate the project area from the main channel.

Up to approximately 30,000 cubic yards of material may need to be excavated, sorted, and redeposited in the channel at these sites. Gravel in excess of what will be needed for creating or modifying the floodplain and side channel to their design specifications may be placed in mid-channel or river bank areas within the vicinity of the excavation. Any instream work will be conducted during seasons of the year that are least likely to result in impacts to winter-run and spring-run Chinook salmon, steelhead, and green sturgeon incubating eggs.

1.3.3 Placement of Instream Habitat Structures

In order to improve conditions within this reach, instream habitat structures consisting of logs, rootwads, and boulders will be placed into the active channel of the Upper Sacramento River using construction equipment (*e.g.*, front end loaders, excavators) and/or hand tools. Placement of instream habitat structures in the active main channel and/or side channels is expected to create instantly available juvenile salmonid rearing habitat. Structures that create quiet water or debris accumulation at the stream margins are beneficial for salmonid fry survival following emergence. Coupled with gravel augmentation, both log structures and boulder clusters help to sort augmented gravels that become mobilized during high flows, and help to direct flows that hydraulically scour and maintain pools. The enhancement or creation of large, deep pools with abundant cover can improve rearing habitat for juvenile salmonids.

Three potential habitat structure designs have been identified:

- **Boulder Clusters** – structures placed in the active channel and along riverbanks. Heavy equipment (*i.e.*, dump trucks, excavators, loaders, and/or bulldozers) will be required for transporting and positioning boulders.

- **Digger Logs** – logs placed with one end anchored on the bank and the other extending into a pool. Digger logs will usually be positioned to point downstream, although there may be some situations where pointing them upstream will be appropriate (*e.g.*, where the intention of the log placement is to create scour).
- **Spider Logs** – several logs placed together, at angles, to mimic a log jam. Each of the logs will be partially buried in the bank or channel or secured to bedrock or large boulders in the channel with cable and polyester resin adhesive, or to live trees with threaded rebar.

Instream habitat structures will be placed, as needed, within gravel augmentation and side channel enhancement sites within the Upper Sacramento River. Using an adaptive management approach, the SRRT will identify potential placement sites based on the results of ongoing anadromous fisheries monitoring within the area. Up to 30 boulder clusters and 100 woody material structures will be placed within the Upper Sacramento River in a given year. The designs for instream habitat structures will be consistent with guidance provided in the California Salmonid Stream Habitat Restoration Manual, 4th Edition (Flosi et al. 2010).

1.3.4 Temporary Access to Restoration Sites

Access to all sites will use existing roads or trails, where feasible, to minimize impacts on vegetation. Several gravel augmentation and all floodplain and side channel enhancement and instream habitat structure placement sites will require temporary access routes from existing roads or trails to the river. Up to a total of nine temporary access routes may be created/re-used each year (three routes per site and up to three sites per year), which will temporarily disturb up to a total of 0.6 acres (< 0.2 acres per site and up to three sites) of existing gravel bars and/or vegetation per year including up to a total of 135 linear feet (< 45 linear feet per site and up to three sites) of vegetation disturbed at the channel margin. Disturbed areas, not intended for future road access or gravel placement, will be covered with river rock or revegetated with native plant species and mulched with certified weed-free hay as appropriate following the completion of construction activities. Access routes that may be re-used (*e.g*. Keswick, Salt Creek) will be left in their disturbed state throughout the life of the program or until they are no longer needed.

1.3.5 River Crossings

Some sites will require a temporary river crossing to access the project. All crossings within the main channel will be designed to ensure that conditions are maintained for effective upstream and downstream fish passage, at all times and under all flow conditions.

Work will never restrict passage across the entire Sacramento River channel. Gravel placement will occur starting from one bank of the river with front end loaders working out from a river access route and distributing the gravel cumulatively further into the channel throughout the project area. At some points, the loaders will drive completely across the river. Continuous flow will occur over the loader route and the gravel placement area so that even when equipment is completely traversing across the river salmonids will have easy access both upstream and downstream through the project site. Flow through side channels will be blocked during side channel work to protect water quality in the main channel but the main channel will always remain open for unrestricted upstream and downstream passage.

1.3.6 Conservation Measures and Avoidance/Minimization Measures

1.3.6.1 *Measures to Minimize Exposure of Potential Impacts to Listed Species*

- Restrict instream work to in-river work windows that minimize impacts and the potential for take of vulnerable life stages of the listed species (*e.g.*, incubating eggs, pre-emergent fry).

- During side channel work, a gravel berm will be constructed at both the upstream and downstream ends of each site to isolate the project area from the main channel, keeping fish from moving into the work area, and keeping sediment from mobilizing downstream.

- Conduct pre-construction salmonid redd surveys within 200 feet downstream of a project site (aerial and/or boat) and implement avoidance measures (*e.g.*, modification of work area; turbidity management such as a sediment curtain, or placing a gravel berm to redirect flow; changing timing of activities) to minimize effects if project activities may affect egg survival.

- Use heavy equipment operation practices that minimize the potential for injury or death of vulnerable life stages of listed fishes, including, alerting fish to equipment operation in the channel before gravel is placed in the water (*e.g.*, slow, deliberate equipment operation and tapping water surface prior to entering river channel).

- Work in the water will only occur for up to 12 hours per day to allow for a 12 hour window of time for fish to migrate through without noise disturbance.

1.3.6.2 *Measures to Control Turbidity and Suspended Sediment during Construction*

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

- Equipment operation in the active channel will be kept to the minimum necessary to meet the project goals. When in-channel work is unavoidable, clean spawning gravel will be used where feasible to create a pad in the channel from which equipment will operate.

- Turbidity and settleable solids will be monitored to maintain compliance with U.S. Army Corps of Engineers Section 404 and SWRCB 401 permit requirements. If exceedances occur, work will be slowed or halted to allow turbidity to subside.

- If instream work may cause turbidity within 200 feet downstream of a project site that could affect egg survival of active winter-run or spring-run Chinook salmon redds, avoidance measures (*e.g.*, modification of work area, turbidity management such as placing gravel berm to redirect flow, changing timing of activities) will be implemented to minimize potential turbidity related effects .

1.3.6.3 *Measures to Minimize or Avoid Adverse Effects to Riparian Vegetation*

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

- Disturbed areas adjacent to the river (less than nine acres per year), not intended for future road access or gravel placement, will be covered with river rock or revegetated with native plant species and/or mulched with certified weed-free hay following the completion of construction activities. Recolonization is expected to occur within two years in restoration areas, and within five years at access route areas.

- Equipment used for the project will be thoroughly washed off-site to remove invasive plant seed, stems, etc. and inspected to prevent transfer of aquatic invasive species, such as quagga mussel and New Zealand mud snail, prior to arriving at the construction area.

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

1.3.6.4 *Measures to Prevent and Manage Potential Spills of Hazardous Materials*

- A Spill Prevention Containment and Countermeasures Plan (SPCCP) will be in place, and spill prevention and cleanup kits will be in close proximity to construction areas and workers will be trained on their use.

- Heavy equipment operating in the river will use biodegradable hydraulic fluid, and equipment will be checked daily for leaks and any leaks fixed prior to activities in sensitive areas.

- All construction equipment refueling and maintenance will be restricted to designated staging areas located away from the river and sensitive habitats.

"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 interrelated or interdependent activities associated with the proposed action.

1.4 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).

The project action area, the area subject to the proposed federal action, encompasses an approximately 59-mile reach of the Upper Sacramento River and adjacent land between Keswick Dam and RBDD. This area of evaluation is large enough to encompass both the potential direct impacts on listed species, such as mortality of rearing juveniles, and the potential indirect impacts, such as elevated turbidity that may extend beyond the individual project sites.

The upper Sacramento River between Keswick Dam and RBDD presents several opportunities for improving and restoring salmonid spawning and rearing habitats. As of 2014, an interagency group of experts has identified 13 specific restoration sites that are intended to maintain flexibility for providing salmonid spawning and rearing habitat enhancement through long-term gravel replenishment, in-channel gravel placements, and side channel and floodplain enhancements to meet the goals of the CVPIA (b)(13) Habitat Restoration Program. The criteria used to select sites and develop conceptual designs include: biological need, site suitability and access, engineering feasibility, environmental compliance and permitting, gravel availability and transportation, and cost-benefit. The proposed action includes 13 known sites and several unknown future sites (Table 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.

2.1 Analytical Approach

This 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 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 an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- 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.
- 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 (Table 3). 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.

[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).

Table 3. ESA listing history.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Chinook salmon (*Oncorhynchus tshawytscha*)	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
	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 (*O. mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488
Green sturgeon (*Acipenser medirostris*)	Southern DPS	4/7/2006 71 FR 17757 Threatened	4/7/2006 71 FR 17757 Threatened	10/9/2009 74 FR 52300

In 2011, NMFS completed a status review of five Pacific salmon ESUs and one steelhead DPS, including CV spring-run Chinook salmon, CCV steelhead, and Sacramento River winter-run Chinook salmon, and concluded that the species' status should remain as previously listed in 2005/2006 (76 FR 50447; August 15, 2011). The 2011 status reviews (NMFS 2011a, 2011b, 2011c) additionally stated that, although the listings should remain unchanged, the status of these populations has worsened over the past five years since the 2005/2006 reviews and recommended that status be reassessed in two to three years as opposed to waiting another five years. Five year status reviews are currently underway, to be completed in 2015.

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 the Central Valley Recovery Plan (NMFS 2014a), 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.

2.2.1 Sacramento River winter-run Chinook salmon

The distribution and timing of winter-run Chinook salmon varies depending on the life stage, and is shown in Table 4 below.

Table 4. The temporal occurrence of adult (a) and juvenile (b) winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Winter run relative abundance	High				Medium				Low			
a) Adults freshwater												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[a,b]												
Upper Sacramento River spawning[c]												
b) Juvenile emigration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff[d]												
Sacramento River at Knights Landing[e]												
Sacramento trawl at Sherwood Harbor[f]												
Midwater trawl at Chipps Island[g]												

Sources: [a] (Yoshiyama et al. 1998); (Moyle 2002); [b](Myers et al. 1998a) ; [c] (Williams 2006) ; [d] (Martin et al. 2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2011); [f,g] Delta Juvenile Fish Monitoring Program, USFWS (1995-2012)

2.2.1.1 *Critical Habitat and Physical and Biological Habitat Features (PBHFs)*

The Sacramento River is designated critical habitat for winter-run Chinook salmon, and includes the river water, river bottom, and the adjacent riparian zone. The following is the status of the physical and biological habitat features that are considered to be essential for the conservation of winter-run:

2.2.1.1.1 *Adult Migration Corridors*

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.

2.2.1.1.2 *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 RBDD. However, the majority of spawning habitat currently being used occurs in the first 10 miles below Keswick Dam. The available spawning habit is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, the 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.

2.2.1.1.3 *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."

2.2.1.1.4 *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.

2.2.1.1.5 *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. 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).

Adequate prey for juvenile salmon to survive and grow. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz et al. 2009).

2.2.1.1.6 *Riparian and Floodplain Habitat*

Riparian and floodplain habitat is defined as providing "for successful juvenile development and survival." Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010, Michel et al. 2012).

2.2.1.1.7 *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.

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.

2.2.1.1.8 *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.

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.

<u>2.2.1.2 *Description of Viable Salmonid Population (VSP) Parameters*</u>

As an approach to evaluate the likelihood of viability of the Sacramento River winter-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. 2000a).

2.2.1.2.1 *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 (National Marine Fisheries Service 2011c). In recent years, since carcass surveys began in 2001 (Figure 1), 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 1). 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 (National Marine Fisheries Service 2011c). Slight increase in 2014, with 3,015 adults, remains below the high (17,296) within 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 Livingston Stone National Fish Hatchery (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 appear to be persisting into 2015 and hatchery production will again be increased.

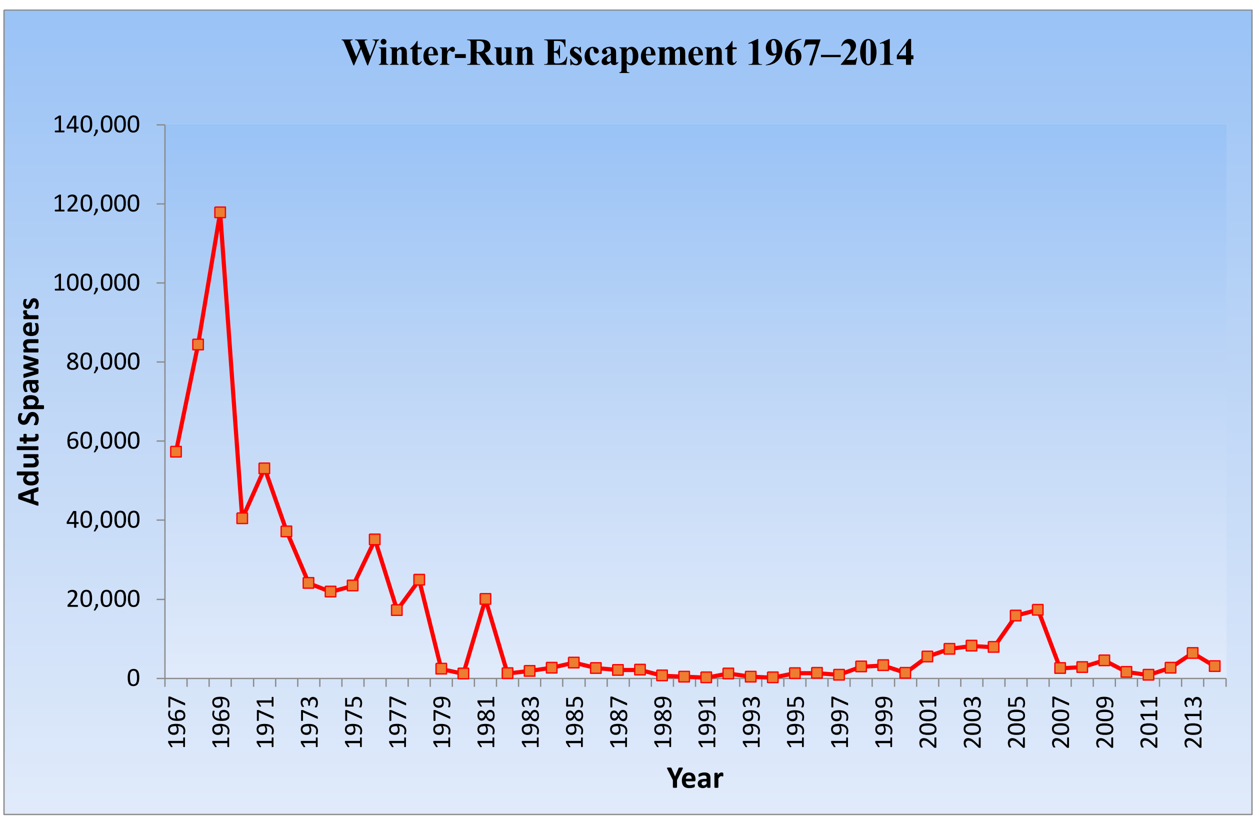

Figure 1. Winter-run Chinook salmon escapement numbers 1970-2014, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD ladder counts used pre-2000, carcass surveys post 2001 (California Department of Fish and Game 2012).

2.2.1.2.2 *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 2) 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 2), 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.

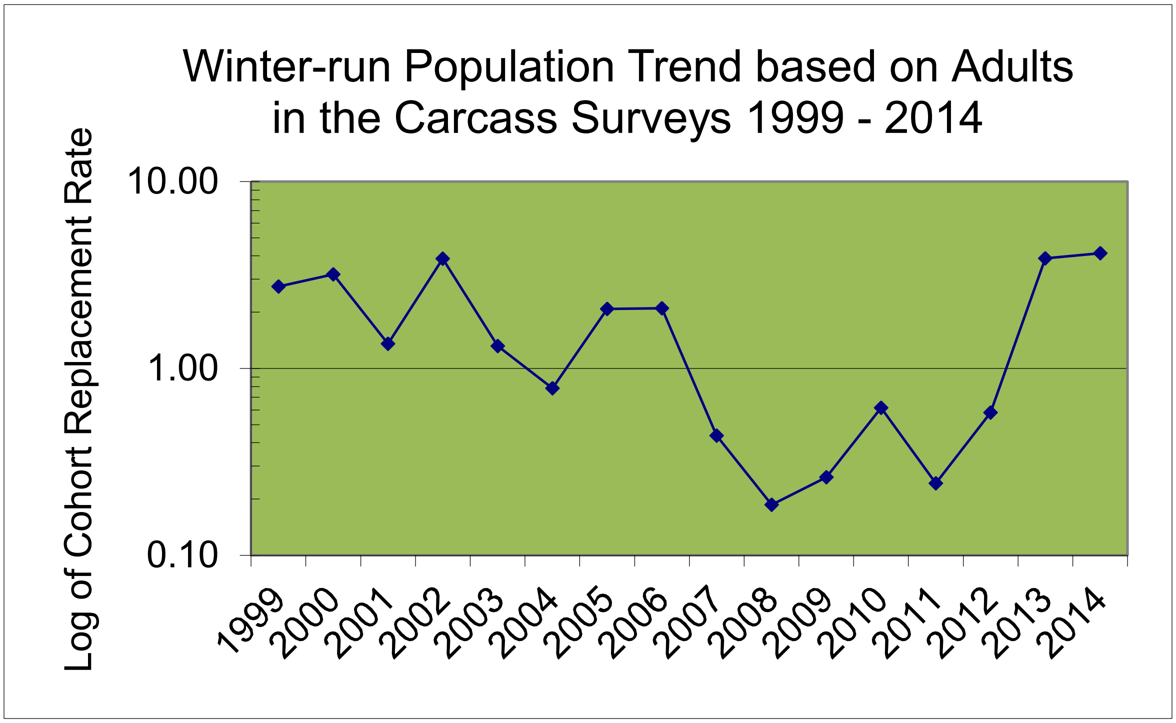

Figure 2. Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1999–2014.

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. 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 (National Marine Fisheries Service 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).

2.2.1.2.3 *Spatial Structure*

The distribution of winter-run spawning and initial rearing historically was limited to the Little 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 National Fish Hatchery [CNFH] weir). The Battle Creek Salmon and Steelhead Restoration Project 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. 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 (National Marine Fisheries Service 2011c). 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 2020. 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 2014). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program above Shasta Dam, and planning is currently moving forward.

2.2.1.2.4 *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-origin winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012.

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. 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).

2.2.1.2.5 *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 1); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 2); (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 (National Marine Fisheries Service 2011c) 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 (previous review), and that several listing factors have contributed to the recent decline, including drought and poor ocean conditions (National Marine Fisheries Service 2011c). A status review is currently underway and expected to be completed before the end of 2015.

2.2.2 Central Valley spring-run Chinook salmon

The distribution and timing of spring-run Chinook salmon varies depending on the life stage, and is shown in Table 5 below.

2.2.2.1 *Critical Habitat and Primary Constituent Elements (PCEs)*

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

2.2.2.1.1 *Spawning Habitat*

The upper Sacramento River is not the primary spawning location for spring-run Chinook salmon. The majority occurs in the tributaries to the Sacramento River. 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.

2.2.2.1.2 *Freshwater Rearing Habitat*

Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

Table 5. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River basin[a,b]	–/–	–/–	M/M	M/M	H/H	H/H	M/M	M/M	M/M	L/–	–/–	–/–
Sac. River Mainstem[b,c]	–/L	L/L	M/M	M/M	M/M	M/M	M/M	L/L	–/–	–/–	–/–	–/–
Mill Creek[d]	–/–	–/–	L/L	M/H	H/H	H/M	M/L	L/–	–/–	–/–	–/–	–/–
Deer Creek[d]	–/–	–/–	L/L	M/H	H/H	H/M	M/–	–/–	–/–	–/–	–/–	–/–
Butte Creek[d,g]	–/–	L/M	M/M	M/H	H/H	H/M	L/–	–/–	–/–	–/–	–/–	–/–
(b) Adult Holding[a,b]	–/–	–/L	L/M	M/H	H/H	H/H	H/H	H/M	M/L	L/–	–/–	–/–
(c) Adult Spawning[a,b,c]	–/–	–/–	–/–	–/–	–/–	–/–	–/–	L/M	H/H	M/L	–/–	–/–

(d) Juvenile migration

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River Tribs[e]	M/M	M/M	M/M	–/–	–/–	–/–	–/–	–/–	–/–	M/M	H/H	H/H
Upper Butte Creek[f,g]	H/H	H/H	M/M	M/M	M/M	L/L	–/–	–/–	–/–	L/L	L/L	H/H
Mill, Deer, Butte Creeks[d,g]	H/H	H/H	M/M	M/M	M/M	L/L	–/–	–/–	–/–	L/L	L/L	L/L
Sac. River at RBDD[c]	H/H	L/L	L/L	L/L	L/–	–/–	–/–	–/–	–/–	–/–	H/H	H/H
Sac. River at KL[h]	M/M	M/M	H/H	H/H	M/M	–/–	–/–	–/–	–/–	–/–	M/M	H/H

Relative Abundance: H = High; M = Medium; L = Low

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

2.2.2.1.3 *Freshwater Migration Corridor*

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.

2.2.2.1.4 *Estuarine Areas* - This PCE is outside of the action area for the proposed project.

2.2.2.2 *Description of VSP Parameters*

2.2.2.2.1 *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, now blocked by dams) 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. Abundance from 1993 to 2004 were consistently over 4,000 (averaging nearly 5,000), while 2005 to 2014 were lower, averaging just over 2,000 (CDFG Grandtab 2015).

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 makes identification of spring-run Chinook salmon in the mainstem difficult to determine, but counts of Chinook salmon redds in September are typically used as an indicator of spring-run Chinook salmon abundance. Fewer 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, 2014). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely 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 CV 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 6). 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 CV 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 CV spring-run Chinook salmon remained well below estimates of historic abundance.

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.

2.2.2.2.2 *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. 2000a). In general, declining productivity equates to declining population abundance. McElhany et al. (2000a) 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 CV spring-run Chinook salmon tributary population CRR remained over 1.0, but then declined to a low of 0.47 in years 2007 through 2011 (Table 6). The productivity of the Feather River and Yuba River populations and contribution to the ESU currently is unknown, however the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.91, and 6.61 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 6. Central Valley Spring-run Chinook salmon population estimates from CDFW Grand Tab (2015) with corresponding cohort replacement rates for years since 1990.

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
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	5,033	1,969	3,064	3,961	0.65	0.47	5,731	0.78	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,744	0.72	0.53
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	1.32	0.71
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.76	0.99
Median	10,085	3,700	6,327	6,326	2.00	1.85	10,034	1.00	1.27

[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

2.2.2.2.3 *Spatial Structure*

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.

The Central Valley Technical Review Team estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Figure 3) (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 CV 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).

With only one of four diversity groups currently containing independent populations, the spatial structure of CV 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 CV 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.

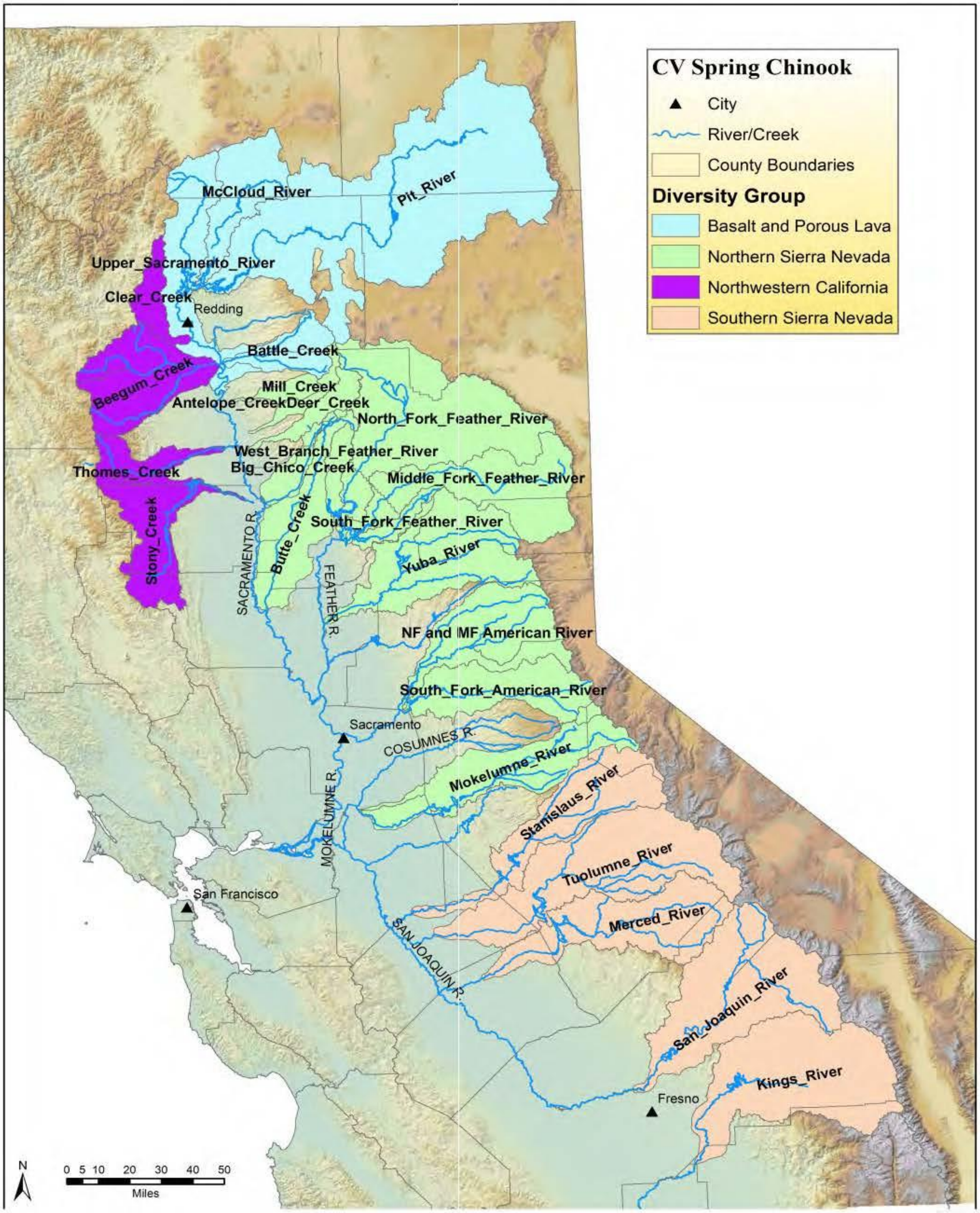

Figure 3. Diversity Groups for the Central Valley spring-run Chinook salmon ESU.

A final rule was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the San Joaquin River Restoration Project (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 CV spring-run Chinook salmon within the experimental population area, and in specific instances elsewhere. The first release of CV 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 CV spring-run Chinook salmon ESU has yet to be determined.

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 (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).

2.2.2.2.4 *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. 2000a). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery spring-run Chinook salmon stocks in the 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 like the SJRRP, to reintroduce a spring-run population below Friant Dam, which are underway, are needed to improve the diversity of CV spring-run Chinook salmon.

2.2.2.2.5 *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 CV 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 CV 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 CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased (Williams et al. 2011). The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

2.2.3 California Central Valley steelhead

The distribution and timing of steelhead varies depending on the life stage, and is shown in Table 7 below.

Table 7. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1]Sacramento R. at Fremont Weir	Low	Low	Low	Low	Low							Low	Low	Low	Low	Medium	High	High	High	Medium	Low	Low	Low	Low
[2]Sacramento R. at RBDD	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Medium	Medium	High	Medium	Low	Low	Low	Low
[3]Mill & Deer Creeks	Medium	Medium	High	Medium	Medium	Low	Low	Low	Low	Low	Low	Low							Medium	High	High	Low	Low	Low
[4]Mill Creek at Clough Dam	Low	Low	Medium	High	Medium	Medium	Low	Low										Low	Medium	High	High	High	Medium	Medium
[5]San Joaquin River	High	High	Medium	Medium	Low	Low							Low	Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	High	High

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

Relative Abundance: = High = Medium = Low

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

2.2.3.1 *Critical Habitat and PCEs*

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 (up to the confluence with the Merced River), including its tributaries, and the waterways of the Delta. Critical habitat for CCV steelhead is defined as specific areas that contain the PCEs and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PCEs for CCV steelhead.

2.2.3.1.1 *Spawning Habitat*

Tributaries to the Sacramento River with year-round flows have the primary spawning habitat for CCV steelhead. 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.

2.2.3.1.2 *Freshwater Rearing Habitat*

Tributaries to the Sacramento River with year-round flows have the primary rearing habitat for CCV steelhead. 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. Freshwater rearing habitat has a high conservation value even if the current conditions are significantly degraded from their natural state.

2.2.3.1.3 *Freshwater Migration Corridors*

Migration corridors 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. 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.

2.2.3.1.4 *Estuarine Areas* - This PCE is outside of action area for the prosed project.

2.2.3.2 *Description of VSP Parameters*

2.2.3.2.1 *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 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.

CNFH 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. Steelhead returns to CNFH 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.

Redd counts are conducted in the American River, with an average of 154 redds have been counted on the American River from 2002-2010 (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. 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. 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. The overall catch of steelhead at these facilities has been highly variable since 1993. 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.

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.

2.2.3.2.2 *Productivity*

An estimated 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.

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. 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.

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

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 2011b). Since 2003, fish returning to the CNFH 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. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production.

2.2.3.2.3 *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.

Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005; NMFS 2011b). 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.

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.

The NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a), includes recovery criteria for the spatial structure of the DPS which includes, 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.

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 2011b).

2.2.3.2.4 *Diversity*

a. 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 CV 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 (CNFH, 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.

b. 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.

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 CV 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). 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). 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).

2.2.3.2.5 *Summary of DPS Viability*

All indications are that natural Central Valley steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al. 2005; NMFS 2011b); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish. 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 2011b). 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.

2.2.4 Southern DPS of North American Green Sturgeon

The distribution and timing of sDPS green sturgeon varies depending on the life stage, and is shown in Table 8 below.

Table 8. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,c,i]	Low	Low	Medium	Medium/High	High	High/Medium	Medium	Medium	Medium	Low	Low	Low
SF Bay Estuary[d,h,i]	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Low

(b) Larval and juvenile (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]					Medium	High	High	Medium				
GCID, Sac River[ej]					Medium	High	High	Medium	Low	Low		

(c) Older Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta*[f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[e]				Medium	Medium	Medium	Medium	Medium	Medium	Medium		
Suisun Bay[e]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

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

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [c](Adams 2002); [d]Kelly *et al.* (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al.* (1995); [h]Heublein (2006); [i]Draft Sturgeon Report Card (Dubois et al. 2009); [j](Poytress et al. 2013, Poytress 2014), [k]Alicia Seesholtz (2014)

2.2.4.1 *Critical Habitat and PCEs*

Critical habitat for sDPS green sturgeon includes, (1) the Sacramento River from the I-Street Bridge to Keswick Dam, including the Sutter and Yolo Bypasses and the American River to the highway 160 bridge (2) the Feather River up to the Fish Barrier Dam, (3) the Yuba River up to Daguerre Point Dam (4) the Sacramento-San Joaquin Delta (as defined by California Water Code section 12220), but with many exclusions (see 74 FR 52300), (5) San Francisco Bay, San Pablo Bay, and Suisun Bay, but with many exclusions, and (6) coastal marine areas to the 60 fathom depth bathymetry line, from Monterey Bay, California to the Strait of Juan de Fuca, Washington. Critical habitat for sDPS green sturgeon is defined as specific areas that contain the PCEs essential to the conservation of the species. PCEs have been identified in freshwater riverine systems (below), as well as for Estuarine and Coastal Marine Areas (not included here as they do not occur in the action area for this project). The following are the PCEs for sDPS green sturgeon that occur in the upper Sacramento River:

- Food Resources
- Substrate Type or Size
- Water Flow
- Water Quality
- Migratory Corridor
- Depth
- Sediment Quality

2.2.4.2 *Description of Viability Parameters*

Although the VSP concept was developed for Pacific salmonids, the underlying parameters are general principles of conservation biology and can therefore be applied more broadly. Here, we adopt the VSP parameters for analyzing sDPS green sturgeon viability.

2.2.4.2.1 *Abundance*

Historically, trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources; (1) salvage numbers at the State and Federal pumping facilities, and (2) by incidental catch of green sturgeon by the CDFW's white sturgeon sampling/tagging program. Sturgeon salvage numbers have not been related to year class indices or annual production estimates in white sturgeon (Gringas et al. 2013). Green sturgeon salvage may also be unrelated to abundance trends and capture numbers of green sturgeon in adult white sturgeon monitoring is insufficient to estimate abundance. Recently, more rigorous scientific inquiry has been undertaken to generate abundance estimates (Israel and May 2010, Mora unpublished data).

Beginning in 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctorate thesis at UC Davis, Ethan Mora has been using DIDSON to locate green sturgeon in the Sacramento River, and to derive an adult spawner abundance estimate. This information is stated in the Green Sturgeon Recovery Plan:

Results of these surveys indicate an average annual spawning run of 272 fish (Mora unpublished data). This estimate does not include the number of spawning adults in the lower Feather River, *where green sturgeon spawning was recently confirmed. This estimate is preliminary and involves a number of untested assumptions regarding sampling efficiency, discrimination between green and white sturgeon, and spawner residence time. Although caution must be taken in using this estimate to infer the spawning run size for the Sacramento River until further analyses are completed, this preliminary estimate provides reasonable order-of-magnitude numbers for recovery planning purposes until such time as new information is developed*

2.2.4.2.2 *Productivity*

The parameters of green sturgeon population growth rate and carrying capacity in the Sacramento Basin are poorly understood. Larval count data are available from rotary screw traps set seasonally near Red Bluff and Glen Colusa Irrigation District diversions. This data shows enormous variance among years with the greatest number occurring in 2011 (3,700 larvae captured) (Poytress et al. 2012). In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events (NMFS 2010b). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon. The long lifespan of the species and long age to maturity makes trend detection dependent upon data sets spanning decades. The acoustic telemetry work begun by Ethan Mora (UC Davis) on the Sacramento River and by Alicia Seesholtz (CDWR) on the Feather River, as well as larval and juvenile studies by Bill Poytress (USFWS) may eventually produce a more statistically robust analysis of productivity.

2.2.4.2.3 *Spatial Structure*

Studies conducted at UC Davis (Mora unpublished data) have shown that green sturgeon spawning sites are concentrated in just a handful of locations. Mora (unpublished data) found that in the Sacramento River, just 3 sites accounted for over 50 percent of the green sturgeon documented in June of 2010, 2011, and 2012. This finding has important implications for the application of the spatial structure VSP parameter, which is largely concerned with spatial structuring of spawning habitat. Given the high density of individuals within a few spawning sites, extinction risk due to stochastic events is expected to have increased since before large dams were in place.

Green sturgeon have been historically captured and are regularly detected within the Delta area of the lower San Joaquin River (Radtke 1966). Anglers have reported catching a small number of green sturgeon at various locations in the San Joaquin River upriver of the Delta. However, there is no known modern usage of the upper San Joaquin River and adult green sturgeon spawning has not been documented.

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River, and also breed opportunistically in the Feather River and possibly even the Yuba River. Other watersheds, including the San Joaquin River basin may have supported opportunistic green sturgeon spawning in the past ((Adams 2007), (Beamesderfer et al. 2007)). The apparent extirpation from the San Joaquin River narrows the available habitat within their range, offering fewer habitat alternatives.

Concentration of adults into a very few select spawning locations makes the species highly vulnerable to poaching and catastrophic events.

2.2.4.2.4 *Diversity*

Diversity, as defined in the VSP concept in (McElhany et al. 2000b), includes purely genetically-driven traits such as DNA sequence variation, as well as traits that are driven by a combination of genetics and the environment such as ocean behavior, age at maturity, and fecundity. Variation is important to the viability of a species for several reasons. First, it allows a species to utilize a wide array of environments. Second, diversity protects a species from short term spatial and temporal changes in the environment by increasing the likelihood that at least some individuals will persist in spite of changing environmental conditions. Third, genetic diversity facilitates adaptation to changing environmental conditions over the long term.

Whether sDPS green sturgeon display these diversity traits and if there is sufficient diversity to buffer against long term extinction risk is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates. Human alteration of the environment is pervasive in the California Central Valley. As a result, many aspects of sDPS green sturgeon diversity such as run timing and behavior have likely been adversely influenced through mechanisms such as altered flow and temperature regimes.

2.2.4.2.5 *Summary*

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (NMFS 2010a). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (National Marine Fisheries Service 2010a). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany et al. 2000b). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS has not been designated as viable.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an Evolutionarily Significant Unit (ESU) represented by a single population at moderate risk of extinction is at high risk of extinction over a large timescale. This concern applies to any DPS or ESU represented by a single population, suggesting that sDPS green sturgeon face a high extinction risk in the future. The position of NMFS, upon weighing all available information (and lack of information) is that the extinction risk to sDPS green sturgeon is moderate (National Marine Fisheries Service 2010a).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a more robust estimate of abundance and population trends, and a greater understanding of biology and habitat needs.

2.2.5 Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley, and aquatic habitat at large is climate change.

Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen *et al*. 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991, Dettinger *et al*. 2004). Specifically, the Sacramento River basin annual runoff amount for April-July has been decreasing since about 1950 (Roos 1987, 1991). Increased temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen *et al*. 2004). Factors modeled by VanRheenen *et al*. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100% in shallow snowpack areas). Additionally, an air temperature increase of 2.1°C (3.8°F) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen *et al*. 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south.

Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951- 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally-producing fall-run Chinook salmon are thermally acceptable. This would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

For winter-run Chinook salmon, the embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, so this run is particularly at risk from climate warming. The only remaining population of winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates et al. 2008). The long-term projection of operations of the CVP/SWP expects to include the effects of climate change in one of three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (Reclamation 2008). Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Lindley 2008, Beechie *et al*. 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative for additional populations of winter-run Chinook salmon to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (National Marine Fisheries Service 2014a).

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson et al. 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al*. 2013).

Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. Anderson-Cottonwood Irrigation District Diversion Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central Valley (*i.e*., the Feather River) is limited, in part, by late spring and summer water temperatures. Similar to salmonids in the Central Valley, green sturgeon spawning in tributaries to the Sacramento River is likely to be further limited if water temperatures increase and higher elevation habitats remain inaccessible.

In summary, observed and predicted climate change effects are generally detrimental to the species (McClure 2011, Wade et al. 2013), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure et al. 2013).

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 Sacramento River originates near Mt. Shasta, and flows south for 447 miles before reaching the Sacramento–San Joaquin River Delta and San Francisco Bay. Shasta Dam, which is located at RM 311 on the Sacramento River near Redding, California, was completed in 1945. It serves to control floodwaters and store surplus winter runoff for irrigation in the Sacramento and San Joaquin Valleys, maintain navigation flows, provide flows for the conservation of fish in the Sacramento River and water for municipal and industrial use, protect the Sacramento-San Joaquin Delta from intrusion of saline ocean water, and generate hydroelectric power. Keswick Dam (RM 302) was constructed nine miles downstream from Shasta Dam to create a 23,800 acre-foot afterbay for Shasta Lake and the Trinity River Division, which stabilizes uneven water releases from the powerplants. Below Keswick Dam, the Anderson-Cottonwood Irrigation District Diversion Dam (ACID Dam; RM 297) is seasonally in place to raise the water level for diversions into the ACID canal. The 59 mile reach of the Sacramento River between Keswick Dam and RBDD is commonly referred to as the Upper Sacramento River.

Coarse sediment from the upper watershed is prevented from being transported downstream by Shasta and Keswick dams, resulting in an alluvial sediment deficit and reduction in fish habitat quality within the Upper Sacramento River reach (Wright and Schoellhamer 2004). In addition to the reduction of sediment supply, recruitment of large woody material to the river channel and floodplain has also declined due to a reduction in bank erosion and blockage of wood transport by Shasta Dam.

The combination of degraded physical habitat characteristics, fish passage barriers, and changes in hydrology resulting from dams and diversions since the mid-1800s has been associated with salmonid and green sturgeon declines within the Sacramento River watershed.

2.3.1 Hydrology

Flows in the Sacramento River in the 65 mile reach between Shasta Dam and RBDD are regulated by Shasta Dam and again, just downstream at Keswick Dam. Water stored in the reservoirs during the winter and spring is released in the summer and fall for municipal and industrial supply, irrigation, water quality, power generation, recreation, and fish and wildlife purposes. Historically, the Upper Sacramento River was highly responsive to periodic precipitation events and seasonal variation. Since completion of the dams, flows are now lower in the winter and spring and higher in the summer and fall. During July, August, and September, the mean monthly flows of the Sacramento River at Keswick since 1963 are nearly 400 percent higher than the mean monthly flows prior to 1943 (DWR department of water resources 1981, as cited in SRCAF handbook (2003). In this reach, flows are influenced by tributary inflow. Major west-side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east-side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes creeks.

2.3.2 Land Use

As reported by SRCAF (2003), the Keswick-RBDD Reach has a variety of land uses—urban, residential, industrial, and agricultural. About 35 percent of the area is in agriculture, and about 12 percent is urban, residential, or industrial. Industrial land uses within this reach include lumber mills and gravel removal operations. Residential and commercial land uses in the cities of Redding, Anderson, and Red Bluff are common as well. In addition, this reach has the most recreational facilities on the Sacramento River (SRCAF 2003). Historically, the river between Redding and Anderson supported several gravel mining operations (SRCAF 2003).

2.3.3 Water Quality

The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of surface water downstream of Keswick Dam is also influenced by other human activities along the Sacramento River downstream of the dam, including historical mining, agricultural, and municipal and industrial activities. The quality of water in the Sacramento River is relatively good; only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000). Water quality issues within the upper Sacramento River include the presence of mercury, pesticides such as organochlorine, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000).

The Central Valley Regional Water Quality Control Board (CVRWQCB) has determined that the 25-mile segment of the Upper Sacramento River between Keswick Dam and the mouth of Cottonwood Creek is impaired by levels of dissolved cadmium, copper, and zinc that periodically exceed water quality standards developed to protect aquatic life (CVRWQCB 2002).

The reach is also listed under Clean Water Act (CWA) 303(d) by the CVRWQCB for unknown sources of toxicity (CVRWQCB 2007). Water temperature in the Sacramento River is controlled by releases from Shasta, Whiskeytown, and Keswick reservoirs. NMFS issued an opinion on the long-term operation of the CVP and SWP (NMFS 2009), which included Upper Sacramento River water temperature requirements to protect listed anadromous fish and their critical habitats. However, the ability to meet temperature requirements has proven extremely difficult during drought years.

2.3.4 Predation

Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass congregate downstream of Keswick Dam and prey on juvenile salmon in the tail waters. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker et al. (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow.

2.3.5 Fisheries and Aquatic Habitat

The Upper Sacramento River between Keswick Dam (River Kilometer (RK) 486) and RBDD (RK 391) currently serves as the only spawning ground for winter-run Chinook salmon, and is an important migration corridor for adult and juvenile spring-run Chinook salmon and steelhead, particularly populations from Cottonwood Creek, Clear Creek, Cow Creek and Battle Creek, as well as other smaller tributaries. Green Sturgeon utilize the upper Sacramento River as a migratory corridor as well as for spawning and juvenile rearing.

Shasta and Keswick dams have presented impassable barriers to anadromous fish since 1943 (Moffett 1949 as cited in Poytress et al. 2014). ACID Dam and RBDD presented partial barriers to salmonid migration until improvements were made in 2001 and 2012 (NMFS 2009, 2014a), respectively, although ACID Dam continues to present an impassable barrier to green sturgeon (NMFS 2009).

2.3.5.1 *Sacramento River winter-run Chinook salmon*

The distribution of Sacramento River winter-run Chinook salmon spawning and rearing is currently limited to the upper Sacramento River, with managed flows out of Shasta Dam. Keswick Dam re-regulates flows from Shasta Dam and mixes it with water diverted from the Trinity River through the Spring Creek tunnel to control water temperatures below ACID pursuant to actions in the NMFS opinion, to provide cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (NMFS 2009). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River above the dams is now inaccessible to winter-run (NMFS 2014a).

The proportion of the winter-run Chinook salmon spawning above ACID has increased since the ladder improvements in 2001. Although variable, between 2002 and 2014, an average of 45 percent spawn between Keswick Dam and ACID Dam, and the last three years, an average of 66 percent (CDFW 20014 unpublished aerial redd counts). Data on the temporal distribution of winter-run Chinook salmon upstream migration suggest that in wet years about 50 percent of the run has passed the RBDD by March, and in dry years, migration is typically earlier, with about 72 percent of the run having passed the RBDD by March (Poytress et al. 2014).

The upper Sacramento River contains the only remaining habitat that is currently used by spawning Sacramento River winter-run Chinook salmon. As reported by NMFS (2014a), historical winter-run population estimates, were as high as over 230,000 adults in 1969, but declined to under 200 fish in the 1990s (Good *et al.* 2005). A rapid decline occurred from 1969 to 1979 after completion of the RBDD. Over the next 20 years, the population eventually reached a low point of only 186 adults in 1994. At that point, winter-run Chinook salmon were at a high risk of extinction, as defined by Lindley *et al*. (2007). However, several conservation actions, including a very successful conservation hatchery and captive broodstock program at LSNFH, construction of a temperature control device (TCD) on Shasta Dam, maintaining the RBDD gates up for much of the year, and restrictions in ocean harvest, have likely prevented the extinction of natural-origin winter-run Chinook salmon. LSNFH, which is located at the base of Keswick Dam, annually supplements the in-river production by releasing on average 180,000 winter-run smolts into the upper Sacramento River. The LSNFH operates under strict guidelines for propagation that includes genetic testing of each pair of adults and spawning no more than 10 percent of the hatchery returns. This program and the captive broodstock program (phased out in 2007) were instrumental in stabilizing the winter-run Chinook population following very low returns in the 1990s.

More recently, since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2012, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011. 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 (National Marine Fisheries Service 2011c). In 2013, the population increased to 6,075 adults, and in 2014, 3,015, which are both well above the 2007–2012 average, but below the high for the last ten years.

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 expected lower than average survival in 2014, hatchery production from the LSNFH conservation program was tripled to offset the impact on the naturally spawning fish. Normally LSNFH produced an average of 176,348 fish per year, with in-river natural production resulting in an average of 4.7 million. In 2014, hatchery production represented 50-60% of the total in-river juvenile production, compared to 3 to 4 percent on average in a normal year. Drought conditions are expected to persist into 2015 and hatchery production will again be increased.

2.3.5.2 *CV spring-run Chinook Salmon*

The status of the spring-run population within the mainstem Sacramento River above RBDD appears to have declined from a high of 25,000 in the 1970s to an average low of less than 800 counted at RBDD beginning in 1991. Significant hybridization with fall-run has made identification of a spring-run population in the mainstem very difficult to determine, and there is speculation as to whether a true spring-run population still exists below Keswick Dam. This shift may have been an artifact of the manner in which spring-run were identified at RBDD. More recently, fewer spring-run were counted at RBDD because an arbitrary date, September 1, was used to determine spring-run, and gates are now (beginning in 2012) open year round (NMFS 2014a). The extent of non-hybridized spring-run spawning in the Sacramento River mainstem is unknown. However, the physical habitat conditions below Keswick Dam is capable of supporting spring-run, although in some years high water temperatures can result in substantial levels of egg mortality. Current redd surveys (2001-2014) have observed an average of 41 salmon redds in September, from Keswick Dam downstream to the RBDD, ranging from zero to 105 redds (CDFG, unpublished data, 2015). This is typically when spring-run spawn, however, there is no peak that can be separated out from fall-run spawning, so these redds also could be early spawning fall-run. Additionally, even though habitat conditions may be suitable for spring-run occupancy, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning it is likely to have caused extensive introgression between the populations (CDFW 1998).

2.3.5.3 *CV steelhead*

Estimates of CCV steelhead abundance in the mainstem Sacramento River typically use the RBDD counts for historical trend data. Since 1991, the RBDD gates have been opened after September 15, making estimates of CV steelhead pass RBDD unreliable. Since the RBDD gates started operation in 1967, the CV steelhead abundance in the upper Sacramento River has declined from 20,000 to less than 1,200 on average beginning in 1992. CV steelhead passage above RBDD after 1991 can be estimated based on the average of the 3 largest tributaries (*i.e*., Battle Creek, Clear Creek and Cottonwood Creek). The average of these tributaries for the last 14 years (1992 through 2005) is 1,282 adults, which represents a continuous decline from the 1967 through 1991 average RBDD count of 6,574. Actual estimates of CV steelhead spawning in the mainstem Sacramento River below Keswick Dam have never been made due to high flows and poor visibility during the winter time.

2.3.5.4 *Green sturgeon*

Green Sturgeon utilize the upper Sacramento River as a migratory corridor and for spawning and juvenile rearing. Approximately 45 percent on average (141 fish), of green sturgeon distribution and abundance in the Sacramento River from 2010 to 2014, was observed above RBDD (Ethan Mora 2015). Although observations of green sturgeon have been found as far upstream as near the mouth of Cow Creek (RK 451), spawning occurring above RBDD has only been documented as far upstream as the confluence with Ink's Creek (RK 426), and is mostly concentrated in the mid-April to mid-June time period (Poytress *et al.* 2013). Other confirmed spawning sites are at the mouth of Payne's Creek (RK 430), and at the RBDD. Rotary screw trap monitoring of juveniles fish passing RBDD has incidentally captured juvenile green sturgeon between May and the end of August, since 2002, but numbers have been highly variable, with a median of 193 fish (Poytress *et al.* 2014).

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 assessment will consider the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of federally listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and green sturgeon, and the magnitude, timing, frequency, and duration of project impacts to these listed species. Specifically, the assessment will consider the potential impacts related to these species resulting from the Sacramento River Restoration Projects, including 1) hazardous materials entering the water; 2) loss of riparian vegetation; 3) increased turbidity; and, 4) physical disturbance. Additionally, the assessment will consider the potential impacts to critical habitat and beneficial effects of habitat enhancement and restoration.

Due to the life history timing of winter-run and spring-run Chinook salmon, and steelhead, it is possible for one or more of the following life stages to be present at some point within the action area throughout the year: adult migrants, spawners, incubating eggs, and rearing and emigrating juveniles. Additionally, it is possible for one or more life stages of green sturgeon (*i.e.*, migrating and holding adults; or rearing and emigrating juveniles) to be present in the lower 37 miles of the action area (RM 280 to RM 243). Timing of construction and potential exposure to juveniles varies in the action area's three zones (Table 9), and assumptions of juvenile rearing densities are based on data from CDFG (1998), including approximately 0.05 salmon per foot and 0.04 rainbow trout/steelhead per foot.

The proposed seasonal work windows are designed to minimize adverse effects to incubating salmonid and green sturgeon eggs and pre-emergent fry. Additionally, redd surveys will be conducted by a qualified biologist prior to construction activities that occur near spawning habitat during spawning and incubation periods, and avoidance measures will be implemented if needed to further minimize potential effects to incubating eggs. Furthermore, the potential for hazardous material spills impacting eggs and pre-emergent fry is discountable as a result of BMPs described in the project description above, and further below. Although potential adverse effects to incubating eggs and pre-emergent fry are unlikely to occur as a result of the measures above, it is possible that a small portion of redds would not be detected, and impacts would occur. Migrating adults may be present during project activities and may experience some delay, which is described further under "Physical Disturbance" below.

Table 9. Potential Exposure of Juvenile Winter-Run and Spring-Run Chinook Salmon, Steelhead, and Green Sturgeon to Project Activities and Associated Potential Effects.

Zone	Construction Window	Potential Exposure to juveniles	Activities: Not Likely to Adversely Affect	Activities: Likely to Adversely Affect
Zone 1	All Year	None expected	• End Dump Talus Cone	• None
Zone 2	October 1 to May 15[a] (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)	Oct-March 1: winter-run rearing and outmigrating Oct-Apr 15: spring-run outmigrating; spring-run and steelhead rearing April: steelhead outmigrating	• End Dump Talus Cone • Lateral Berm	• Riffle Supplementation • Floodplain and Side Channel Enhancement • Habitat Structure Placement • River Crossings
Zone 3	October 1 to March 1[a] (anytime flows are <10,000 cfs; pre-construction salmonid redd surveys conducted)	Oct-March 1: winter-run, spring-run, steelhead, and green sturgeon rearing; and outmigrating winter-run and spring-run	• End Dump Talus Cone • Lateral Berm	• Riffle Supplementation • Floodplain and Side Channel Enhancement • Habitat Structure Placement • River Crossings

[a] May be conducted year-round in areas, such as floodplains and side channels, when flowing water is either naturally or artificially (*e.g.*, cofferdam) absent.

2.4.1 Hazardous Materials

The potential spill of hazardous materials (*e.g.,* fuel, lubricants, hydraulic fluid) during construction and staging activities into the upper Sacramento River could have deleterious effects on juvenile and adult winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and green sturgeon. Additionally, operation of construction equipment in or adjacent to the river presents the risk of a spill of hazardous materials into the river (*e.g.,* construction equipment leaking fluids).

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

Adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway because the prevention and contingency measures will require frequent equipment checks to prevent leaks, will keep stockpiled materials away from the water, and will require that absorbent booms are kept on-site to prevent petroleum products from entering the river in the event of a spill or leak. Heavy equipment operated in the river will use biodegradable hydraulic fluid. Implementation of BMPs will prevent fuel spills or toxic compounds from causing injury or death to individual fish.

The use of avoidance and minimization measures for the handling and containment of hazardous materials will minimize the risk of injury or mortality to all life stages of winter-run and spring-run Chinook salmon, steelhead, and green sturgeon to a discountable level, and will not reach a level where take will occur.

2.4.2 Loss of Riparian Vegetation

Impacts to existing vegetation will be avoided to the extent practicable. Disturbed riparian areas, not intended for future road access or gravel placement, will be revegetated with native plant species and mulched with certified weed-free hay, within a year (timed to maximize survival) following the completion of construction activities. The loss of riparian vegetation is an indirect effect of creating and maintaining temporary access points to the river, and covering vegetation with gravel, as well as a direct effect of temporary removal for floodplain and side channel enhancement. Riparian vegetation, particularly shaded riverine aquatic (SRA) habitat, provides overhead cover and a substrate for food production for juvenile salmonids and green sturgeon. The shade from the vegetation helps to cool water temperatures in the river and seasonally provides insects for fish to forage. SRA is important to the juvenile salmon and steelhead as they migrate down the river to the sea. Terrestrial insects that live on riparian vegetation fall into the river and provide an important food source for fish. Riparian trees and shrubs will eventually end up in the river channel as floods erode the bank or sweep them from the floodplain. Once in the river channel, the stems, trunks, and branches become very important structural habitat components for aquatic life, including fish. Most of the aquatic invertebrates found in the river occur on the woody debris. These invertebrates, in turn, are the primary food of juvenile salmon and steelhead. Large wood affects the hydraulics of flows around it that results in a more complex channel geomorphology and the storage of spawning gravels. The loss of riparian vegetation can therefore increase predation rates, and reduce food production, and feeding rates for juveniles.

Riparian loss each year for up to six project sites, will be less than 9 acres of vegetation disturbed. This loss is expected to be temporary, and not expected to be cumulative each year. Since some site locations will be used repeatedly each year, those sites may experience a longer term loss (natural recolonization expected to occur within approximately 2-5 growing seasons to be replaced). Gravel augmentation methods, floodplain and side channel enhancement, and placement of instream habitat structures may each temporarily impact the SRA riparian vegetation along the river channel margin (less than 500 linear feet at each site). Overall, although the amount of riparian vegetation that will be lost is temporary, some vegetation, including SRA habitat, the loss will be longer-term. Juveniles will have access to adjacent suitable rearing habitat, but will likely experience some impact due to the longer-term temporary loss of SRA riparian habitat.

2.4.3 Increased Turbidity

The re-suspension and deposition of instream sediments is an indirect effect of construction equipment and gravel entering the river. Short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, and exposure to sediment released into the water column. Fish responses to increased turbidity and suspended sediment can range from behavioral changes (alarm reactions, abandonment of cover, and avoidance) to sublethal effects (*e.g.*, reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe and Jensen 1996). If this occurs while embryos are incubating, injury or mortality to incubating eggs or alevins may occur through the infiltration of fine sediment into salmonid redds with a reduction of intra-gravel water circulation and in severe cases entombment of salmonid eggs and through preventing green sturgeon eggs from adhering to each other. In the action area, silt and sand on the river bottom will be disturbed during placement of new materials, however, the amount of sediment that may be re-suspended during project installations is not likely to be significant; any re-suspension and re-deposition of instream sediments is expected to be localized and temporary and will not reach a level that will acutely affect aquatic organisms. The use of in-river work windows will generally prevent the siltation of listed salmonid redds and will avoid green sturgeon eggs. In Zones 2 and 3, pre-construction surveys for spawning salmonids and redds will minimize the likelihood of injury resulting from the re-suspension and re-deposition of instream sediments.

Riffle supplementation sites and floodplain and side channel enhancement sites require applying the gravel directly to the riverbed and/or grading it, thereby increasing the likely exposure to increased turbidity to listed juvenile salmonids (all zones) and juvenile green sturgeon (Zone 3). Although some rearing and migrating juveniles may be in the vicinity, response to any activity will be to temporarily avoid the area of increased turbidity for adjacent suitable habitat. Additionally, the Clean Water Act § 401Water Quality Certification that will be issued for the Sacramento River Habitat Restoration Program will limit the potential effects of fine sediment on fish by limiting the maximum increase of turbidity over background levels.

BMPs to control erosion and storm water sediment runoff will be implemented including, but not limited to, straw bales, straw wattles, silt fences, and other measures as necessary to minimize erosion and sediment-laden runoff from project areas. Instream construction will proceed in a manner that minimizes sediment discharge. Following completion of restoration activities, clean spawning gravel used for temporary crossing will be removed from the channel or spread evenly across the bottom of the channel, consistent with existing gravels. All crossings within the main channel will be designed to ensure that conditions are maintained for effective upstream and downstream fish passage, at all times and under all flow conditions. Instream work that may cause increased turbidity within the immediate vicinity of active redds and within 200 feet downstream of the project footprint will include additional minimization measures to ensure redds are not impacted. Impacts of potential increased turbidity are expected to be short-term, localized, and minimal, due to timing of gravel augmentation to avoid sensitive life stages, implementation of BMPs, and ability of juveniles to move to adjacent habitat, and are therefore considered insignificant, and not expected to reach a level where take occurs.

2.4.4 Physical Disturbance

Physical disturbance may occur during construction activities and the placement of materials, which has the potential to affect the juvenile and adult life stages of salmonids and green sturgeon through displacement and disruption of normal behaviors. Displacement may temporarily expose juvenile fish to a greater risk of predation in zones 2 and 3. Some adult and juvenile listed fish may experience up to 12 hours of migration delay due to construction activities. Repeated disturbance may potentially increase stress levels which could result in lower reproductive success in holding adult winter-run and spring-run Chinook salmon, steelhead or green sturgeon that may be present immediately downstream of a construction site, where they could be exposed to increased turbidity; however, adult fish will be expected to actively avoid disturbance areas and move to other nearby holding sites, within the upper Sacramento River; therefore, not considered a significant stressor for adults. During construction activities, juvenile fish will be able to detect areas of disturbance and will typically actively avoid those portions of the project footprint where equipment is actively working or associated with the turbidity plume. Occasionally, feeding juvenile salmonids may be attracted to activity stirring up sediment, but whenever they detect immediate danger, they are able to quickly move away. Additionally, rearing habitat for juvenile fish is generally well-distributed throughout the action area, allowing for juvenile movement to other areas to avoid the physical disturbance of construction activities. Disturbance to listed fishes resulting from riffle supplementation, floodplain and side channel enhancement, and habitat structure placement is expected to be short-term due to the nature and duration of proposed instream and shoreline work. The duration of potential exposure from instream work varies by restoration site (Table 2), and is expected to be less than 1.5 weeks for instream habitat structure placement and for excavation/contouring in the active main channel associated with reconnection of floodplain and side channel habitats to less than 4 weeks for riffle supplementation.

Direct injury or death may occur during instream construction activities from the installation of spawning gravel and instream habitat structures, and while grading the riverbed. Materials added to the riverbed and equipment working in the river could injure or kill salmonid and green sturgeon adults and juveniles. The risk is highest for juvenile salmonids, which rear in shallow water. Measures to alert fish to equipment operation in the channel before gravel is placed in the water (*e.g.*, slow, deliberate equipment operation and tapping water surface prior to entering river channel), may provide opportunity for fish to leave the area before the activity begins.

The location of sites (outside of adult holding habitat) and the use of pre-construction surveys (aerial and/or boat) will minimize the risk to holding or spawning salmonid and green sturgeon adults, and incubating eggs. Some redds may remain undetected, resulting in impacts if additional minimization measures are not implemented during the earlier months of project timing (October through the end of December). CDFW surveys of winter-run Chinook salmon include aerial redd count surveys and carcass surveys, which conclude that an average of around 80 percent of redds remain undetected during aerial surveys (CDFG, unpublished data, 2015). Adult salmonids and green sturgeon are expected to move out of the area to adjacent suitable habitat before equipment enters the water or before gravel, logs, or boulders are placed over them. Therefore, the potential impact to adult salmonids and green sturgeon are considered extremely unlikely to occur and considered discountable, and not expected to reach a level where take occurs.

Although there is risk to juveniles, the peak of winter-run Chinook salmon juvenile migration past Red Bluff generally occurs August through October (Poytress *et. al.* 2014) with nearly 60 percent (on average) of the broodyear passing Red Bluff by October 1, when instream construction activities may begin. The risk of exposure for juvenile spring-run Chinook salmon from many activities is greater because peak outmigration is within the construction season, and they may continue to inhabit the Upper Sacramento River throughout the construction season. Although juvenile steelhead peak migration is April through September (Poytress *et. al.* 2014), which is outside of the construction season, juveniles may remain in the upper Sacramento River year-round. Additionally, juvenile green sturgeon migrate past RBDD between May and August (Poytress *et. al.* 2014), but may continue to inhabit areas within Zone 3 year-round.

Juvenile spring-run Chinook salmon and steelhead generally originate from tributaries and migrate through the action area at larger sizes and juvenile green sturgeon will have grown past the larval stage prior to construction. These larger juvenile salmonids and sturgeon are more mobile, which enables them to avoid disturbance and move to adjacent suitable habitat. For activities where gravel is deposited on previously formed augmentation sites, such as lateral berms or end-dump talus cones, potential impacts are very low, as gravel is very unlikely to contact and adversely affect juveniles; therefore, potential impacts from these methods are extremely unlikely to occur and considered discountable, and not expected to reach a level where take occurs.

Riffle supplementation sites, habitat structure placement, and floodplain and side channel enhancement sites, however, may require applying gravel directly to the riverbed, grading it, river crossings at some sites, and heavy equipment in the river, thereby increasing the likely exposure and chance for adverse effects to listed juveniles in the area. Nonetheless, the majority of gravel augmentation activities will occur within shallow areas within the middle of the channel, where fewer juveniles are expected to be rearing. Previous studies indicate that juvenile salmonids tend to be found within 10-20 feet of river banks (Allen 2000, FISHBIO and Normandeau Associates 2012, FISHBIO 2012). There is limited information regarding habitats occupied by juvenile green sturgeon; however, "habitat preference… in the laboratory suggests that wild juveniles should be in deep pools with some rock structure" (Kynard et al. 2005). Although some rearing and migrating juveniles may be found further from the banks, the area disturbed by gravel placement or excavation and associated turbidity at any given time is expected to be less than 25 percent of the river width, and to be most concentrated within about 200 feet downstream of the project site; therefore, juveniles will have opportunities to move to other portions of the channel where they can avoid potential injury or death. Although juveniles are expected to avoid areas where equipment is actively placing or excavating gravel, some juvenile salmonids (all zones) and juvenile green sturgeon (Zone 3 only) may attempt to find shelter in the substrate and be injured or killed by equipment. Materials placed at riffle supplementation sites are intended to be used immediately and will only be mobilized under higher flows that occur infrequently. Although BMPs designed to encourage fish movement out of the area prior to construction will likely minimize effects, some impacts to juveniles, resulting in injury or death are expected to occur as a result of the riffle supplementation method, floodplain and side channel enhancement, river crossings, as well as placement of habitat structures within the channel.

2.4.5 Effects to Critical Habitat

Some short-term adverse effects to critical habitat and PCEs/PBHFs (described above in section 2.2) are likely to occur during implementation of the proposed action. Although the action area's water quality has some potential to be negatively impacted, implementation of BMPs make this very unlikely to occur. Some adults and juveniles may experience up to 12 hours of disturbance to the migration corridor due to construction activities, but continued passage routes will be present. There may be long-term temporary loss (two to five years to fully regrow) of some riparian habitat (including SRA habitat) as a result of creating temporary access points to the river and covering vegetation with gravel, as well as temporary removal for floodplain and side channel enhancement. Gravel augmentation methods, floodplain and side channel enhancement, and placement of instream habitat structure will impact SRA riparian vegetation along the channel margin (< 500 linear feet at each site; 3,000 feet each year). Overall, some of the riparian vegetation that will be lost from access roads and restoration activities will be long-term temporary (total riparian loss expected to be less than 9 acres), which is likely to result in some harm to listed salmonids.

Gravel augmentation, floodplain and side channel enhancement, and placement of instream habitat structures may cause a temporary increase in turbidity and may redistribute and deposit silt or sand downstream of project sites in the upper Sacramento River, which could temporarily degrade current spawning gravel and reduce food availability. Juveniles are expected to move to available adjacent habitat. In addition, physical disturbance to spawning or rearing habitat will occur, and be unavailable for use during implementation of gravel augmentation, floodplain and side channel enhancement, or instream habitat structure placement, but this will be temporary and adjacent suitable habitat is available. BMPs will be employed during implementation of the proposed action so that spawning gravel will not be negatively affected. Implementation of these BMPs will ensure these potential effects are insignificant, and not expected to reduce the conservation value of critical habitat.

Overall the proposed action will not diminish, but will improve and increase the conservation value of the spawning habitat and rearing habitat, principal PCEs/PBHFs, for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (described above in the "Status of the Species" section 2.2). The proposed action may also secondarily or indirectly improve spawning and rearing habitat for the Southern DPS of North American green sturgeon.

2.4.6 Beneficial Effects

All coarse sediment from the upper watershed is trapped by Shasta and Keswick dams, which has resulted in a sediment deficit and reduction in fish habitat quality. In addition to the reduction of sediment supply, recruitment of LWM to the river channel and floodplain has also declined in the upper Sacramento River after Shasta and Keswick dams were built. As a result of project activities to augment spawning gravel, enhance floodplain and side channel habitats, and place instream habitat structures, spawning and rearing habitat are expected to improve and increase based on previous monitoring, which has indicated that similar restoration activities have created new spawning and rearing habitat for salmonids. The aggregate benefits of implementing habitat restoration each year, is expected to increase the conservation value of the habitat, and increase numbers of listed fish.

Gravel augmentation through talus cone or lateral berm methods provides a source of appropriately sized gravels to restore spawning habitats once gravels are mobilized and re-deposited downstream by high flows. Riffle supplementation will create instantly available spawning habitat up to 15 acres per year.

Floodplain and side channel habitats serve as important refuge and rearing areas for salmonids. Excavation and contouring activities to enhance floodplain and side channel habitats will create instantly available habitat for rearing by up to 15 acres per year.

Instream habitat structures such as woody material and boulders contribute to habitat diversity and create and maintain foraging, cover, and resting habitat for both adult and juvenile anadromous fish. Placement of instream woody material on the banks of the active channel will create instantly available habitat by creating diverse cover for juvenile rearing, and possibly for holding adults, by up to four acres each year.

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.

Non-Federal actions that may affect the action area include angling and State angling regulation changes, agricultural practices, private water contracts, water withdrawals and diversions, adjacent mining activities, and increased population growth resulting in urbanization and development of floodplain habitats, which may increase urban/suburban runoff and affect water quality. While state angling regulations have moved towards restrictions on selected sport fishing to protect listed fish species, incidental hooking of Chinook salmon, hook and release mortality of steelhead, and trampling of redds by wading anglers may continue to cause a threat. Habitat restoration projects may have short-term negative effects associated with instream construction activities, but these effects are temporary, localized, and the outcome is expected to benefit listed species and habitats. Increased water turbidity levels for prolonged periods of time may result from agricultural practices, adjacent mining activities, and increased urbanization and/or development of riparian habitat, and could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile Chinook or steelhead in the vicinity and downstream of the project area. High turbidity concentration can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg and Northcote 1985). Farming and ranching activities within or adjacent to the action area may have negative effects on water quality due to runoff laden with agricultural chemicals.

Water withdrawals and diversions may result in entrainment of individuals into unscreened or improperly screened diversions, and may result in depleted river flows that are necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of LWM. Future urban development may adversely affect water quality, riparian function, and aquatic productivity.

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 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.

2.6.1 Status of the Species and Effects of the action on listed species

The Status of the Species ESUs/DPSs are described above in section 2.2, and the action area is considered a major migratory corridor for all listed species, and is the only holding and spawning habitat currently used by winter-run Chinook salmon.

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

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (National Marine Fisheries Service 2010a).

As described in the effects section above (2.4), the impact of in-water work during gravel augmentation, side channel enhancements, river crossings, or habitat structure placement have the highest likelihood to affect listed species. The effects of gravel placement vary depending on the method used. The End Dump Talus Cone and Lateral Berm methods are unlikely to result in take of a listed species. Juvenile and adult salmonids will have the opportunity to temporarily avoid the area for suitable adjacent habitat during implementation, and redd surveys will be conducted prior to gravel placement. The potential for impacts from these gravel augmentation methods is discountable. The Riffle Supplementation Method, habitat structure placement, and floodplain and side channel habitat enhancements, which may all include river crossings, have the highest likelihood of killing, injuring, or harassing juvenile salmonids when they are outmigrating or rearing in larger numbers during augmentation, placement, or enhancement. Additionally, winter-run and spring-run Chinook salmon redds may remain undetected, and may experience impacts to incubating eggs or pre-emergent fry.

As a result of implementation of the proposed project, spawning and rearing habitats are expected to increase and improve for listed species. A long-term benefit of the continued project is that population abundances are expected to increase.

The cumulative effects described above in the action area of the upper Sacramento River, are not expected to be additive to the temporary adverse effects of the project, and baseline conditions are expected to improve as a result of the Project.

2.6.2 Status and effects to critical habitat

Gravel injections, placement of instream habitat structures, and side channel enhancements may cause a temporary increase in turbidity and may deposit silt or sand into the Sacramento River, which could degrade current spawning gravel and reduce food availability. In addition, physical disturbance to the migratory corridor, and to spawning or rearing habitat could occur during gravel placement, floodplain and side channel enhancements, instream habitat structure placement, and river crossings. BMPs will be in place during implementation of the Project, including timing of implementation, which will avoid spawning timing, so that spawning gravel will not be negatively affected. In addition, BMPs to wash the gravel prior to injecting will minimize and localize turbidity plumes. Implementation of these BMPs will ensure the majority of these potential effects remain insignificant. Sediment mobilization during project implementation may affect incubating eggs or pre-emergent fry if redds are undetected during surveys. There may be long-term temporary loss (two to five years to fully regrow) of some riparian habitat (including SRA habitat) as a result of creating temporary access points to the river and covering vegetation with gravel, as well as temporary removal for floodplain and side channel enhancement.

Overall the Project will not diminish, but will improve and increase the conservation value of the PCEs/PBHFs spawning habitat and rearing habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV steelhead. The proposed action may also secondarily or indirectly improve spawning and rearing habitat for green sturgeon. The immediate and long-term effects of the Upper Sacramento River Anadromous Fish Habitat Restoration projects, are anticipated to be beneficial to designated critical habitat for these species.

2.6.3 Summary

Long-term gravel augmentation, and rearing habitat restoration were identified as high priority recovery actions in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014a). The "Effects of the Action" section acknowledges and analyzes the potential effects of the habitat restoration project in the upper Sacramento River. Some potential effects of the implementation of the project are expected to result in incidental take of listed anadromous fish in the action area, although negative effects are expected to be minimal. Most significant immediate and long-term effects of the habitat restoration projects will be to improve overall conditions for listed salmonids by increasing and improving spawning and rearing habitat. Since green sturgeon utilize the upper Sacramento River as a migratory corridor as well as for spawning and juvenile rearing, there may be some benefits to them as well.

The adverse effects that are anticipated to result from the implementation are not the type or magnitude that will be expected to appreciably reduce the likelihood of survival and recovery of the affected species in the action area, or at the ESU/DPS level. Nor are any temporary adverse effects to critical habitat expected to reduce the value of designated or proposed critical habitat for the conservation of the species. VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be appreciably reduced; in contrast, implementing this Project is expected to improve these parameters, which will be necessary for the Sacramento River populations to reach a viable status, or as it functions as a major migratory corridor for all species. The Central Valley Salmon and Steelhead Recovery Plan has identified the upper Sacramento River population as the highest priority, or "Core 1" for recovery of the winter-run Chinook salmon ESU, a "Core 2" (secondary priority) for the CV spring-run Chinook salmon ESU, and a Core 2 for the CV steelhead DPS. NMFS expects that any adverse effects of this project will be outweighed by the immediate and long-term benefits to species survival, and increasing abundance, produced by the improvement in spawning and rearing habitat.

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' opinion that the proposed action is not likely to jeopardize the continued existence of winter-run Chinook salmon, spring-run Chinook salmon, CV steelhead, green sturgeon, or destroy or adversely modify their respective designated critical habitats.

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 opinion, NMFS determined that incidental take will occur as follows:

Juvenile winter-run and spring-run Chinook salmon, steelhead, and green sturgeon may be killed, injured, or harassed during the implementation of upper Sacramento River Anadromous Fish Habitat Restoration Programmatic. In addition, winter-run and spring-run Chinook salmon incubating eggs and pre-emergent fry may be killed.

The actual number of take per species resulting from the activities of the proposed project are impossible to track, due to the variability and uncertainty associated with the response of listed species to the effects of the project, the varying population size of each species, annual variations in the timing of spawning and migration, and individual habitat use within the project area. However, it is possible to designate as ecological surrogates, those elements of the project that are expected to result in take, that are also somewhat predictable and/or measurable, with the ability to monitor those surrogates to determine the level of take that is occurring. To help inform the effects analysis and conclusions for each species, and to help illustrate the impacts associated with the surrogates described below, we have included estimates in Table 10 below, based on fish density data.

The most appropriate threshold for take, is an ecological surrogate of temporary habitat disturbance during the riffle supplementation method of gravel augmentation, floodplain and side channel excavation, habitat structure placement, river crossings, SRA riparian habitat loss, and project site maintenance (numbers 1-6 below; Table 10).

Assumptions include anticipated density of rearing juvenile salmonids, based on snorkel surveys in the upper Sacramento River (CDFG 1998b), which averaged approximately 0.05 salmon per foot and 0.04 rainbow trout/steelhead per foot in riffle habitat. There are no data available for juvenile green sturgeon densities, but is likely less than half the density of salmon juveniles, therefore 0.025 per foot will be used. Additionally, the area disturbed by the project activity at any given time is expected to be less than 25 percent of the river width.

Further assumptions include percentage of winter-run and spring-run Chinook salmon redds that are undetected during aerial surveys. This number is estimated to be around 80 percent on average, which can be split into primarily three CDFW survey sections (1, 2, and 3 – all in Zone 2 described in this programmatic). The total area in these 3 sections is 1.337 square miles, and the total area of disturbance from project implementation is approximately 0.027 square miles, which is 2 percent of the total area of undetected redds that may be impacted due to project activities (Doug Killam 2014).

NMFS anticipates annual take will be limited to:

1. Take in the form of harm to juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon, from temporary disruption of 1,100 foot sections of mid-channel riffle rearing habitat due to gravel augmentation using the riffle supplementation method, plus 200 feet for turbidity plume, equaling 1,300 feet. Placement of up to 20,000 cubic yards of spawning gravel per project site, up to three sites per year. The disruption will affect the behavior of listed fish, increase predation risk, decrease feeding, and increase competition resulting in the take of listed fish each year (Table 10).

2. Take in the form of harm to juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon from temporary disruption of 100 foot sections of mid-channel riffle rearing habitat due to floodplain and side channel excavation activities, plus 200 feet for turbidity plume, equaling 300 feet, occurring at up to three project sites per year. The disruption will affect the behavior of listed fish, increase predation risk, decrease feeding, and increase competition resulting in the take of listed fish each year (Table 10).

3. Take in the form of harm to rearing juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon from temporary disruption of 1,100 foot sections of rearing habitat due to placement of up to 15 boulder clusters and 50 log structures per project site occurring underwater or near the water's edge, plus 200 feet for turbidity plume, equaling 1,300 feet, at up to three project sites per year in the main channel, which will likely require the use of heavy equipment and temporary gravel bar for placement. The disruption will affect the behavior of listed fish, increase predation risk, decrease feeding, and increase competition resulting in the take of listed fish each year (Table 10).

4. Take in the form of harm to rearing juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon from temporary disruption of up to 300 foot sections of migratory habitat, and migratory delay, plus 200 feet for turbidity plume, equaling 500 feet, due to heavy machinery crossing the river to implement project sites located on islands or that are inaccessible from the bank side, up to six project sites per year. The disruption will affect the behavior of listed fish, increase predation risk, decrease feeding, and increase competition resulting in the take of listed fish each year (Table 10).

5. Take for post-project maintenance is expected to occur every few years in floodplain and side-channel enhancement sites, and include, minor sediment removal, excavating machinery, hand removal of woody debris, or minor rock maintenance not to exceed the original project designs. One additional site per year has been added to number 2 described above and in Table 10 below.

6. Take in the form of harm to rearing juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon from the long-term loss of up to 3,000 linear feet of SRA riparian habitat removed during project implementation (500 linear feet at 3 gravel sites and 3 side channel sites each year). The loss of SRA habitat may cause a behavior modification of juvenile fish avoiding the disturbed areas and having reduced growth and

survival, or the loss may cause reduced food and cover, which may result in increased competition and increased risk of predation (Table 10).

7. Take in the form of injury or death to winter-run and spring-run Chinook salmon incubating eggs and pre-emergent fry, as a result of project activities mobilizing sediment and burying or smothering undetected redds in Zone 2. Two percent of the total area of undetected redds may result in impacts to redds that are undetected as a result of project activities. The proportion of area that may impact redds that remain undetected is the best surrogate for take, as it is not possible to quantify the number of undetected redds downstream of each project site.

The take from the above descriptions (one through five) may include injury or death of a small number of juvenile CV steelhead, winter-run and spring-run Chinook salmon, and green sturgeon, as described in Effects Section. In addition, take from these activities is expected to harm the species by temporarily modifying important elements of rearing habitat. Juvenile steelhead, winter-run and spring-run Chinook salmon, and green sturgeon will be affected because rearing and migration habitat will be temporarily disrupted. Disruption of habitat utilization may cause fish migration to be delayed or to be displaced, which may result in increased predation risk, decreased feeding, and increased competition. The behavioral modifications that result from the habitat modification are the ecological surrogates for take. There is not a stronger ecological surrogate based on the information available at this time because it is not possible to quantify the exact numbers of individuals that may be affected, however, we have included estimates of fish potentially impacted based on expected fish densities for illustrative purposes below.

Take from long-term loss of SRA riparian habitat (number 6 above), may indirectly result in harm to species as modification of behavior of juvenile fish include avoiding the disturbed areas and having reduced growth and survival, or the loss may cause reduced food and cover, which may result in increased competition and increased risk of predation.

Table 10. Ecological Surrogate describing the amount and extent of take as a result of the Project.

Species and life stage	Activity of known sites by Zone	Life Stage/Presence	Habitat Disturbance Amount	Potential numbers of fish impacted per site/annually
Central Valley steelhead Juveniles	Zone 2: RS- 5 sites EX- 5 sites HS- 5 sites Zone 3: RS- 3 sites EX- 4 sites HS- 2 sites	Zone 2: October 1 – April 15: rearing; April: outmigrating; Zone 3: October 1 – March 1: rearing USR rearing/migrating density: 0.04 fish per foot	RS and HS: 1,300 foot sections. EX: up to 300 foot sections RC and RR: up to 500 foot sections	RS and HS: 13/39 EX: 3/12 RC and RR: 5/30
Central Valley spring-run Chinook salmon Juveniles		Zone 2: October 1 – April 15: rearing and outmigrating Zone 3: October 1 – March 1: rearing and outmigrating USR rearing/migrating density: 0.05 fish per foot		RS and HS: 16/48 EX: 4/16 RC and RR: 6/36
Sacramento River winter-run Chinook salmon juveniles		Zone 2: October 1 – March 1: rearing and outmigrating Zone 3: October 1 – March 1: rearing and outmigrating USR rearing/migrating density: 0.05 fish per foot		RS and HS: 16/48 EX: 4/16 RC and RR: 6/36
Southern DPS of North American green sturgeon juveniles	Zone 3: RS- 3 sites EX- 4 sites HS- 2 sites	Zone 3: October 1 – March 1: rearing and outmigrating USR rearing/migrating density: 0.025 fish per foot		RS and HS: 8/24 EX: 2/8 RC and RR: 3/18

RS: riffle supplementation gravel augmentation; EX: floodplain and side channel excavation; HS: habitat structure placement; RC: river crossings; RR: riparian removal; USR: Upper Sacramento River (between Keswick and Red Bluff Diversion Dams)

2.8.2 Effect of the Take

In the 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. Reclamation shall ensure impacts from the sites to be implemented each year are within the parameters of the opinion. Uncertainties regarding which sites will be implemented each year could lead to impacts not analyzed.
2. Reclamation shall minimize impacts to listed species.
3. Reclamation shall minimize impacts to riparian vegetation.
4. Reclamation shall prepare and provide for NMFS' approval, a monitoring and maintenance plan, as well as prepare and provide annual reports.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Reclamation or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The 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) Reclamation shall obtain NMFS approval of proposed sites each year.
    b) Reclamation shall obtain NMFS approval of final plans at each site, each year, prior to implementation.
    c) Reclamation shall continue meeting and working with the SRRT, including consideration of recommendations and concerns.

2. The following terms and conditions implement reasonable and prudent measure 2:

    a) Fish Passage: Reclamation shall ensure upstream and downstream fish passage is unobstructed throughout construction period within a portion of the Sacramento River.
    b) Sedimentation and Turbidity: Within one week prior to construction, Reclamation shall coordinate with CDFW to obtain real-time aerial or boat redd survey data, and perform pre-construction surveys the day prior to construction; if redds from listed

species are present within 200 feet downstream, Reclamation shall contact NMFS with minimization plan and wait for final approval before implementation.

c) To avoid impacting undetected winter-run and spring-run Chinook redds (including incubating eggs and pre-emergent fry), Reclamation shall implement "additional measures" described in the Project Description above for minimizing sediment mobilization during the months of October, November, and December for projects implemented in Zone 2 (and may extend to Zone 3 depending on observed redds).

d) Reclamation shall use techniques to gently encourage fish to leave any watered side channel areas prior to creating berms to isolate construction. If fish remain in pools, Reclamation shall contact NMFS and CDFW for relocation.

3. The following terms and conditions implement reasonable and prudent measure 3:

   a) Reclamation shall replace any SRA removed during site access, or implementation of restoration activities within the project footprint. If the site is to be used again the following year, replace within the Action Area in sections of the river that have diminished SRA habitat. A detailed re-vegetation plan should be provided to NMFS and should include a timeframe, and a list of species and designs depicting the proposed location for each species and their density. The vegetation plan should also include proposed irrigation and vegetation monitoring schedules which will likely be needed for several years.

4. The following terms and conditions implement reasonable and prudent measure 4:

   a) Reclamation shall develop the monitoring and maintenance plan in coordination with the SRRT, and provide to NMFS by September 1, 2016 for approval. This plan shall include how listed species and habitat will be monitored, and any annual maintenance needed for specific sites.

   b) Reclamation shall provide an annual report, by September 1, of each year, documenting of the effects of the action on listed species and critical habitat in the action area.

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) The effectiveness of some types of stream restoration actions are not well documented, partly because decisions about which restoration actions deserve support do not always address the underlying processes that led to habitat loss. NMFS recommends that the Action Agencies use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery, and to identify key actions in the action area when prioritizing project sites each year. The final recovery plan for Central Valley listed salmonids is available at:

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_salmon_recovery_domain.html

2.10 Reinitiation of Consultation

This concludes formal consultation for the Upper Sacramento River Anadromous Fish Habitat Restoration Programmatic.

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.

MAGNUSON-STEVENS 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 the 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

The Fisheries Management Plan for Pacific Coast Salmon identifies the upper Sacramento River as EFH, which consists of four major components: spawning and incubation habitat; juvenile rearing habitat; juvenile migration corridors; and adult migration corridors and adult holding habitat (Pacific Fishery Management Council 1999). Additionally, the Action Area contains the following designated Habitat Areas of Particular Concern (HAPC): (1) Complex Channels and Floodplain Habitats – although degraded from historical conditions; (2) Thermal Refugia – the upper Sacramento River is dependent on cold water releases from Shasta and Keswick dams for listed anadromous fish; and (3) Spawning Habitat – Shasta and Keswick dams block gravel recruitment for spawning habitat and require annually injected gravel to maintain ideal spawning substrate. The other two HAPCs for Pacific Salmon, (4) Estuaries, and (5) Marine and Estuarine Submerged Aquatic Vegetation, are not present in the Action Area.

3.2 Adverse Effects on Essential Fish Habitat

While the ESA portion of this document determined that impacts to riparian vegetation, water quality, and migration delays were either discountable or insignificant to pacific salmon, we conclude that aspects of the proposed action would adversely affect EFH for these species. We conclude that the following adverse effects on EFH designated for Pacific Salmon are reasonably certain to occur:

1) Freshwater EFH quality will be reduced due to a short-term increase in turbidity, dissolved oxygen demand and temperature due to riparian and channel disturbance, and longer-term improvement due to improved habitat diversity and complexity of side channel habitat restoration.
2) Forage availability will decrease in the short-term due to riparian and channel disturbance, and improve over the long-term due to improved habitat diversity and complexity of side channel habitat restoration.
3) Natural cover will decrease in the short-term due to riparian and channel disturbance, and improve over the long-term due to improved habitat diversity and complexity of side channel habitat restoration.
4) Fish passage/migration will be impaired/delayed during river crossings to access island sites;
5) Spawning habitat for fall-run or late fall-run Chinook salmon will be unavailable or impacted during construction of side-channels, river supplementation gravel injection, and habitat structure placement; long-term increase in spawning habitat quantity and quality.

3.3 Essential Fish Habitat Conservation Recommendations

The following six conservation recommendations are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH:
1) For effects 1-3 listed above (HAPC #1), NMFS recommends that Reclamation replaced any SRA riparian habitat at a 3:1 ratio within the action area, specifically in areas with diminished SRA habitat.
2) For effect 4 listed above, NMFS recommends adopting T&C 2 (a) above as a fish passage measure
3) For effect 5 listed above (HAPC #3), NMFS recommends retaining minimization measures described for pre-construction redd surveys for listed species, for fall- and late-fall-run Chinook salmon redds.

Fully implementing the following EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, designated EFH for Pacific Coast Salmon FMP.

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

The 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)).

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.

FWCA recommendation: At any project site within the Action Area that experiences foot traffic, Reclamation should post interpretive signs 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.

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 is the Reclamation. Other interested users could include the Corps, USFWS, CDFW, and CDWR. Individual copies of this opinion were provided to the Reclamation. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

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 and 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 and MSA, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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