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

JUL 18 2017

Refer to NMFS No: WCR-2015-3217

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Office of Energy Projects
888 First Street, N.E.
Washington, D.C. 20426

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 License Amendment for the Battle Creek Hydroelectric Project (FERC No. 1121), Phase 2, in Shasta and Tehama counties

Dear Ms. Bose:

Thank you for your letter of June 18, 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 proposed Federal Energy Regulatory Commission (FERC) License Amendment for the Battle Creek Hydroelectric Project, Phase 2 (FERC No. 1121), on Battle Creek in Shasta and Tehama counties, California.

Based on the best available scientific and commercial information, the attached biological opinion concludes that the FERC License Amendment for the Battle Creek Hydroelectric Project, Phase 2 is not likely to jeopardize the continued existence of federally listed species, 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 conservation recommendations. FERC has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed response in writing to NMFS within 30 days of receipt of these conservation recommendations that includes a description of the measures proposed for avoiding, mitigating, or offsetting the impact of the proposed action on EFH (50 CFR 600.920(k)). If unable to complete a final response within 30 days, FERC should provide an interim written response within 30 days before submitting its final response.

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,

for Maria C Rea
Barry A. Thom
Regional Administrator

Enclosure

CC: CHRON File: 151422-WCR2015-SA00156
FERC No. 1121 Service List

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

Battle Creek Hydroelectric Project (FERC No. 1121), Phase 2 License Amendment
NMFS Consultation Number: WCR-2015-3217

Action Agency: Federal Energy Regulatory Commission (FERC)

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	Species Yes Critical Habitat NA*	No	NA
Central Valley Spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No
California Central Valley Steelhead (*O. mykiss*)	Threatened	Yes	No	No

* Designated critical habitat for Sacramento River winter-run Chinook salmon is outside of the action area.

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: Maria Chu

for ~~Barry~~ Barry A. Thom
Regional Administrator

Date: JUL 18 2017

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1. INTRODUCTION

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

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (BO) 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 NMFS' California Central Valley Area Office.

In 1999, the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), NMFS, California Department of Fish and Wildlife (CDFW) (formerly the California Department of Fish and Game), and Federal Energy Regulatory Commission (FERC) licensee, Pacific Gas and Electric Company (PG&E), were all signatories to a Memorandum of Understanding (MOU) that proposed the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project; Jones and Stokes 2005a,b; Reclamation et al. 1999), which assumed occupancy would be for all three listed salmonid species. The purpose of the Restoration Project is to reestablish approximately 42 miles of salmon and steelhead habitat on Battle Creek, plus an additional 6 miles of habitat on its tributaries. Restoration is being accomplished primarily through the modification of the existing Battle Creek Hydroelectric Project's (FERC Project Number 1121) (BC Hydroelectric Project) facilities and operations, including fish passage and instream flow releases.

On June 22, 2005, NMFS consulted with the Federal lead for the Restoration Project, Reclamation, and completed the BO for construction of the entire Restoration Project (NMFS 2005). At that time, it was thought that the entire Restoration Project would be completed by the summer of 2009. The signatories to the MOU later decided to implement the Restoration Project in three phases—Phase 1A, Phase 1B, and Phase 2. There have been significant delays to project implementation due to land owner and contracting issues, as well as due to needing to revise environmental documents. These delays have led to increases in costs, which have led to further delays due to funding shortages, which has moved the completion date back more than 10 years. This current consultation is with FERC (and PG&E as the licensee), as proposed changes to the BC Hydroelectric Project trigger the need for an amended license. NMFS issued a BO for Phase 1A, on July 21, 2009 (NMFS 2009b), and FERC issued an Order Amending License on August 25, 2009, authorizing the modifications to the BC Hydroelectric Project for Phase 1A of the Restoration Project. Similarly, NMFS issued a BO for Phase 1B, on April 27, 2010 (NMFS 2010), and FERC issued an Order Amending License on May 21, 2010, authorizing the modifications to BC Hydroelectric Project for Phase 1B of the Restoration Project. On March 2, 2015, the Licensee filed an application for amendment of license in order to authorize implementation of the final modifications to the BC Hydroelectric Project (Phase 2) of the Restoration Project.

Although the construction for Phase 1A (North Fork Battle Creek) was completed in 2013, hydraulic evaluations indicated some issues with the fish screen and ladder at upper dam, North Battle Creek Feeder Dam, that will need further work. Because of these issues, PG&E did not “accept” the facilities on the North Fork from Reclamation and the two entities have decided that fish should not be allowed to use the newly built fish ladder (and screen) at the downstream dam, Eagle Canyon Dam. Allowing salmonids to use the fish ladder at Eagle Canyon Dam would provide access to the preferred higher quality spawning and rearing (temperatures) habitat. Currently, Reclamation has scheduled the construction fixes on the upper dam’s screen and ladder to be completed in 2018.

For Phase 1A, PG&E proposed to increase the minimum instream flows in North Fork Battle Creek and at Asbury Dam in Baldwin Creek (tributary to mainstem Battle Creek), and NMFS’ biological opinion for Phase 1A analyzed the effects of the proposed action including this proposed increase in minimum instream flows (NMFS 2009b). In addition, FERC’s Order Amending License for Phase 1A, Ordering paragraph H, amended Article 33 of the license to require the licensee to maintain minimum instream flows related to Phase 1A at the completion of installation of the appropriate facilities of Phase 1A. Except for flows below Asbury Dam, which has been occurring since construction completion, those minimum instream flows related to Phase 1A have not been provided to date, and NMFS will address issues of compliance with NMFS’ biological opinion for Phase 1A and FERC’s Order Amending License for Phase 1A in separate correspondence.

Since 1996, Reclamation has made agreements with PG&E (Interim Flow Agreements) to maintain higher minimum instream flows than required in the current FERC license (which are lower than the proposed Project Flow increases), until the long-term Restoration Project could be fully implemented on Battle Creek. The Interim Flow Agreements represent a short-term set of resource conditions that are not conditions of PG&E’s existing FERC license. The Interim Flow Agreements include Reclamation paying PG&E a portion of forgone power generation resulting in increased flow releases below the Eagle Canyon Dam on the North Fork and Coleman Diversion Dam on the South Fork. An Interim Flow Science Team was established that includes representatives from PG&E, Reclamation, the Fish Agencies (NMFS, USFWS, and CDFW), and a stakeholder representative from the Greater Battle Creek Watershed Working Group

(GBCWWG). The Interim Flow Science Team provides scientific information to Reclamation and PG&E related to changes in hydrologic and climatic conditions, instream habitat conditions, and fishery data that may indicate need for temporarily modifying the flow objectives set in the Interim Flow Agreement.

The NMFS Recovery Plan (NMFS 2014b) identified the need for reintroduction of winter-run Chinook salmon into Battle Creek in order for a population to be established. The Battle Creek Winter-Run Chinook Salmon Reintroduction Plan was completed in August of 2016 (ICF 2016).

1.2 Consultation History

June 25, 2015, FERC sent NMFS a request to initiate formal consultation and a biological assessment on the proposed project.

July 9, 2015, NMFS requested clarification on effects described in the biological assessment. On July 16, 2015, PG&E provided the information requested.

October and November of 2015, NMFS requested clarification on occurrences of powerhouse outages related to effects to listed fish; PG&E provided responses though further discussion was needed.

January and February of 2016, phone conversations and email exchanges occurred between PG&E and NMFS to further clarify powerhouse outages. PG&E provided a change in the project description, which included an adjusted table for planned and unplanned outages, which increased the frequency and duration for a number of outages, on January 25, 2016, as well as final clarification on February 17, 2016.

June 29, 2016, PG&E began conversations with the Fish Agencies regarding their draft Facility Monitoring Plan; discussions continued through January, 2017.

July 11, 2016 PG&E filed a Petition for Reconsideration with the State Water Resources Control Board (SWB) of their draft 401 Water Quality Certification.

October 24, 2016, SWB requested to meet with Fish Agencies to discuss conditions of their draft 401 Water Quality Certification.

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).

The entire Restoration Project consists of modifications to facilities at nine dam sites located on North Fork Battle Creek, South Fork Battle Creek, Baldwin Creek, Lower Ripley Creek, and Soap Creek, including an increase in instream flow requirements (Table 1, Table 2, Figure 1, Figure 2, and Figure 3). As noted above, the MOU signatories decided to implement these modifications in three phases (Phase 1A, Phase 1B, and Phase 2). The proposed action analyzed in this BO is FERC's proposed action of issuing an order amending the BC Hydroelectric Project license authorizing implementation of Phase 2 of the Restoration Project, based on the Licensee's application for amendment of the license filed with FERC on March 2, 2015. The Restoration Project BO (NMFS 2005) analyzed the short-term effects of construction of the Project, including construction and demolition-related effects of Phases 1A, 1B, and 2; therefore, those short-term construction related effects are considered part of the environmental baseline (Section 2.3) of this BO. As described above in Section 1.1, effects of operation of the BC Hydroelectric Project license as modified in Phases 1A and 1B (the earlier phases) of the Restoration Project have been consulted on, and are also considered part of the environmental baseline (Section 2.3) of this BO.

"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). NMFS has not identified any interrelated or interdependent actions associated with the proposed action. Although the Coleman National Fish Hatchery (CNFH) is situated within the Battle Creek watershed, the Restoration Project area and the BC Hydroelectric Project are upstream. The CNFH program does not fit the definition of an interrelated or interdependent action.

The proposed action will authorize implementation of Phase 2 of the Restoration Project, which includes: installing a new fish screen and fish ladder at Inskip Diversion Dam; installing a tailrace connector tunnel from South Powerhouse to Inskip Canal; removing Lower Ripley Creek Feeder, Soap Creek Feeder, South, and Coleman diversion dams; and removing South Diversion Dam's associated conveyance system. The tailrace/penstock bypass connector will allow water from the South Powerhouse to pass directly to the Inskip Canal without mixing North Fork and South Fork water. South Fork Battle Creek water also may be diverted to Inskip Powerhouse via the new fish screen at the Inskip Diversion Dam. Water diverted through the fish screen will supplement both the Inskip Canal and the attraction flow needed at the entrance to the new fish ladder.

The Restoration Project also includes a number of other measures upon completion of each phase, as it relates to that phase. Those elements that were related to Phase 1 (A and B), or North Fork Battle Creek, are considered part of the environmental baseline. The elements below, as they pertain to Phase 2 (South Fork Battle Creek), are included in the proposed action. Among these measures are those listed below:

- Transferring water rights at removed diversion dams to the CDFW or otherwise ensuring the water remains in the stream to benefit fish;
- Creating a Water Acquisition Fund for future purchases of additional instream flow releases that may be recommended under the adaptive management process during the first 10-year period following completion of the Restoration Project;
- Using an Adaptive Management Fund to implement any additional modifications or refinements to the Restoration Project components developed under the Restoration Project Adaptive Management Plan (AMP) protocols.

The continued operations of the BC Hydroelectric Project post-Phase 2 is ultimately the proposed action being evaluated under this consultation. Currently Phase 2 is scheduled (Reclamation 2016) to begin construction in 2018, and to be completed by the end of 2020, but will then need to undergo testing, which is expected to extend the period before Phase 2 is fully operational until the end of 2021; however, funding shortages may cause further delay in implementation. Phase 2 implementation is described in more detail below.

1.3.1 South Diversion Dam and Canal

South Diversion Dam diverts water from South Fork Battle Creek into South Canal. South Canal runs for approximately 5.7 miles through tunnels, metal flumes, and excavated channel sections to its confluence with the Cross Country Canal. The proposed modifications at South Diversion Dam and Canal will enable salmon and steelhead to migrate unimpeded along this reach of the creek. The proposed modifications include those listed below.

- Complete removal of South Diversion Dam;
- Removal of appurtenant dam facilities;
- Removal/filling in of South Canal, including the restoration of natural drainages running across the canal alignment;
- Improve access roads;
- Excavate a pilot channel to facilitate mobilization of sediments trapped by the dam in the stream channel and to ensure fish passage.

1.3.2 Soap Creek Feeder Diversion Dam

Soap Creek Feeder Diversion Dam is located on Soap Creek about 1 mile upstream of its confluence with South Fork Battle Creek. It diverts water into a pipeline (approximately 300 feet long) that discharges into South Canal. The proposed modifications at Soap Creek Feeder Diversion Dam will enable salmon and steelhead to migrate unimpeded along this reach of the creek and provide an increased contribution of cold spring water to South Fork Battle Creek. The proposed modifications include those listed below.

- Complete removal of Soap Creek Feeder Diversion Dam;
- Removal of appurtenant facilities, including pipeline and junction box where flow enters South Canal;
- Access road improvements.

1.3.3 Inskip Diversion Dam and South Powerhouse

Inskip Diversion Dam and South Powerhouse are located on South Fork Battle Creek. South Powerhouse receives water for power generation from Union Canal and discharges water through a tailrace into South Fork Battle Creek. Inskip Diversion Dam is located approximately 1,100 feet downstream of South Powerhouse and diverts water via the Inskip Canal approximately 5.4 miles downstream where it joins Eagle Canyon Canal to the Inskip Powerhouse. The proposed modifications at Inskip Diversion Dam and South Powerhouse will improve fish passage at Inskip Diversion Dam and prevent fish from entering Inskip Canal. The following modifications are proposed.

- Construction of a fish ladder at Inskip Diversion Dam;
- Installation of a fish screen on Inskip Canal;
- Replacement of appurtenant facilities, including the headworks and sluiceway;
- Construction of an Inskip Canal wasteway to ensure that any flows exceeding the capacity of the canal could be removed from the canal in a controlled manner;
- Construction of a South Powerhouse tailrace connector to divert South Powerhouse tailrace flows to Inskip Canal;
- Modification of the South Powerhouse tailrace channel to prevent the mixing of North Fork Battle Creek water with South Fork water;
- Improvement of access roads and associated power line relocations;
- Establishment of waste/borrow areas for material excavated during construction (this material will be reused to the extent possible for construction of other project features).

1.3.4 Lower Ripley Creek Feeder Diversion Dam

The Lower Ripley Creek Feeder Diversion Dam is located on Ripley Creek about one mile upstream of its confluence with South Fork Battle Creek. The diversion dam provides water to Inskip Canal via a 384-foot-long feeder canal. The proposed modifications at the Lower Ripley Creek Feeder Diversion Dam will enable salmon and steelhead to migrate unimpeded along this reach of the creek. The proposed modifications include those listed below.

- Complete removal of Lower Ripley Creek Feeder Diversion Dam;
- Removal of appurtenant dam facilities;
- Removal/filling in of the feeder canal, including grading to prevent ponding and allow cross-slope drainage to continue downslope;
- Improvement of access roads.

1.3.5 Coleman Diversion Dam and Inskip Powerhouse

Inskip Powerhouse is located on South Fork Battle Creek and generates power with a mixture of North Fork and South Fork Battle Creek water delivered by the Inskip and Eagle Canyon Canals. After the water passes through the turbine at Inskip Powerhouse, it is discharged into a tailrace that delivers water from the powerhouse directly to Coleman Canal or South Fork Battle Creek. Coleman Diversion Dam is located approximately 900 feet downstream of Inskip Powerhouse on South Fork Battle Creek and diverts water into Coleman Canal. Coleman Canal conveys water to the Coleman Powerhouse located about 10 miles to the west of Coleman Diversion Dam. The proposed modifications at the Coleman Diversion Dam and Inskip Powerhouse will enable salmon and steelhead to migrate unimpeded along this reach of the creek and ensure that North Fork water is not discharged into South Fork Battle Creek. Some modifications at the Coleman Diversion Dam and Inskip Powerhouse project site were already completed under Phase 1B (i.e., construction of an Inskip Powerhouse penstock bypass facility to direct overflows from the Eagle Canyon and Inskip Canals into Coleman Canal, and construction of Inskip Powerhouse tailrace connector to direct powerhouse discharges into Coleman Canal). The following modifications are proposed for Phase 2.

- Complete removal of Coleman Diversion Dam;
- Removal of appurtenant facilities;
- Excavation of a pilot channel to facilitate mobilization of sediments trapped by the dam in the stream channel and to ensure fish passage.

Table 1. Summary of individual components of each phase of the Restoration Project.

Site Name Component	Phase 1A	Phase 1B	**Phase 2**
North Battle Creek Feeder Diversion Dam	Install fish screen and ladder; minimum instream flow for N. BC Feeder reach ranging from 47 to 88 cfs; Improve access road		
Eagle Canyon Diversion Dam and Canal	Install fish screen/ladder; remove Eagle Canyon (EC) spring collection facility; Minimum instream flow for EC reach 35 to 46 cfs; Improve access trail Replace section of EC Canal with buried pipeline		
Wildcat Diversion Dam, Pipeline, and Canal	Remove dam, pipeline and canal; Improve access roads and trail		
3* Diversion Dams			**Remove 3 dams**
Inskip Diversion Dam and South Powerhouse			**Install fish screen and ladder, South Powerhouse/Inskip Canal connector (tunnel), Instream flow for Inskip reach ranging from 40 to 86 cfs**
Coleman Diversion Dam and Inskip Powerhouse		Construct Inskip Power-house and Coleman Canal connector; Replace Inskip Power-house bypass;	**Remove dam**
Asbury Diversion Dam	Install instream flow release monitoring/recording equipment; minimum instream flow for Baldwin Creek at 5 cfs; Modify dam/fish barrier		
cfs= cubic feet per second *Ripley, Soap, South			

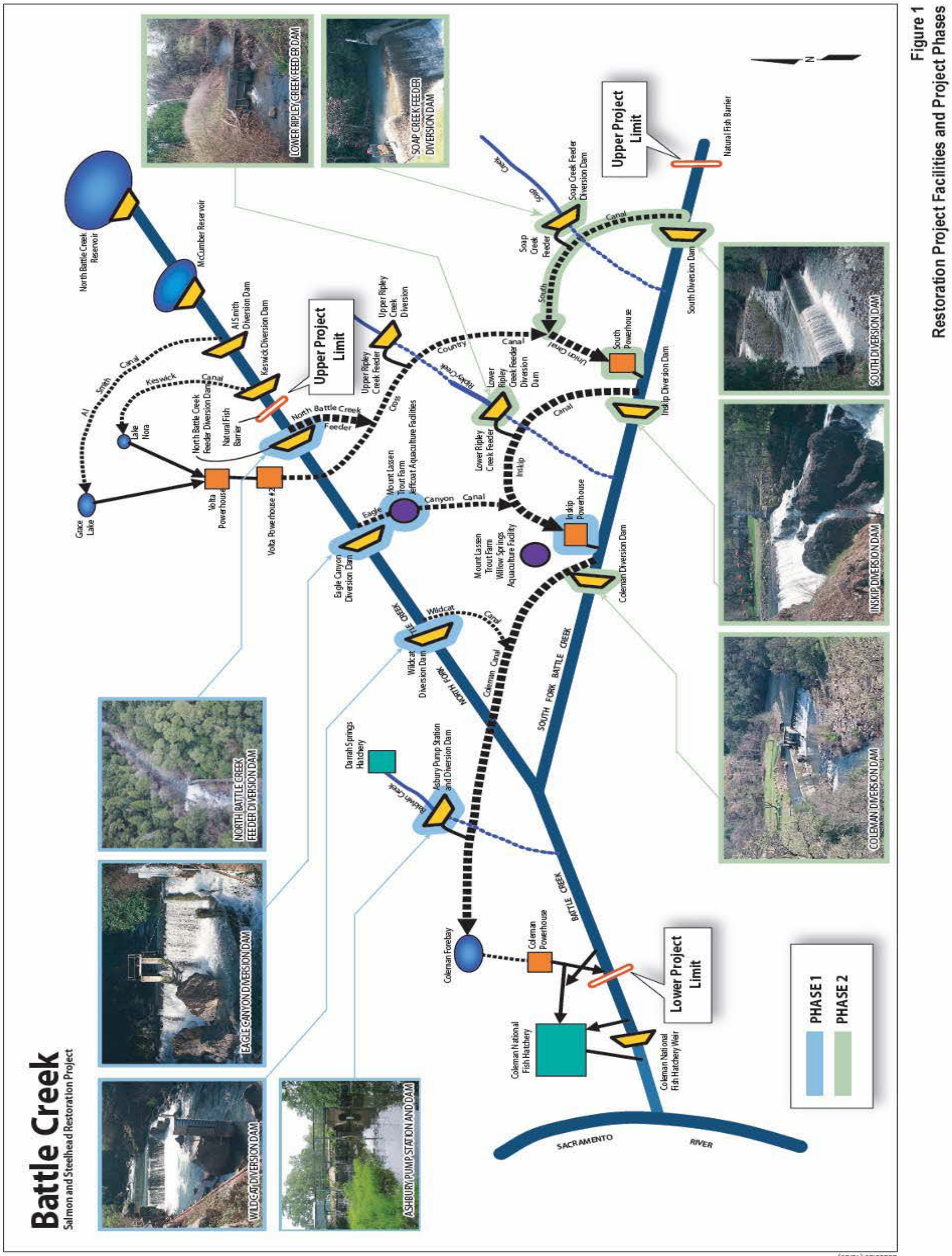

Figure 1. Battle Creek Salmon and Steelhead Restoration Project components by Phase.

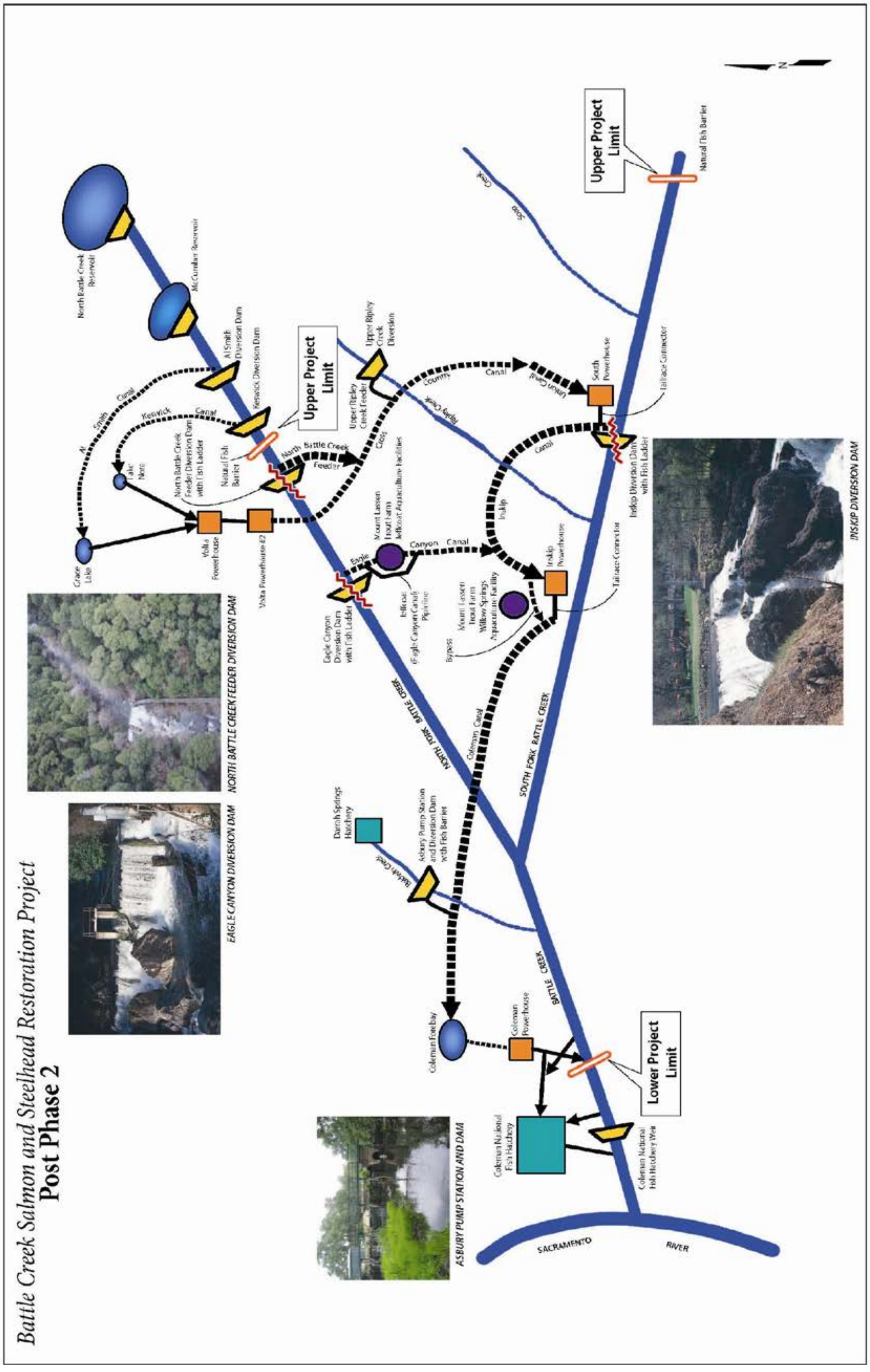

Figure 2. Post Phase 2 of the Battle Creek Salmon and Steelhead Restoration Project.

Table 2. Post Phase 2 Restoration Project Monthly Minimum Instream Flow Requirements on the South Fork as proposed per the MOU (1999). Post Phase 1A requirements on the North Fork are included here although they have not been met to date.

Dam	Monthly Minimum Flow Release (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North Fork Battle Creek												
North BC Feeder	88	88	88	67	47	47	47	47	47	47	47	88
Eagle Canyon[1]	46	46	46	46	35	35	35	35	35	35	35	46
Wildcat[1]	Facility removed; no diverted flows											
South Fork Battle Creek												
South[2]	Facility removed; no instream flow requirement											
Inskip[2]	86	86	86	61	40	40	40	40	40	40	40	86
Coleman[2]	Facility removed; no diverted flows											
Ripley Creek[3]	Facility removed; no diverted flows											
Soap Creek[3]	Facility removed; no diverted flows											
Baldwin Creek												
Asbury	5	5	5	5	5	5	5	5	5	5	5	5

[1]As part of the Phase 1A License Amendment, the FERC license requirement changes the original 5 cfs in the North Fork to the flows listed. However, these flows have not been provided to date. As a result of an Interim Flow Agreement between Reclamation and PG&E, the minimum release downstream of Eagle Canyon and Wildcat dams was increased from 5 cfs to 30 cfs.

[2]Under Phase 1A and Phase 1B, the FERC minimum instream flow requirements downstream of South, Inskip, and Coleman dams did not change from the 5 cubic feet per second (cfs) year round. The Interim Flow Agreement has increased flows to 30 cfs downstream of Coleman Dam, until Project Flows are provided as a result of implementation of Phase 2.

[3]Under Phase 1A and Phase 1B, there were no FERC minimum instream flow requirements for these creeks (all storm flows diverted). Stream flow is primarily spring-based out of Ripley Creek, averaging 1.5 cfs year-round but peaking higher during storms; Soap Creek stream flow averages around 9 cfs year-round.

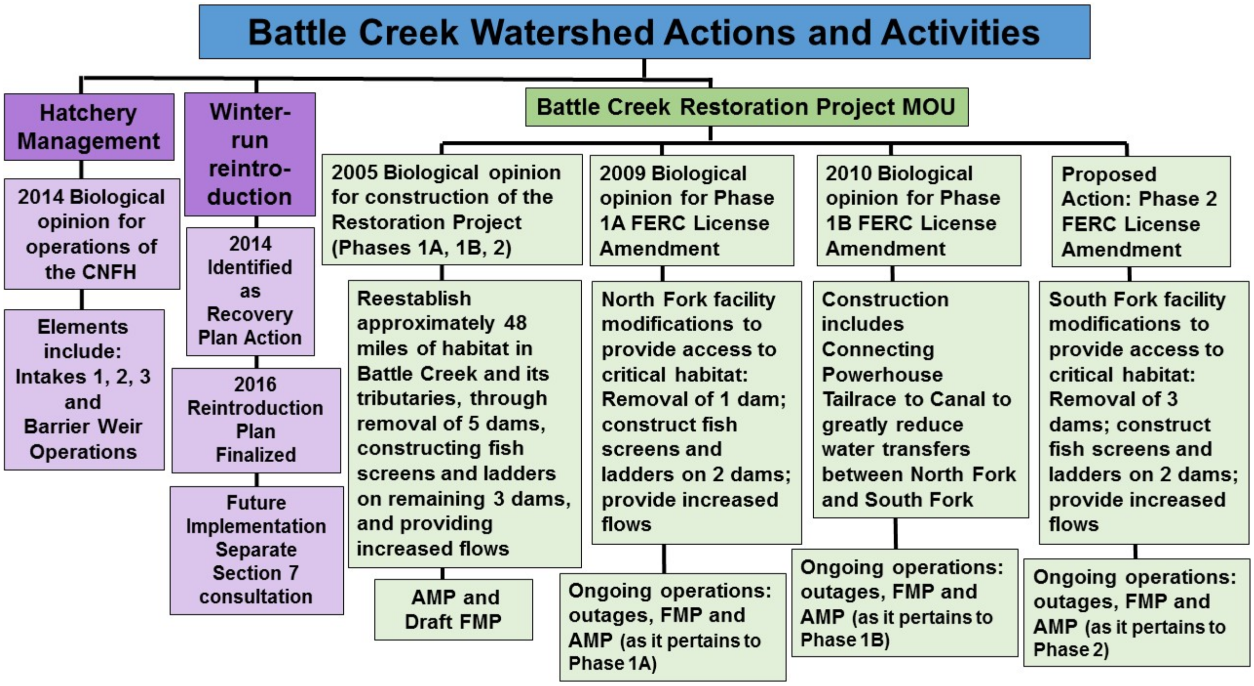

Figure 3. Deconstructing Battle Creek Watershed Actions and Activities, including the Proposed Action (Phase 2). Memorandum of Understanding (MOU); Adaptive Management Plan (AMP); Facility Monitoring Plan (PG&E's FMP)

1.3.6 Maintenance of facilities of the Battle Creek Hydroelectric Project

Historically, planned and unplanned powerhouse outages for maintenance of facilities (e.g., powerhouses, screens/ladders) have varied in frequency and duration. These outages can cause water from the canals that feed these powerhouses to be released to adjacent stream reaches. These outages and subsequent canal spills often result in short-term fluctuations of flow and water temperature in the affected short stream channel sections located between the powerhouses and the downstream canal intakes. Under environmental baseline conditions, powerhouse outages can cause canal flows to spill and flow down natural pathways to South Fork Battle Creek. These spills can occur either near the existing powerhouses or from gates at the head of the canal if workers need to enter water conveyance facilities associated with the powerhouse (PG&E 2015).

Example (PG&E 2015): "South or Inskip powerhouses are shut down for maintenance or because of lightning strikes, transmission grid disruptions, or other emergencies. When this occurs, the associated penstock intake facilities are shut off. In the event the powerhouse and the penstock facilities are shut down, water in the canals feeding South Powerhouse will be diverted back into the tailrace/penstock bypass connector between South Powerhouse and Inskip Canal. The bypass systems allow water to continue to be diverted to downstream powerhouses and, together with the tailrace/penstock connectors at South and Inskip Powerhouses, essentially eliminate any discharge of North Fork Battle Creek water to South Fork Battle Creek. One exception occurs at an emergency overflow wasteway in the Inskip Canal located in the area between the South Powerhouse tailrace connector tunnel outlet and the diversion from Inskip

Diversion Dam. The wasteway consists of a 100-foot-long concrete overflow box and pipe set in the southwestern Inskip Canal embankment and has a capacity of 150 cubic feet per second (cfs). It is designed to protect Inskip Canal from uncontrolled overtopping, which could lead to a canal failure. The Inskip Canal wasteway allows flows that exceed the canal capacity to be spilled from the canal in a controlled manner. Flows may exceed the canal capacity when water is being discharged from the powerhouse and the penstock spillway and diverted from South Fork Battle Creek. These circumstances are rare, short in duration, and unintentional. The water discharged from the overflow wasteway, a mixture of North Fork and South Fork water, would enter South Fork Battle Creek at this location."

On North Fork Battle Creek, flow fluctuations occur in North Battle Creek Feeder, Eagle Canyon, and Wildcat reaches when Keswick and Al Smith Canals are taken off line for annual scheduled maintenance of the Volta 1 and Volta 2 Powerhouses. These same reaches also could be affected by an unplanned outage at Volta 1 Powerhouse, or when the Cross Country Canal is taken out of service for several days during annual scheduled maintenance of the South Powerhouse. Similarly, the Eagle Canyon and Wildcat reaches and the mainstem below the confluence of North Fork and South Fork Battle Creek can experience flow fluctuations when Eagle Canyon Canal is taken out of service during annual maintenance of the Inskip Powerhouse.

On South Fork Battle Creek, flow fluctuations occur in the Coleman reach when scheduled maintenance at Coleman Powerhouse and Canal results in spills at the Coleman Diversion Dam. These spills continue to occur until canal maintenance is completed. When the canal is brought back into service, it is common for the Coleman Powerhouse to remain offline, thereby shifting the spills at Coleman Diversion Dam downstream to the mainstem reach adjacent to Coleman Forebay until the powerhouse is brought back online.

On mainstem Battle Creek, Coleman Powerhouse tailrace discharges directly into Battle Creek approximately 1.3 miles upstream from CNFH. One of the CNFH water intakes is located in the powerhouse's tailrace, and PG&E coordinates with the hatchery when planned and unplanned outages occur. A new tailrace barrier constructed in 2004 at the confluence of the tailrace and Battle Creek prevents anadromous fish from entering the tailrace (PG&E 2015).

The biological assessment provided 15 years of historical data for planned and unplanned powerhouse outages that occurred between January 1991 and December 2006 (PG&E 2015). For each powerhouse (Volta 1, Volta 2, South, Inskip, and Coleman) and the associated canal system, each outage event is identified as planned or unplanned. Planned outages are scheduled outages where necessary maintenance or repair work is carried out on the powerhouse and canals. The annual planned outages tend to last the longest and almost always involve the dewatering of the canals for some portion of the outage. Unplanned outages typically are associated with the powerhouses or distribution system, and the outages are usually of shorter duration (lasting from less than a couple of hours to several days). An additional outage type occurs when the powerhouse is de-rated. De-rating occurs when problems associated with the powerhouse or canal reduce the upper operating limit of the powerhouse. During these situations, spills can occur at the forebay/headerbox or anywhere along the canal if the water diverted into the canal exceeds the temporary capacity of the system (PG&E 2015).

If dewatering occurs during maintenance or repair of a facility, a fish capture and relocation would be implemented by qualified PG&E staff working with Fish Agencies to ensure minimal impacts. This would include use of dip nets and potentially electroshock of juveniles if needed, and fish would be immediately released in adjacent waters.

The biological assessment (PG&E 2015) provided a list of each planned and unplanned outage, including the start date, duration for the outage (hour and minutes), potential reaches affected by the outage, base flow (post–Phases 1A and 1B, and Phase 2) in the affected reach prior to the outage event, any additional spill flow (post Phases 1A and 1B, and Phase 2) caused by the outage event, and location of the spill or discharge (e.g., at the diversion dam or powerhouse). Under the Restoration Project, tailrace connectors constructed between South Powerhouse and Inskip Canal (Phase 2) and between Inskip Powerhouse and Coleman Canal and the Inskip bypass facility (designed to return bypass flow to the Coleman Canal) (Phase 1B) would minimize the potential for canal spills during planned or unplanned powerhouse outages. The connectors and the bypass facility would provide benefits during outages by reducing or preventing the spill of canal water, thereby minimizing the magnitude, frequency, and duration of flow and water temperature fluctuations in affected stream reaches.

If the Coleman Canal is removed from service as the result of an unplanned event, such as a hazard tree or landslide, that occurs outside the period identified by FERC License Article 33(e) (February through April) or other months agreed to by the resource agencies and lasts more than 12 hours, PG&E will consult with NMFS and the resource agencies to evaluate the potential extent of false attraction that may have occurred as a result of the outage/mixing of North Fork water into the South Fork. PG&E and the resource agencies will use available information or conduct additional studies if necessary to determine whether a significant number of spring-run or winter-run Chinook salmon (e.g., 25% or more of the annual population holding in the mainstem Battle Creek) were attracted into South Fork Battle Creek. Depending on the results of this evaluation, PG&E may monitor temperatures and adjust flows up to 60 cfs below Coleman Diversion Dam to ensure that suitable holding habitat is maintained during the summer period (May through September). Additionally, as required by FERC License Article 33(d), a 0.10 ft/hr ramping rate criteria will be applied when the canals are returned to service.

Since PG&E submitted the final Application for Amendment of License for Phase 2 to FERC (March 2015), additional considerations were taken into account that amounted to increases to the frequency and duration of outages. As a result, PG&E provided NMFS with the adjusted planned or unplanned conditions that would result in sudden increases of water into South Fork (SF), North Fork (NF), or the mainstem after Phase 2, which are described in Table 3 below.

Table 3. Updated Estimated Frequency of Planned and Unplanned* Outages Post-Phase 2.

Facility	Planned	Frequency	Duration	Estimated Magnitude	Mixing
Inskip Canal	Y	1x/yr	1-3 wks; 1-3 months every 5 yrs	≤ 220 cfs	NF into SF below South Powerhouse (PH) to above Inskip Dam
Inskip Canal	N	1x/5yrs	14 days	≤ 220 cfs	NF into SF below South PH to above Inskip Dam
Coleman Canal	Y	1x/yr	1-3 wks; 1-3 months every 5 yrs	~ 270 cfs	NF into SF below Inskip PH
Coleman Canal	N	1x/5yrs	14 days	~ 270 cfs	NF into SF below Inskip PH
Spilled Coleman Canal at Siphon	Y	2x/yr	4 hours	~270 cfs	SF into NF – near mouth of confluence
Spilled Coleman Canal at Siphon	N	2x/yr	High flows	~ 270 cfs	SF into NF – near mouth of confluence
Coleman PH maintenance	Y	1x/yr	1-3 weeks; 1-3 months every 5 yrs	≤ 340 cfs	None
Coleman PH/Forebay Failure	N	≤ 4x/yr	4 hours; 1-3 months during failure	Unknown	NF into SF, below Inskip Dam/PH areas
Inskip PH startups	N	≤ 2x/yr	30 minutes	≤ 220 cfs	NF into SF, below Inskip PH
Inskip canal overtop (rain)	N	≤ 1x/3yrs	12 hours	≤ 125 cfs	NF into SF, below Inskip Dam to Inskip PH
Inskip overtop (blockage)	N	No occurrence	Unknown	≤ 220 cfs	NF into SF, below Inskip Dam to Inskip PH
Coleman Canal overcharge	N	≤ 1x/3yrs	12 hours	≤ 75 cfs	Above siphon – NF into SF, below Inskip PH
South PH startup	N	≤ 2x/yr	30 minutes	≤ 150 cfs	NF into SF, below South PH
Inskip Canal sand trap sluice	N	≤ 2x/yr	4 hours	≤ 50 cfs	NF into SF downstream of Inskip Dam/Tunnel #1
Coleman Canal at Siphon #1	N	≤ 2x/yr	4 hours	≤ 220 cfs	NF into SF, below Inskip PH
Coleman PH startup	N	≤ 2x/yr	30 minutes	≤ 340 cfs	None
Sluicing at NBCF Dam	N	Flows	Up to weeks	≤ 120 cfs	None
Sluicing at EC Diversion Dam	N	Flows	Up to weeks	≤ 120 cfs	None
Sluicing at Inskip Dam	N	Flows	Up to weeks	≤ 500 cfs	None
PH shutdowns w/spills at forebays	N	≤ 2x/yr	4 hours	PH dependent	None

*Unplanned outage frequency is based on historical data and best available information. Source: PG&E 2016.

1.3.7 Ecological Process Changes

The goal of the Restoration Project is to restore the ecological processes necessary for the recovery of steelhead and Chinook salmon populations in Battle Creek and to minimize the loss of clean and renewable electricity that may result from modifications to the BC Hydroelectric Project. The Restoration Project would modify BC Hydroelectric Project facilities and operations to provide water management in Battle Creek consistent with the life cycle needs of anadromous fish. Specifically, the Restoration Project proposes that the following modifications to the BC Hydroelectric Project would result in the restoration of ecological processes that support anadromous fish:

- adjustments to BC Hydroelectric Project operations, including allowing cold spring water to reach natural stream channels, reducing the amount of water diverted from streams, and decreasing the rate and manner in which water is withdrawn from the stream and returned to the canals and powerhouses following outages;
- modification of facilities, such as fish ladders, fish screens and bypass facilities, diversion dams, and canals and powerhouse discharge facilities to improve passage and stabilize habitat conditions; and,
- changes in the approach used to manage the BC Hydroelectric Project to better balance hydroelectric energy production with habitat needs, using ecosystem-based management that protects and enhances fish and wildlife resources and other environmental values using adaptive management, reliable facilities, and water rights transfers, among other strategies.

1.3.8 Proposed Conservation Measures

The conservation measures for the Battle Creek Hydroelectric Project, post-Restoration Project will be implementation of the AMP and PG&E's Facility Monitoring Plan. The AMP monitors salmonid populations and their use of habitat within the action area. The AMP will be implemented by USFWS, and any actions implemented will undergo separate ESA section 7 consultation when appropriate. The Facility Monitoring Plan monitors the operations and facilitates maintenance of the new fish ladders and fish screens. The Facility Monitoring Plan will be implemented by PG&E. Although implementation of these two plans was initially expected to occur immediately after modifications were completed, since the Restoration Project was split into three phases, only those elements that are related to each specific phase will be implanted when modifications for that phase has been completed. To date, implementation has not begun for any portion of either plan.

1.3.8.1 *Adaptive management Plan*

The adaptive management objectives outlined in the AMP focus on management of BC Hydroelectric Project operations within the Restoration Project to facilitate habitat changes beneficial to salmon and steelhead. A corresponding long-term increase in salmon and steelhead populations is expected as a result of appropriate management actions. Trigger events leading to adaptive management actions will not be based solely on population data but also will rely on measurements indicating habitat conditions. The AMP objectives do not include or exclude existing or potential future anadromous fish propagation or supplementation activities, nor do they include specific "active" experimentation of proposed instream flows or experimental changes to BC Hydroelectric Project facilities to elucidate relationships between management actions and ecological processes, nor do they address the possibility of future development within Battle Creek (Terraqua Inc. 2004[1]). The AMP objectives for the Restoration Project focus on improvements in anadromous fish population dynamics, improvements to the habitat, and improvements designed to ensure safe passage of adults and juveniles. Below is the list of objectives in the AMP:

The population objectives are to:

- ensure successful salmon and steelhead spawning and juvenile production;
- restore and recover the assemblage of anadromous salmonids (i.e., winter-run Chinook salmon, spring-run Chinook salmon, steelhead) that inhabit the stream's cooler reaches during the dry season;
- restore and recover the assemblage of anadromous salmonids that enter the stream as adults in the wet season and spawn upon arrival; and
- ensure salmon and steelhead fully use available habitat in a manner that benefits all life stages, thereby maximizing natural production and full utilization of the ecosystem carrying capacity.

The habitat objectives are to:

- maximize habitat quantity through changes in instream flow;
- maximize habitat quantity by ensuring safe water temperatures;
- minimize false attraction and harmful fluctuation in thermal and flow regimes resulting from planned outages or detectable leaks from the BC Hydroelectric Project; and
- minimize the stranding and isolation of salmon and steelhead resulting from variations in flow regimes caused by BC Hydroelectric Project operations.

Fish passage objectives are to:

- provide upstream passage of adults at dams;
- provide downstream passage of juveniles at dams; and
- provide upstream passage of adults to their appropriate habitat over natural obstacles while ensuring appropriate levels of spatial separation between runs (Terraqua, Inc. 2004).

To determine whether the population objectives of the AMP are being met, assessments of population size, trends in productivity, population substructure, and population diversity must be compared to corresponding guidelines set forth by NMFS. The AMP has adopted NMFS's definitions of *viable populations*, as described in the Central Valley Salmon and Steelhead

[1] This AMP was prepared under the direction of the Adaptive Management Parties (PG&E, CDFW (formerly CDFG), USFWS, and NMFS) by Terraqua, Inc., under subcontract to the U.S. Bureau of Reclamation using funding provided by California Bay-Delta Authority.

Recovery Plan (NMFS 2014b) as the intermediate population goal and identifies the maximization of salmon and steelhead production and full utilization of carrying capacity as the final goal. The fish passage objectives are intended to assist in restoring the natural process of dispersal, and the habitat objectives will work to restore natural ecological variation associated with the natural function of the ecosystem. Further threats to population diversity not covered by the AMP objectives will be addressed through the AMP "linkages" (Terraqua, Inc. 2004). Meetings of the Adaptive Management Technical Team (AMTT) will be scheduled four times per year, including an annual meeting in March, when possible adaptive management actions will be considered. The Adaptive Management Policy Team (AMPT) will meet at least annually in late March. These March meetings of the AMTT and AMPT are scheduled to finalize annual reports in time for funding agency deadlines. Ad hoc meetings may be scheduled by the AMTT or AMPT to address emergencies without advance public notice, but such meetings will consider only the emergency at hand. All meetings will be open to the public, and all scheduled meetings will be announced to the public. Protocols also specify meeting announcement requirements, voting rules, report writing, adaptive management responses, proposal ranking, modification of adaptive management objectives, and dispute resolution (Terraqua, Inc. 2004).

1.3.8.2 *Facility Monitoring Plan*

A detailed draft Facility Monitoring Plan has been prepared by PG&E. The draft monitoring plan delineates a program related to the Restoration Project's components that expands on typical FERC license monitoring requirements. The focus of this plan is to monitor compliance with new instream flows and the performance of new fish ladders and fish screens, all of which are elements of the Restoration Project. PG&E will perform all necessary maintenance on and replacement of the fish screens, fish ladders, and stream gages as indicated by the monitoring plan, and will perform and assume the costs for the following facility monitoring:

- verifying operations at the various outlet and spillway works for North Battle Creek Feeder, Eagle Canyon, Inskip, and Asbury (Baldwin Creek) diversion dams by monitoring properly calibrated remote sensing devices that continuously measure and record total flow and the fluctuation of stage immediately below each dam during all operations;
- periodically measuring spring flow as the difference between the flow gage in the fish ladder and gage CB-112 (California Data Exchange Center [CDEC] gage BNF) to determine its contribution to the instream flow requirement below Eagle Canyon Diversion Dam and provide confirmation that facilities have not been installed to capture this water for conveyance to Eagle Canyon Canal;
- monitoring stream stage for ramping purposes at an appropriate location at the facility;
- continuing operation of gage CB-110 (CDEC gage BAS) to measure discharges from the Inskip Powerhouse tailrace connector during outages of the Coleman Canal and during outages at Inskip Powerhouse;
- identifying debris problems at the fish ladders at North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams by operating properly calibrated remote sensing devices that continuously monitor water surface elevations at the tops and bottoms of the ladders;

- operating an underwater video camera to document ladder effectiveness and fish movement through the ladder during the initial 3-year period of operation (or potentially longer) as provided in the terms of the MOU;
- identifying instances of plugging at the fish screens at North Battle Creek Feeder, Eagle Canyon, and Inskip Diversion Dams by operating properly calibrated remote sensing devices that continuously monitor water surface elevation differences on the inlet and outlet sides of the screens (if the monitoring reports a critical malfunction of the screen, the failsafe feature would shut down the inlet to the canal until the situation has been remedied); and
- recording operation of waste gates, overpours, and spillways during dewatering of the conveyance for maintenance or to release excess water during emergencies.

1.4 Action Area

The "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 action area for this project includes that portion of Battle Creek and all of its tributaries between the first total natural fish passage barriers on the North and South Forks of Battle Creek, and the confluence of Battle Creek with the Sacramento River (Figure 2). The first natural impassable barrier on the North Fork is an unnamed feature approximately 14 miles upstream from the confluence of the North and South forks. The first natural impassable barrier on the South Fork is known as Angel Falls, and is located approximately 6 miles upstream from the South Diversion Dam (NMFS 2005).

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 BO 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.

This biological opinion relies on the regulatory definition of "destruction or adverse modification", which “means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features” (81 FR 7214; February 11, 2014).

The designations of critical habitat for Central Valley (CV) spring-run Chinook salmon and California Central Valley (CCV) steelhead used the term primary constituent element (PCE) or essential features. The recently revised critical habitat regulations (81 FR 7414; February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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 BO 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 2014b), status reviews, and listing decisions (Table 4). 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.

Table 4. 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

*Originally listed as Threatened (final rule – 55 FR 46515; November 5, 1990)
**Designated critical habitat for Sacramento River winter-run Chinook salmon is outside of the action area. Therefore, we will not discuss critical habitat for this species any further in this BO.

The BO also examines the condition of critical habitat throughout the designated area, and 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.

In 2016, NMFS completed status reviews for CV spring-run Chinook salmon (NMFS 2016b), CCV steelhead (NMFS 2016a), and Sacramento River (SR) winter-run Chinook salmon (NMFS 2016c), and concluded that the species' status should remain as previously listed in 2005/2006 (81 FR 33468; May 26, 2016). The previous status reviews completed in 2011, also concluded, that the species' status should remain as previously listed (NMFS 2011a, b, c).

<u>2.2.1 SR winter-run Chinook salmon</u>

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

Table 5. The temporal occurrence of adult (a) and juvenile (b) winter-run Chinook salmon 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 *Description of Viable Salmonid Population (VSP) Parameters*

As an approach to evaluate the likelihood of viability of the SR 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. 2000).

2.2.1.1.1 *Abundance*

Historically, SR winter-run Chinook salmon population estimates were as high as 120,000 fish in the 1960s, but declined to fewer than 200 fish by the 1990s (National Marine Fisheries Service 2011c). In recent years, since carcass surveys began in 2001 (Figure 4), 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 4). 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). A 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 SR winter-run Chinook salmon 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.

Elevated water temperatures in the upper Sacramento River in 2014 and 2015, due to the extended drought in California and limited cold water pool in Shasta Reservoir, contributed to 5.9 percent and 4.2 percent egg-to-fry survival rates to RBDD in 2014 and 2015, respectively (Poytress 2016; USFWS 2016). Under varying hydrologic conditions from 1995 to 2013, winter-run Chinook salmon egg-to-fry survival ranged from three to nearly 10 times higher than in 2014 and 2015 (Martin et al. 2001; Poytress et al. 2014; Poytress and Gruber 2015). Due to the anticipated lower than average survival in 2014 and 2015, hatchery production from LSNFH was tripled to approximately 612,000 juveniles in 2014, and doubled to approximately 420,000 in 2015 to offset the impact of the drought (USFWS 2016).

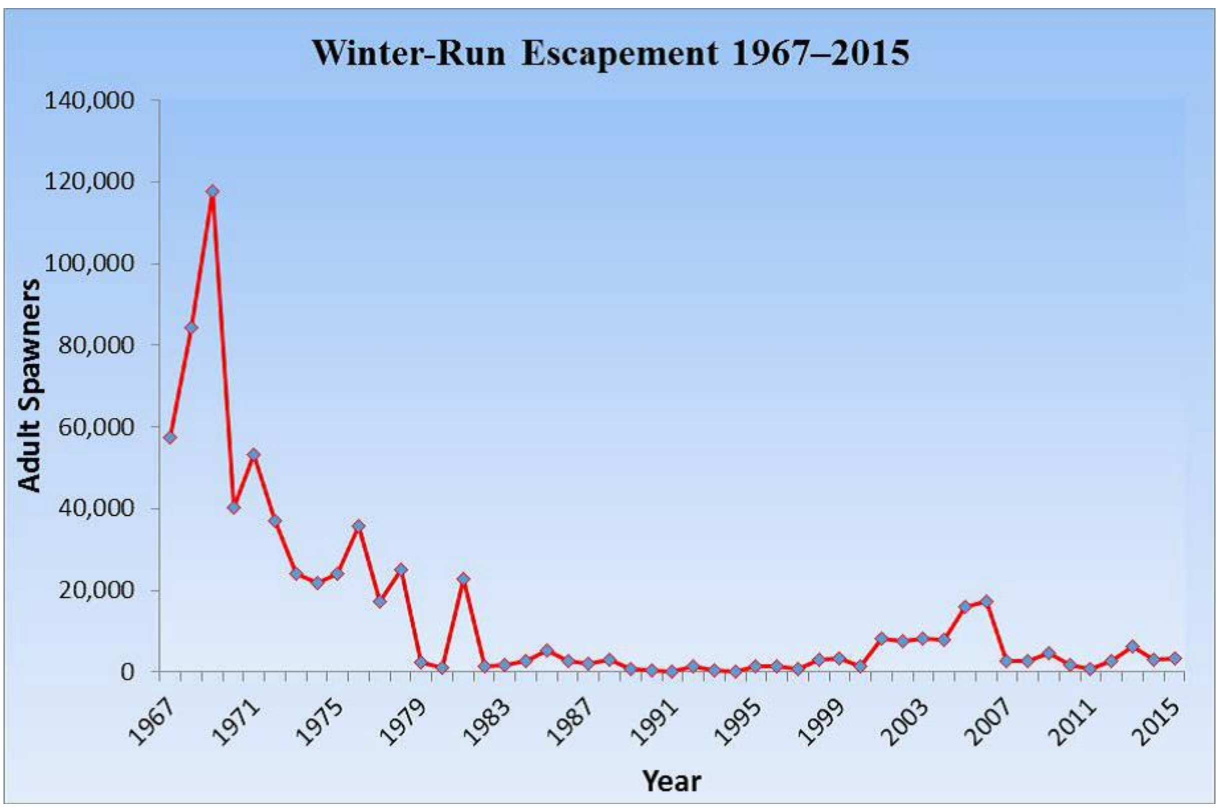

Figure 4. Sacramento River winter-run Chinook salmon escapement numbers 1967-2015, includes hatchery broodstock and tributaries, but excludes sport catch. RBDD ladder counts used pre-2000, carcass surveys post 2001 (California Department of Fish and Game 2017).

2.2.1.1.2 *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 SR winter-run Chinook salmon population was not replacing itself. In 2013, and 2014, SR winter-run Chinook salmon experienced a positive CRR, possibly due to favorable in-river conditions in 2011, and 2012 (wet years), which increased juvenile survival to the ocean.

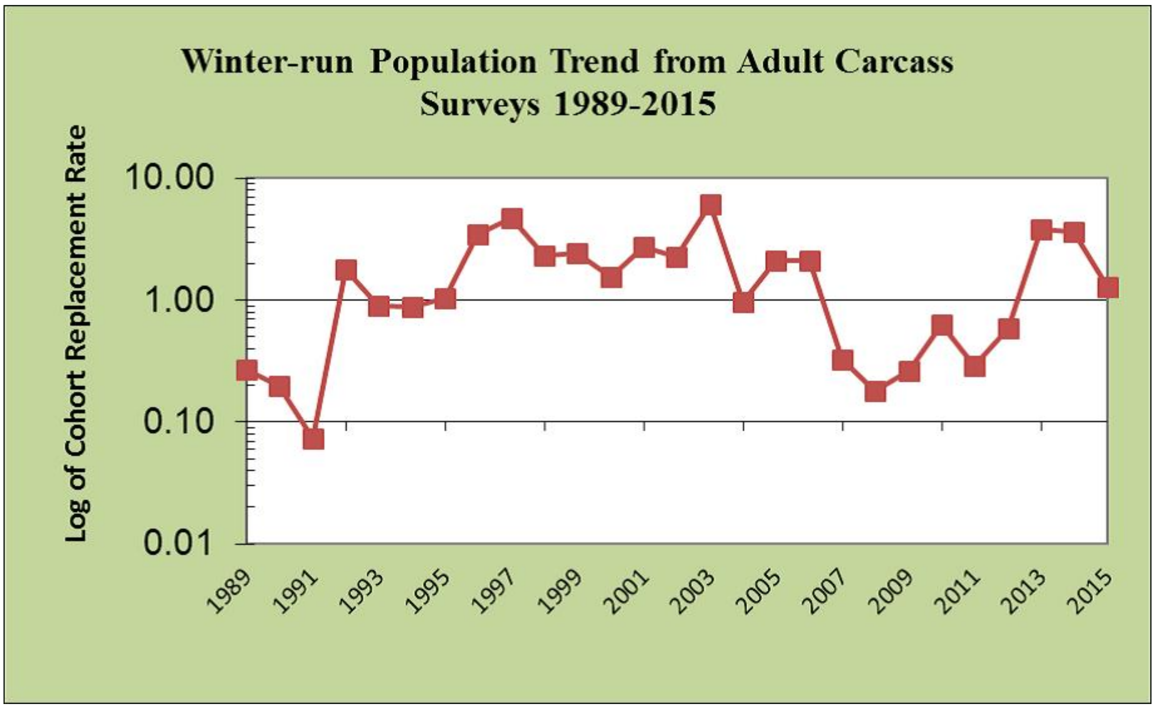

Figure 5. SR winter-run Chinook salmon population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1999–2015.

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 2014c). However, juvenile SR winter-run Chinook salmon productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

2.2.1.1.3 *Spatial Structure*

The distribution of SR winter-run Chinook salmon 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 CNFH barrier weir). The Restoration Project is currently removing these impediments, which should restore spawning and rearing habitat for SR winter-run Chinook salmon in the future. Approximately 299 miles of former tributary spawning habitat above Shasta Dam is inaccessible to SR winter-run Chinook salmon. Most components of the SR winter-run Chinook salmon life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam.

The greatest risk factor for SR winter-run Chinook salmon 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. SR winter-run Chinook salmon 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 and passage and flow benefits may not be fully realized until the end of 2021. The Central Valley Salmon and Steelhead Recovery Plan includes criteria for recovering the SR winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2014b). Additionally, NMFS (2009a) included a requirement for a pilot fish passage program above Shasta Dam, and planning is currently moving forward.

2.2.1.1.4 *Diversity*

The current SR winter-run Chinook salmon 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 SR winter-run Chinook salmon 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 Chinook salmon recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012.

Concern over genetic introgression within the SR winter-run Chinook salmon 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 Chinook salmon 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).

2.2.1.1.5 *Summary of ESU Viability*

There are several criteria (only one is required) that would qualify the SR winter-run Chinook salmon 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 4); (2) a negative growth rate over 6 years (2006–2012), which is two complete generations (Figure 5); (3) a significant rate of decline since 2006; and (4) increased risk of catastrophe from oil spills, wild fires, or extended drought. The previous 5-year status review (National Marine Fisheries Service 2011c) on SR winter-run Chinook salmon concluded that the ESU had increased to a high risk of extinction. In summary, that 5-year status review suggested that the extinction risk for the SR winter-run Chinook salmon 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). The recent Viability Report completed by NOAA's Southwest Science Center (Williams et al. 2016) states that winter-run Chinook salmon are at a greater extinction risk than the previous review. The most recent 5-year status review for winter-run Chinook salmon concluded that the extinction risk of the ESU has increased since the last status review largely due to extreme drought and poor ocean conditions. Additionally, that best available information on the biological status of the ESU and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate and should be maintained (NMFS 2016).

2.2.2 CV spring-run Chinook salmon

The distribution and timing of CV spring-run Chinook salmon varies depending on the life stage, and is shown in Table 6 below.

2.2.2.1 *Critical Habitat and PBFs*

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; September 2, 2005). Following is a description of the condition of the PBFs for CV spring-run Chinook salmon critical habitat.

2.2.2.1.1 *Spawning Habitat*

The majority of primary spawning habitat occurs in the tributaries to the Sacramento River, located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. 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*

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 intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

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 PBF. 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.

Table 6. 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]					Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low					
Sac. River Mainstem[b,c]		Low	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low								
Mill Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium	Low	Low									
Deer Creek[d]					Low	Low	Medium	High	High	High	High	Medium	Medium											
Butte Creek[d,g]			Low	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Low											
(b) Adult Holding[a,b]				Low	Low	Medium	Medium	High	High	High	High	High	High	High	High	Medium	Medium	Low	Low					
(c) Adult Spawning[a,b,c]															Low	Medium	High	High	Medium	Low				

(d) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Tribs[e]	Medium	Medium	Medium	Medium	Medium	Medium													Medium	Medium	High	High	High	High
Upper Butte Creek[f,g]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	High	High
Mill, Deer, Butte Creeks[d,g]	High	High	High	High	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low							Low	Low	Low	Low	Low	Low
Sac. River at RBDD[c]	High	High	Low	Low	Low	Low	Low	Low	Low												High	High	High	High
Sac. River at KL[h]	Medium	Medium	Medium	Medium	High	High	High	High	Medium	Medium											Medium	Medium	High	High

Relative Abundance: = High = Medium = 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.

2.2.2.1.4 *Estuarine Areas*

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

<u>2.2.2.2 *Description of VSP Parameters*</u>

2.2.2.2.1 *Abundance*

Historically CV 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 a 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; in 2012 zero redds were observed, and in 2013, 57 redds were observed in September

(CDFW 2015). 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.

For many decades, CV spring-run Chinook salmon were considered extirpated from the Southern Sierra Nevada diversity group in the San Joaquin River Basin, despite their historical numerical dominance in the Basin (Fry 1961, Fisher 1994). More recently, there have been reports of adult Chinook salmon returning in February through June to San Joaquin River tributaries, including the Mokelumne, Stanislaus, and Tuolumne rivers (Franks 2014, Workman 2003, FishBio 2015). These spring-running adults have been observed in several years and exhibit typical spring-run life history characteristics, such as returning to tributaries during the springtime, over-summering in deep pools, and spawning in early fall (Franks 2014, Workman 2003, FishBio 2015). For example, 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Additionally, in 2014, implementation of the spring-run Chinook salmon reintroduction plan into the San Joaquin River has begun, which if successful will benefit the spatial structure, and genetic diversity of the ESU. These reintroduced fish have been designated as a nonessential experimental population under ESA section 10(j) when within the defined boundary in the San Joaquin River (78 FR 79622; December 31, 2013). Furthermore, while the San Joaquin River Restoration Project (SJRRP) is managed to imprint CV spring-run Chinook salmon to the mainstem San Joaquin River, we do anticipate that the reintroduced spring-run Chinook salmon are likely to stray into the San Joaquin tributaries at some level, which will increase the likelihood for CV spring-run Chinook salmon to repopulate other Southern Sierra Nevada diversity group rivers where suitable conditions exist.

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 7). 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).

Additionally, in 2002 and 2003, mean water temperatures in Butte Creek exceeded 21^{o}C for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) diseases in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to a pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the diseases. In 2015, Butte Creek again experienced severe temperature conditions, with nearly 2,000 fish entering the creek, only 1,081 observed during the snorkel survey, and only 413 carcasses observed, which indicates a large number of pre-spawn mortality.

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 abundance was lower, with just over 5,000 fish for the tributaries combined, which indicates a highly fluctuating and unstable ESU abundance. Even more concerning was returns for 2015, which were record lows for some populations. In the next several years, numbers are anticipated to remain quite low as the effects of the 2012-2015 drought are fully realized.

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. 2000). In general, declining productivity equates to declining population abundance. McElhany et al. (2000) suggested criteria for a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used. Cohort replacement rates (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 7). The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run Chinook salmon ESU currently is unknown; however, the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.84, and 8.68 in 2013, due to increases in abundance for most populations. Although 2014 returns were lower than the previous two years, the CRR was still positive (1.85). However, 2015 returns were very low, with a CRR of 0.14, when using Butte

Creek snorkel survey numbers, the lowest on record. Using the Butte Creek carcass surveys, the 2015 CRR for just Butte Creek was only 0.02.

Table 7. Central Valley Spring-run Chinook salmon population estimates from CDFW Grand Tab (2015) with corresponding cohort replacement rates for years since 1986.

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average Tributary Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1,658	5.24		4,948	2.30	
1991	5,101	4,303	798	1,376	0.36		5,240	0.56	
1992	2,673	1,497	1,176	1,551	0.60		5,471	0.38	
1993	5,685	4,672	1,013	1,307	0.64	1.55	4,795	1.63	1.22
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	30,533	6,746	23,787	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	16,865	4,135	12,730	9,916	0.54	2.09	14,300	0.55	1.30
2002	17,212	4,189	13,023	12,238	2.13	2.35	16,730	1.75	1.46
2003	17,691	8,662	9,029	9,287	1.63	2.17	14,161	1.92	1.43
2004	13,612	4,212	9,400	9,945	0.74	1.79	14,916	0.81	1.37
2005	16,096	1,774	14,322	11,701	1.10	1.23	16,295	0.94	1.19
2006	10,828	2,061	8,767	10,908	0.97	1.31	15,088	0.61	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,591	0.71	1.00
2008	6,162	1,418	4,744	8,857	0.33	0.78	11,285	0.38	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,323	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.53	6,862	0.39	0.49
2011	5,033	1,969	3,064	3,961	0.65	0.47	5,703	0.82	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,702	3.87	1.16
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	4.85	2.06
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.68	2.32
2015	3,074	1,586	1,488	7,057	0.14	2.63	9,930	0.21	2.28
Median	9,775	3,616	6,159	6,541	1.97	1.89	10,220	1.00	1.46

[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*

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

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 6) (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). Most historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated; 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 2014).

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.

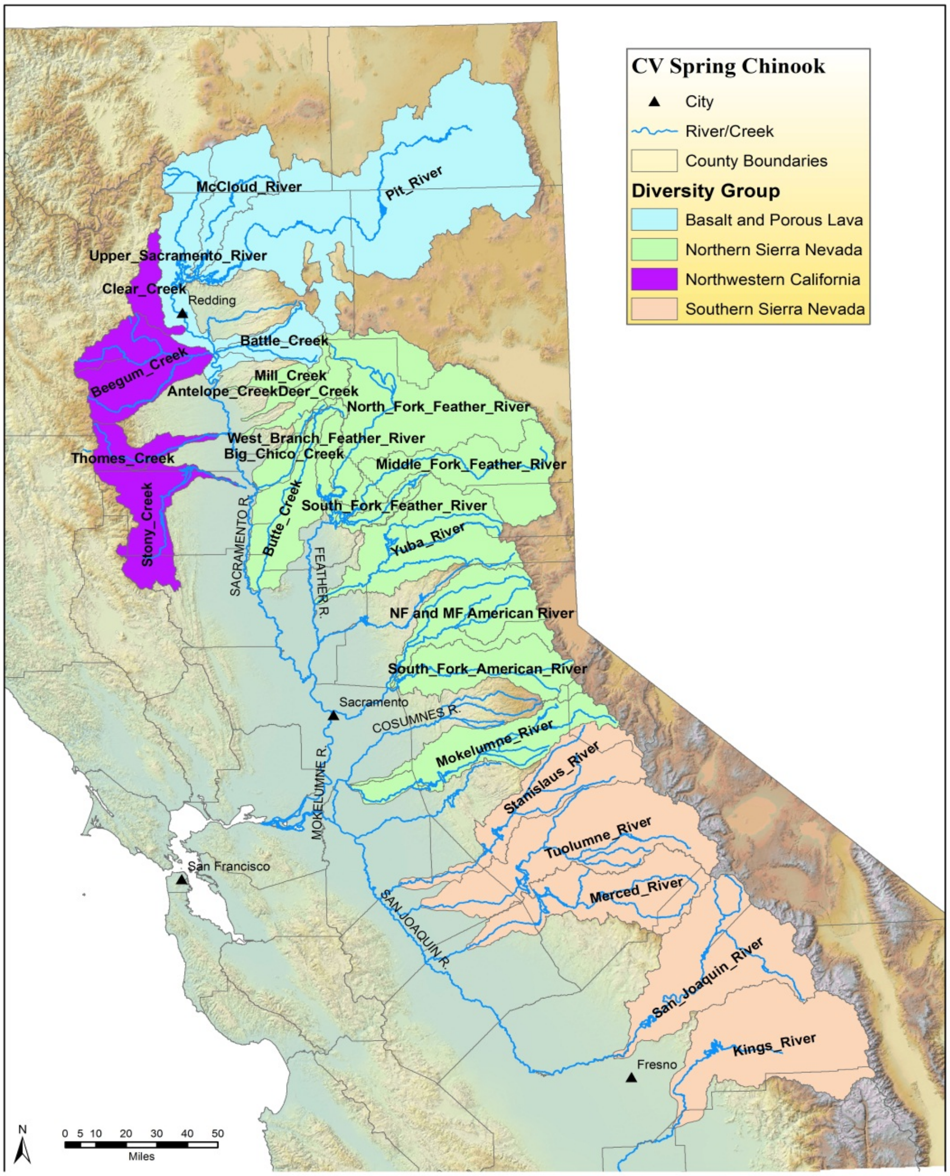

Figure 6. Diversity Groups for the Central Valley spring-run Chinook salmon ESU.

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 79622; 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. The rule includes protective regulations under ESA section 4(d) that provide specific exceptions to prohibitions 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. Releases have continued annually during the spring. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined.

Snorkel surveys (Kennedy and Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and 2004, as well as observed Chinook fry in December of 2003, which would indicate spring-run Chinook salmon spawning timing. In addition, monitoring on the Stanislaus since 2003 and on the Tuolumne since 2009 has indicated upstream migration of adult spring-run Chinook salmon (Anderson et al. 2007), and 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Finally, rotary screw trap (RST) data provided by Stockton USFWS corroborates the spring-run Chinook salmon adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Franks 2014). Although there have been observations of springtime running Chinook salmon returning to the San Joaquin tributaries in recent years, there is insufficient information to determine the specific origin of these fish, and whether or not they are straying into the basin or returning to natal streams. Genetic assessment or natal stream analyses of hard tissues could inform our understanding of the relationship of these fish to the ESU.

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 (2014b). 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 2014b).

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

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery CV 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 retain 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 (NMFS 2014b). 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.

In 2012 and 2013, most tributary populations increased in returning adults, averaging over 13,000. However, 2014 returns were lower again, just over 5,000 fish, indicating the ESU remains highly fluctuating. The most recent status review conducted in 2015 (NMFS 2016) looked at promising increasing populations in 2012-2014; however, the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record highs.

The recent drought impacts on Butte Creek can be seen from the lethal water temperatures in traditional and non-traditional spring-run Chinook salmon holding habitat during the summer. Pre-spawn mortality was observed during the 2007 to 2009 drought with an estimate of 1,054 adults dying before spawning (Garman 2015). A large number of adults (903 and 232) also were estimated to have died prior to spawning in the 2013 and 2014 drought, respectively (Garman 2015). In 2015, late arriving adults in the Chico vicinity experienced exceptionally warm June air temperatures coupled with the PG&E flume shutdown resulting in a fish die off. Additionally, adult spring-run Chinook salmon in Mill, Deer, and Battle creeks were exposed to warm temperatures, and pre-spawn mortality was observed. Thus, while the independent CV spring-run Chinook populations have generally improved since 2010, and are considered at moderate (Mill and Deer) or low (Butte Creek) risk of extinction, these populations are likely to deteriorate over the next three years due to drought impacts, which may in fact result in severe declines.

In summary, the status of the CV spring-run Chinook salmon ESU, until 2015, has probably improved since the 2010 status review. The largest improvements are due to extensive restoration, and increases in spatial structure with historically extirpated populations trending in the positive direction. Improvements, evident in the moderate and low risk of extinction of the three independent populations, however, are certainly not enough to warrant the delisting of the ESU. The recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2015 drought, uncertain juvenile survival during the drought, and ocean conditions, as well as the level of straying of FRFH spring-run Chinook salmon to other CV spring-run Chinook salmon populations are all causes for concern for the long-term viability of the CV spring-run Chinook salmon ESU.

2.2.3 CCV steelhead

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

2.2.3.1 *Critical Habitat and PBFs*

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. Following is a description of the condition of the inland habitat types used as PBFs for CCV steelhead critical habitat.

2.2.3.1.1 *Spawning Habitat*

Tributaries to the Sacramento and San Joaquin rivers with year-round flows have the primary spawning habitat for CCV steelhead. Most of the available spawning habitat is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. 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.

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

Relative Abundance: H = High   M = Medium   L = 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).

2.2.3.1.2 *Freshwater Rearing Habitat*

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

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 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan and Jackson 1996)(McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, 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 CCV 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). Natural-origin 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, although numbers the past five years have been lower, ranging from 185 to 334 (NMFS 2016a).

Redd counts are conducted in the American River, with an average of 142 redds counted on the American River from 2002-2015 (data from Hannon and Deason 2008, Hannon et al. 2003, Chase 2010), with only 58 counted in 2015, a new low for this survey (NMFS 2016a).

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 (2000 to 2010). 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. More recent data shows a slight increase in the annual returns, which averaged 1,134 fish from 2011 to 2015 (CDFW 2016).

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. From 2011 through 2015, an average of 231 redds has been observed in Clear Creek. The vast majority of these steelhead are natural-origin fish, as no hatchery steelhead are stocked in Clear Creek, and adipose fin clipped steelhead are rarely observed in Clear Creek (NMFS 2016a).

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 2016 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 2014b), includes recovery criteria for the spatial structure of the DPS which provide 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 CV spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011b).

2.2.3.2.4 *Diversity*

a. Genetic Diversity: CCV 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 CCV steelhead populations and found that, unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers.

The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley et al. 2007). There are four hatcheries (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 CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good et al. 2005; NMFS 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, as described in the recent 5-year Status Review (NMFS 2016a), 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. 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.

2.2.5 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 CV 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 SR 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 SR 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 SR winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative for additional populations of SR 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 2014b).

CV 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). CV 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 CCV 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 CCV 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.

Under the expected climate warming of around 5°C, substantial salmonid habitat would be lost in the Central Valley, with significant amounts of habitat remaining primarily in the Feather and Yuba rivers, and remnants of habitat in the upper Sacramento, McCloud, and Pit rivers, Battle and Mill creeks, and the Stanislaus River (Lindley *et al*. 2007). Under the less likely but still possible scenario of an 8°C warming, spring-run Chinook salmon habitat would be found only in the upper-most reaches of the north fork Feather River, Battle Creek, and Mill Creek (Lindley *et al*. 2007). Battle Creek offers important cold water inputs for spring-run and steelhead populations, that could prove to provide some of the Central Valley's best protection against extinction for these species as climate change effects take place.

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).

For the purposes of this assessment on effects of the continued operation of the Battle Creek Hydroelectric Project after Restoration Project's Phase 2, environmental baseline conditions are assumed to be the conditions prior to the commencement of Phase 2 of the Restoration Project. Each license amendment triggered by each Phase of the Restoration Project assumed the environmental baseline to be the conditions with existing hydroelectric facilities prior to the Phase being amended (i.e., prior to Phases 1A, 1B, and now 2) with minimum instream flows as required under the FERC license (five cfs on South Fork Battle Creek).

Battle Creek enters the Sacramento River (at river mile 273) approximately five miles southeast of the Shasta County town of Cottonwood. It flows into the Sacramento Valley from the east, draining a watershed of approximately 360 square miles (DWR 2009). The watershed includes the southern slopes of the Latour Buttes, the western slope of Mount (Mt.) Lassen, and mountains south of Mineral, California (Ward and Moberg 2004). Nearly 350 miles of streams in the Battle Creek watershed drain land at elevations as high as 10,400 feet and cascade steeply down through basalt canyons and foothills to the confluence with the Sacramento River (Ward and Moberg 2004).

Battle Creek is comprised of three main branches - the North Fork (approx. 29.5 miles in length from headwaters to confluence), the South Fork (approximately 28 miles in length from headwaters to confluence), and the mainstem valley reach (approximately 15.2 miles from the confluence of the North and South forks to the Sacramento River), in addition to numerous tributaries (Kier Associates 1999).

The Battle Creek Watershed is in the Cascade Range foothill floristic geographic subdivision (Hickman 1993). The Cascade region's geology is derived from the volcanic formations created by Mt. Lassen and its predecessor volcanoes. The volcanic formations produce a type of hydrology that is unusual for the Central Valley, characterized by abundant cold water from spring flows and relatively high dry-season base flows.

Battle Creek is a tributary to the upper Sacramento River and is one of the only watersheds of significant size remaining in the Cascade region that is accessible to anadromous salmonids. It also has habitat types similar to those in which the now scarce runs of winter- and spring-run Chinook salmon evolved (USFWS 1995). Prior to the hydroelectric development in Battle Creek watershed more than a century ago, prime habitat for Chinook salmon and steelhead extended from the confluence with the Sacramento River upstream to natural barrier waterfalls on North Fork and South Fork Battle Creek.

Battle Creek is a high-gradient, headwater stream with an elevation change in excess of 5,000 ft over 50 miles. The creek flows through remote, deep, shaded canyons and riparian corridors with little development near its banks. The Battle Creek channel is characterized by alternating pools and riffles. Boulders, ledges, and turbulence provide diversity to the channel form. Substrate size ranges from sand to boulder with predominantly gravel and cobble throughout the system. Concentration and types of gravel deposits are directly correlated to stream gradient. Sediment mobility studies imply that gravel in Battle Creek moves with enough frequency to keep it clean of fine sediment and loose enough to support spawning by Chinook salmon and steelhead (Reclamation 2001).

Battle Creek flows have been diverted for hydroelectric development, irrigation, and hatchery operations (USFWS 2011). Flows vary seasonally and range from 30 cfs in August to 8,000 to 20,000 cfs during spring. The current anadromous habitat in the Battle Creek watershed is strongly influenced by the BC Hydroelectric Project. Dam construction and operations had extirpated most of the original salmonid populations in Battle Creek by the early 1900s, and continue to have an impact on salmon and steelhead by limiting their habitat and availability of water during high water demands (NMFS 2006).

2.3.1 Fisheries and Aquatic Habitat

Battle Creek has had persistent spawning populations of spring-run Chinook salmon and steelhead in the reaches currently accessible on the mainstem, North Fork and South Fork in recent years, although the populations have been relatively small. Until recently, the Battle

Creek Watershed had eight dams blocking upstream migration of salmonids to much of the suitable and historic habitat; however, through implementation of the Restoration Project, 21 miles of currently blocked historical habitat will be re-opened, and will restore and enhance a total of 48 miles of habitat. The Restoration Project provides increased instream flows and an AMP to evaluate the effectiveness of these flows, though implementation of the AMP has not begun.

Early fisheries investigators claimed that Battle Creek was the most important salmon-producing tributary to the Sacramento River when its ecosystem had its original form and function before settlement in the 1850s (Rutter 1904; CDFG 1993 *as cited in* Kier Associates 1999). It is anticipated that the Battle Creek watershed, once restored, will be a conservation stronghold for CV spring-run and SR winter-run Chinook salmon and CCV steelhead (Battle Creek AMP). Battle Creek provides the only remaining currently accessible habitat (post Restoration Project) in the Sacramento River watershed, other than the Sacramento River, that is thought to be suitable for populations of SR winter-run Chinook salmon. Also, Battle Creek offers the best opportunity for restoration of wild steelhead populations in the upper Sacramento River (McEwan and Jackson 1996). Battle Creek has been identified as having high potential for successful fisheries restoration, because of its relatively high and consistent flow of cold water (Newton *et al*. 2008). It has the highest base flow (i.e., dry-season flow) of any tributary to the Sacramento River between the Feather River and Keswick Dam (Ward and Kier 1999, as cited in Newton *et al*. 2008). As these cold water inputs and good flows still exist, this system, if restored, will allow access by fish to these key areas upstream where cold water is more available.

2.3.1.1 *SR winter-run Chinook salmon*

SR winter-run Chinook salmon are indigenous to Battle Creek (Kier Associates 1999). However, no reliable records exist that document the size of the population prior to 1995. Historically, systematic counts of adult SR winter-run Chinook salmon had not been made because of unfavorable environmental conditions for monitoring during the high-flow winter months when these fish migrate upstream.

The occurrence of successfully reproducing SR winter-run Chinook salmon in Battle Creek was first documented in 1898 and again in 1900, when the U.S. Fish Commission collected salmon fry in specially-designed nets (Rutter 1904). Small, newly-emerged salmon fry (of a size that could only have been SR winter-run Chinook salmon) were captured in Battle Creek in September and early October (Rutter 1904; USFWS 1992).

A spawning run of adult SR winter-run Chinook salmon in Battle Creek was documented during the late 1940s and early 1950s, when the CNFH began late fall-run Chinook salmon egg-taking operations (USFWS 1987). From the 1950s to the early 1960s, California Department of Fish and Game (CDFG – now CDFW) reported the existence of SR winter-run Chinook salmon in Battle Creek during a statewide inventory of steelhead and salmon resources, but provided no estimate of the size of the population in Battle Creek (CDFG 1965). The CNFH trapped SR winter-run Chinook salmon in Battle Creek during the late 1950s, including 309 SR winter-run

Chinook salmon in 1958 (USFWS 1963), suggesting that SR winter-run Chinook salmon populations in Battle Creek reached a level of at least 300 adults during this period.

Documentation of 24 adult SR winter-run Chinook salmon in South Fork Battle Creek in 1965 (CDFG 1966) indicates that SR winter-run Chinook salmon populations persisted in Battle Creek during the mid-1960s. No records exist that document the size of SR winter-run Chinook salmon populations in Battle Creek from the mid-1960s to the mid-1990s.

Since 1995, as part of its brood stock collection efforts, USFWS has counted SR winter-run Chinook salmon in Battle Creek at the CNFH during the September-through-February portion of the SR winter-run Chinook salmon migration period. SR winter-run Chinook salmon are also counted from March through June at the CNFH barrier weir, using trapping and videography. Altogether, these monitoring techniques account for most of the December-to-August spawning and migration period of adult SR winter-run Chinook salmon. Additionally, snorkel surveys and juvenile outmigrant trapping have been conducted on Battle Creek during this time period. Monitoring information derived from the methods described above, has indicated that hatchery-origin SR winter-run Chinook salmon from past artificial propagation efforts at the CNFH (USFWS 1995a, 1996) have returned to Battle Creek. The catch of a small number of non-hatchery-origin winter-run Chinook salmon in 1998 (USFWS 1998) and 2000 indicates that Battle Creek may still have supported a remnant population (fewer than 10 documented fish) of naturally produced SR winter-run Chinook salmon at that time.

Although extensive monitoring for both adult and juvenile SR winter-run Chinook salmon has been consistently conducted in Battle Creek since 2000, no evidence of adult spawning or natal juvenile rearing has been detected (USFWS, unpublished data). Therefore, it is appears that there is no longer a naturally-reproducing population of SR winter-run Chinook salmon in Battle Creek.

Critical habitat for SR winter-run Chinook salmon was only designated within the Sacramento River and lower estuary areas, and not in any tributary streams. Therefore, there is no designated critical habitat for SR winter-run Chinook salmon within the action area.

2.3.1.2 *CV spring-run Chinook Salmon*

Current populations of CV spring-run Chinook salmon in Battle Creek appear to be severely depressed when compared to populations that existed in the 1940s and 1950s. At the beginning of CNFH operations, the hatchery collected 227, 1,181, 468, and 2,450 CV spring-run Chinook salmon from Battle Creek each year from 1943 to 1946, respectively, indicating that a relatively large population was present in the creek (USFWS 1949). From 1952 to 1956, annual estimates of adult CV spring-run Chinook salmon in Battle Creek ranged from 1,700 to 2,200 (CDFG 1961).

Stream surveys in the early 1960s indicated that CV spring-run Chinook salmon utilized various areas of the Restoration Project area including North Fork Battle Creek at Eagle Canyon and South Fork Battle Creek upstream of Panther Creek, but these studies did not provide population estimates (CDFG 1966). CV spring-run Chinook salmon (*i.e.*, 40 to 50 adult fish) were again observed in the Eagle Canyon reach in 1970, but no systematic population estimate was provided (CDFG 1970).

From 1995 to 1998, the USFWS estimated the number of CV spring-run Chinook salmon located in holding habitat upstream of the CNFH barrier dam. These population estimates ranged from about 35 to 178 CV spring-run Chinook salmon (USFWS 1996, 2000, 2002). From 1998 to 2001, the USFWS counted Chinook salmon in Battle Creek during part of the CV spring-run Chinook salmon migration period. These partial counts indicate that perhaps as many as 73 to 111 CV spring-run Chinook salmon passed the CNFH barrier weir into the project area annually from 1999 to 2001. More recently full surveys have been conducted each year from 2002 through 2014 with an average of about 276 for estimated CV spring-run Chinook salmon escapement, and an average of 612 the last three years (CDFW 2015).

2.3.1.3 *CCV steelhead*

Operational records for CNFH provide information on the numbers of CCV steelhead that have been passed upstream of the hatchery's barrier weir to spawn naturally in Battle Creek. Beginning in the early 1950s, an assumed mixture of hatchery and natural CCV steelhead have been intermittently released above the barrier weir. Specifically, hatchery records from 1953 through 2004 document frequent releases of adults (from 100 to approximately 1,500 fish per year) above the CNFH barrier weir and it is likely that additional, undocumented releases also occurred (Campton *et al.* 2004). Releases of natural-origin CCV steelhead adults upstream of the CNFH barrier weir have occurred annually since 2004 (with a few hatchery steelhead passing during open ladder periods), averaging 382 fish (unpublished USFWS).

Prior to weir modification in 2007, CCV steelhead in Battle Creek were able to jump over the CNFH barrier weir when the upstream fish ladder was closed, especially during periods of high flow. Monitoring of CV fall-run Chinook salmon at the hatchery's barrier weir (prior to 2007) showed that escapement past the weir increased as flows exceed 350 cfs. CCV steelhead are generally considered to have superior leaping abilities compared to fall-run Chinook salmon and were therefore able to escape past the weir at lower flows and with greater frequency. During the principal period of CCV steelhead migration in Battle Creek (October-February), average monthly flow ranges from 296 cfs in October to 727 cfs in February, suggesting that some escapement past the weir likely occurred throughout the timing of CCV steelhead migration (Kier Associates 1999). However, the number of uncounted CCV steelhead that escaped past the weir is unknown. When the fish ladders are open, it is believed that most CCV steelhead use the ladders to travel upstream rather than attempting to jump over the barrier weir and are able to be counted (Campton *et al.* 2004).

The existing barrier was modified in 2007 to 2008 by adding a 2-foot-wide lipped crest cap and a 10.5-foot overshot gate. The crest cap provides 100% blockage to upstream migrating salmonids at flows up to 800 cfs (NMFS 2006).

2.3.1.4 *Critical Habitat*

The PBFs of critical habitat for CCV steelhead within the action area are identical to those for CV spring-run Chinook salmon. Therefore, the status of critical habitat within the action area for CCV steelhead can be considered the same as that provided below for CV spring-run Chinook salmon. Environmental baseline conditions of critical habitat PBFs in the action area are described below for CV spring-run Chinook salmon and CCV steelhead.

2.3.1.4.1 *Holding, Spawning, and Rearing Habitat*

The total estimated area of suitable spawning gravel in Battle Creek is 57,000 square feet in the mainstem above Coleman Powerhouse; 81,000 square feet in the North Fork up to the barrier waterfall; and 28,000 square feet in the South Fork up to Angel Falls (Payne and Associates 1994). Concentration and types of gravel deposits are directly correlated to stream gradient. Mobility studies imply that gravel in Battle Creek moves with enough frequency to keep it relatively free of fine sediment and loose enough to support spawning. The Battle Creek channel is characterized by alternating pools and riffles. The channel form, along with boulders, ledges, and turbulence, provides key elements of holding and rearing habitat for CV spring-run Chinook salmon. As a result of recent fires in the upper Battle Creek watershed, and subsequent heavy winter storms, fine sediment has washed into the creek, particularly in the South Fork where fish are currently blocked at Coleman Diversion Dam. This fine sediment has filled in the deep holding pools throughout this reach of the creek, eliminating holding habitat for CV spring-run and SR winter-run Chinook salmon.

2.3.1.4.2 *Migration Habitat*

Absolute natural barriers mark the terminus of anadromous salmonid habitat on North Fork and South Fork Battle Creek. In the steep, high-elevation stream reaches below these absolute barriers there are natural features in the channel, such as boulders clusters and logs that can impede passage depending on vertical drop, flow depth, and flow velocity. A permanent fish barrier weir at CNFH can impede or delay passage to varying degrees (depending on seasonal barrier weir operations) throughout the year. Additionally, there are a number of partial natural barriers (flow dependent), and potentially some complete natural barriers (under all flows) through the Battle Creek watershed (described further, below). Delays in providing project flows and not allowing fish access to habitat upstream of Eagle Canyon Dam on the North Fork have delayed access to critical habitat, and have delayed fish agency's ability to determine whether certain natural barriers are passable through monitoring fish distribution.

2.3.2 Hydroelectric Project Effects

Below are descriptions of the components of the Battle Creek Hydroelectric Project that may result in impacts to listed salmonids.

2.3.2.1 *Migration Impacts at Dams and Natural Barriers*

Currently, the Coleman, Inskip, and South diversion dams on South Fork Battle Creek, continue to block or impede passage. Although Wildcat Dam was removed and construction of fish screens and ladders on Eagle Canyon and North Battle Feeder diversion dams on North Fork Battle Creek were completed in 2013, as part of Phase 1A, hydraulic issues on North Battle Feeder have resulted in PG&E and Reclamation's decision to not allow fish to access the habitat upstream of Eagle Canyon, and as described earlier PG&E has not begun providing minimum instream flows related to Phase 1A. The fish ladder at Coleman Diversion Dam was intentionally closed to fish passage under the 1998 Interim Flow Agreement (in anticipation of the Restoration Project), to provide "sufficient flows" to support salmonids, while blocking passage at the dams to prevent fish from entering the areas above the unscreened diversion dams. Currently similar Interim Flows continue to be provided below Eagle Canyon Dam while the fish ladder has remained closed to fish passage. Interim flows are provided through an agreement between Reclamation and PG&E, including payment to PG&E for a portion of the flows provided.

Passage conditions that support migration of salmonids in Battle Creek also have been affected by the reduction in stream flow attributable to diversions for power production. Natural events, such as floods, can alter physical characteristics of the channel at natural passage impediments (falls, shoots and boulder jumbles), including depth of pools from which the fish jump, height that must be jumped, water velocity, slope of the streambed, and the length of the slope, all factors affecting passage. The USFWS has recently identified/confirmed approximately 20 natural barriers on the North Fork, and approximately 6 on the South Fork that present passage challenges for salmon and steelhead under environmental baseline flows, which had also been identified in the past (Payne and Associates 1998). It is unknown whether project flows will be sufficient to provide for passage, however, it is anticipated that at least some of the natural barriers will be passable. On North Fork Battle Creek, obstacles require greater amounts of streamflow for unimpaired passage than on South Fork Battle Creek. In one case on North Fork Battle Creek (RM 5.14), an especially steep transitory boulder barrier was modified by CDFW in 1997 to provide numerous ascent routes at more gradual slopes (Kier Associates 1999). As part of the adaptive management plan, natural barriers that are impassible under project flows may be removed, or made passable. CDFW recently completed a contract with an outside consultant for the development of construction-ready plans and specifications to improve upstream fish passage at two natural barriers in North Fork Battle Creek. One of the natural barriers is about 600 feet downstream of PG&E's Eagle Canyon Diversion Dam, and the other natural barrier is about 600 feet upstream from the diversion dam. The selected fish passage solutions involve boulder removal and/or relocation and channel regrading. CDFW is now working with the USFWS to identify opportunities to fund the construction of these fish passage projects (Robert Hughes 2017). The natural barrier passage efforts are not part of this consultation.

2.3.2.2 *Reduced Instream Flows*

One of the primary impacts of the BC Hydroelectric Project affecting salmonid spawning success and survival in Battle Creek is streamflow. Diversion of flows for power generation has substantially reduced streamflow in nearly all the reaches of Battle Creek downstream of Keswick Diversion Dam and South Diversion Dam. Minimum instream flow requirements under the current FERC license are five cfs in South Fork Battle Creek, and only three cfs in North Fork Battle Creek. Several of the tributaries to the creek (Soap, Ripley, and Baldwin creeks) have minimum flow requirements of zero cfs. These minimal streamflow requirements have greatly reduced holding, spawning and rearing habitat quality, and area available to salmonids, which has in turn caused a significant reduction in the population sizes and survival rates of these species. Although Interim Flows on the North and South forks have been provided to increase available suitable habitat, until completion of each Project Phase, these are lower than Project Flows (Table 2). Additionally, although Phase 1A was completed in 2013, PG&E has not been providing Project Flows below North Battle Creek Feeder Diversion Dam, due to a decision to wait until the hydraulic concerns for the screen and ladder be fixed prior to "accepting" the facilities from Reclamation. Also due to these concerns, fish have not been allowed access upstream of the lower dam (Eagle Canyon Dam). These delays in habitat improvements have continued to limit the amount of high quality habitat planned by the Restoration Project, and adversely affect the survival and recovery of listed fish in Battle Creek.

2.3.2.3 *Increased Water Temperatures*

Habitat quality and salmonid survival in Battle Creek is substantially affected by water temperature as influenced by the BC Hydroelectric Project's diversion of cold spring water away from adjacent stream sections and reduced flows in the stream below diversion dams. Other factors that influence water temperature in Battle Creek include weather, channel form and dimension, shade, and natural flow levels. Flow diversion and subsequent warming substantially reduce the habitat area that can support migration, holding, spawning, and rearing of salmonids in Battle Creek (Kier Associates 1999).

Transbasin water diversions from North Fork Battle Creek to the South Fork tend to warm North Fork Battle Creek and cool South Fork Battle Creek. These operations have a detrimental effect on habitat conditions in the North Fork while potentially improving temperature conditions in the South Fork. However, the supply of cold water to the South Fork is not reliable. Canal and powerhouse outages occur at unpredictable times, producing substantial flow and temperature fluctuations that reduce habitat value for fish that are lured to the South Fork by the cold water releases from the hydroelectric system.

2.3.2.4 *Entrainment into Canals and Turbines*

Downstream migration of juvenile salmonids has also been impacted by the diversion of water at each dam (prior to the 1998 Interim Flow Agreement). Because up to 97 percent of the flow is diverted from Battle Creek for power production (Jones and Stokes 2005a/b) and fish screens are absent from all of these diversions, if any fish spawned above the dams, juveniles produced are likely to be entrained. Survival of passage through the power canals and turbines is thought to be minimal and most entrained fish are lost from the population. This reduction in juvenile survival is a key factor in the overall decline in salmonid populations in Battle Creek.

2.3.2.5 *Food*

Food availability and type affect fitness and survival of juvenile salmonids. Flow affects stream surface area and production of food. A primary factor affecting food production in Battle Creek is streamflow. Diversion for power generation has substantially reduced streamflow in all the reaches of Battle Creek downstream of Keswick Diversion Dam and South Diversion Dam. In addition, hydroelectric diversions entrain food organisms, exporting nutrients from segments of Battle Creek.

The density of adult salmon carcasses has been shown to increase nutrient input to stream systems and contribute to increased growth rates of juvenile salmonids (Wipfli *et al*. 2003). The historical reduction of Chinook salmon populations may have reduced food availability and productivity of Battle Creek.

2.3.3 Agricultural Effects

There are a number of agricultural activities in Battle Creek, listed below, that may be impacting listed salmonids.

2.3.3.1 *Entrainment into Canals*

There are two significant agricultural diversions on lower Battle Creek, the Gover ditch and the Orwick ditch. Each diverts approximately 50 cfs from the creek. For many years, neither of these diversions had any sort of screening to prevent fish from being entrained into the ditches. Any juveniles that were entrained were most likely lost due to high water temperatures, predation, or desiccation in the fields. Within the last five years both diversions were fitted with fish screens. The screen on the Gover diversion meets most of the NMFS screening criteria and functions well in preventing entrainment of salmonids into the ditch during the irrigation season. However, during high flow periods, this screen is often overwhelmed by flows and debris. The screen panels are often removed during these periods allowing juvenile salmonids to be entrained into the ditch. Until recently, the screen on the Orwick diversion did not meet many of the NMFS screening criteria. It was often overtopped by high flows and screen panels were often removed completely allowing entrainment of juvenile salmonids. The bypass system on the Orwick screen also was inadequate; instead of returning screened fish back to the main channel of Battle Creek, it emptied into a side channel that was dry throughout much of the year. These impacts have caused increased stress and mortality of listed salmonids that were entrained into the diversion.

The fish screening facilities on the Orwick diversion was retrofitted to meet the NMFS fish screening criteria. Two separate actions occurred to improve the effectiveness of the screen and improve survival of juvenile salmonids that enter the Orwick diversion. In 2006, a 600 foot bypass pipe was installed to return fish back to the main channel of Battle Creek, and in 2007, a headgate water control structure was installed. The headgate prevents the screen from being overtopped by high flows. The new bypass pipe replaces an inadequate pipe so that at all times during the year, juvenile salmon and steelhead are safely maintained in a wetted environment from the time that they are diverted from the mainstem Battle Creek until the time that they are returned to Battle Creek via the bypass pipe (USFWS 2009).

2.3.3.2 *Reduced Instream Flows*

These diversions can also divert a significant proportion of the total stream flow in Battle Creek during low water periods. This reduction in stream flow can lead to increased water temperatures and reduced food production and availability, resulting in reduced fitness and survival of juvenile and adult salmonids.

2.3.3.3 *Seasonal Dams*

Irrigators on both ditches have periodically pushed up large gravel dams to ensure sufficient water is diverted into their ditches. These dams are built using heavy equipment within the stream bed to dig up the bed of the creek and pile it into large berms that back water up in front of the diversions and deflect water into the ditches. This instream construction and disruption of the stream bed can cause direct injury and mortality of juvenile salmonids and incubating eggs. These activities also can cause increased mobilization of fine sediments which can negatively impact downstream salmonids and spawning beds.

2.3.4 Hatchery Effects

Two Central Valley hatcheries have the potential to impact naturally spawning populations of listed salmonids in Battle Creek, the CNFH and LSNFH. CNFH operations were consulted on in 2014; NMFS (2014a) concluded the project was not likely to jeopardize the continued existence of federally listed salmonids, and included requirements (terms and conditions) to minimize impacts.

2.3.4.1 *Migration and Handling Impacts at Barrier Weir*

In addition to the barriers to be addressed by the Restoration Project, CNFH operates a barrier weir along with a fish ladder 5.5 miles upstream of Battle Creek's confluence with the Sacramento River (USFWS 2011). Since the beginning of fish culture at Battle Creek in the late 1800s, a variety of seasonal or permanent weirs have been used to congregate salmonids and enable the efficient collection of broodstock. The current weir and fish ladder structure was modified in 2007–2008 when the barrier weir was modified by adding a 2-foot-wide lipped crest cap. This feature provides 100 percent blockage to upstream migrating salmonids at flows up to 800 cfs (NMFS 2006). The modified fish ladder structure contains two forks, one leading directly to the existing CNFH adult holding ponds, and the second providing access to Battle Creek upstream of the barrier weir. The design of the CNFH fish ladder provides up to 300 cfs total flow (ladder flow capacity plus attraction flow). Thus, at flows up to 3,000 cfs, the fish ladder at CNFH now complies with the same criteria (i.e., ladder flow $\geq$10% stream flow) as the fish ladders associated with Restoration Project. Post construction evaluations led to observation of the overshot gate needing further modification, which occurred in 2011 (Reclamation/USFWS 2011). The upstream fish ladder is well designed and relatively effective in allowing unimpeded passage when it is opened. When the upstream fish ladder is closed (August 1 through early March), the barrier weir either blocks passage or diverts fish into the hatchery.

The current management objectives of the fish ladder are to:

- prevent hatchery origin Chinook salmon and steelhead from accessing upper Battle Creek and overwhelming the natural stocks in that area;

- minimize the potential for hybridization between co-occurring, naturally reproducing runs of Chinook salmon in Battle Creek upstream of the barrier weir; and monitor passage of salmonids (Jones & Stokes 2005);
- divert adult fish into the hatchery facilities to provide broodstock for hatchery production;
- minimize interactions between natural and hatchery runs of Chinook salmon and steelhead in Battle Creek upstream of the barrier weir;
- minimize the risk of infectious hematopoietic necrosis virus being shed into CNFH water supply upstream of the barrier weir; and
- monitor and study passing salmonids.

Adult escapement data, collected by the USFWS, are from the fish trapping operations and video observations in the upstream ladder of the CNFH barrier weir. The fish trap and video in the upstream fish ladder is monitored between approximately March 15 and August 1. Early in the season, fish are trapped or brought into the spawning building, and natural-origin fish are released upstream. Around late May fish swim through the ladder to upstream Battle Creek while being counted by video. Beginning on August 1, current Battle Creek fishery management protocol calls for closure of the barrier weir ladder. Although the upstream fish ladder remains closed until March, monitoring begins again about the first of October as adults are routed into CNFH and handled for broodstock collection and spawning purposes (USFWS 2011).
Because the upstream ladder on the barrier weir is closed from August 1 through early March, SR winter-run Chinook salmon and CCV steelhead, which migrate upstream during this period, are likely to be impacted through migration delay, blockage, capture, handling, and unintentional mortality within the hatchery facilities (NMFS 2014a). CV spring-run Chinook salmon migrate into Battle Creek from late March through July and therefore are unlikely to be significantly impacted by the operation of the barrier weir during hatchery operations, although some delay, trapping, and handling may occur within the ladder monitoring station (NMFS 2014a).

The CNFH BO (NMFS 2014a) included requirements for USFWS to investigate alternatives to minimizing handling/delay impacts of natural-origin CCV steelhead, which would also benefit SR winter-run Chinook salmon when reintroduced.

2.3.4.2 *Large Releases of Hatchery-Produced salmonids*

Releasing large numbers of hatchery fish can pose a threat to wild Chinook salmon and steelhead stocks through genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991).

Requirements from the CNFH BO (NMFS 2014a) include development of a plan to assess and quantify impacts from large releases. Studies may include impacts such as competition and predation.

2.3.4.3 *Entrainment Into Water Intakes*

Diversion of the water supply for CNFH out of Battle Creek may result in the entrainment of juvenile salmonids into the hatchery intake system. The primary diversion point for CNFH (intake

1) is located in the tailrace of the Coleman Powerhouse. The water discharged from this powerhouse (and collected by intake 1) is diverted from the creek far upstream, above the natural passage barriers, and therefore is free of anadromous salmonids (USFWS 2000). CNFH also uses two other water intakes on Battle Creek less frequently (intakes 2 and 3). Intake 3 is secondary to intake 1 and has a limited capacity of 50 cfs. If intake 1 is not operating, intake 3 will be utilized first. Intake 3 was fitted with a new screen in 2009 that meets NMFS screening criteria. If more than 50 cfs is needed, when intake 1 is not operating, or during emergency uses as well, intake 2 will be used. Intake 2 entrains or impinges juvenile salmonids because it takes water directly from lower Battle Creek and remains completely unscreened.

Periodic salvage operations conducted by USFWS hatchery personnel have been moderately successful at rescuing entrained fish from the hatchery canal and sand filter. However, further studies are needed. Requirements from the CNFH BO (NMFS 2014a) include USFWS developing a plan to evaluate the risk of entrainment, and effectiveness of salvage, for several years at intake 2, resulting in a recommendation on whether or not the diversion should be screened.

2.3.4.4 *Deleterious Genetic Effects*

Genetic integration of CNFH domestic stocks with wild Battle Creek salmonid populations has occurred over many years. During the SR winter-run Chinook salmon propagation program at CNFH there was evidence of hatchery crossings of SR winter-run Chinook salmon with wild Battle Creek spring-run Chinook salmon (USFWS 2000). The steelhead propagation program at CNFH also has had a long history of crossing hatchery origin fish with naturally-spawned Battle Creek fish and passing hatchery origin adults into upper Battle Creek to spawn with wild CCV steelhead. Because of domestication effects in hatchery stocks (*i.e.*, a reduction in fitness of a stock due to prolonged hatchery propagation), the integration of these domestic stocks with wild populations, particularly wild populations whose numbers have been depressed through other factors, can reduce the overall fitness of the wild population and reduce its likelihood of recovering to self-sustaining levels (Chilcote 2003; Reisenbichler *et al.* 2003).

In 2004, agencies made a decision involving the management of steelhead and CNFH operations (USFWS, NMFS, CDFG, and Reclamation), ending the practice of deliberately passing hatchery origin steelhead above the CNFH barrier weir. The cessation of passing hatchery steelhead above the weir was implemented in order to allow the naturally-spawning population in upper Battle Creek to recover without excessive influence from the hatchery stock. Additionally, CNFH stopped spawning natural-origin CCV steelhead for their propagation program in 2009, due to low number of natural-origin returns.

FRFH produced spring-run Chinook salmon have been observed to stray into other watersheds, including Battle Creek, which may impact the genetic integrity of natural-origin Battle Creek spring-run Chinook salmon.

2.3.5 Predation

Predation by native and nonnative species may cause substantial mortality of salmonids and other species, especially where the stream channel or habitat conditions have been altered from natural conditions (California Department of Water Resources 1995). The existing diversion dams in the action area may create environmental conditions that increase the probability that predator species will capture juvenile Chinook salmon and steelhead during downstream movement. Water turbulence in the vicinity of the dams and other structures may disorient migrating juvenile Chinook salmon and steelhead, increasing their vulnerability to predators. In addition, changes in water temperature, flow velocity and depth affect the quality of habitat and potentially increase vulnerability of fish species to predation by other fish species, birds, and mammals.

2.3.6 Land Use

A mix of privately owned and publicly (Federal and State) managed lands exist in Battle Creek. The headwaters of Battle Creek is Lassen Volcanic National Park; managed and operated by the National Park Service. The surrounding forest is managed by the U.S. Forest Service (USFS) at elevations above ~ 6,000 feet. Sierra Pacific Industries (SPI) is a private timberlands company owning a substantial portion of the watershed encompassing both North Fork Battle Creek and South Fork Battle Creek from elevations ranging ~ 3,000 – 6,000 feet. For the lower watershed (below ~ 3,000 ft), cattle grazing is the predominant land use. Cultivated crops in the bottom land of the valley is < 0.1% of total land area (Ward and Moberg 2004).

In 2012, the Ponderosa Fire burned roughly 27,000 acres of mostly private timberlands in the larger BC watershed. Subsequent to the fire, post-fire management has included salvage logging operations, reforestation efforts, and the establishment of fuel breaks over much of these burned lands. The watershed has also been subject to multiple large storm events in the years since the fire, and in some areas, these events resulted in significant erosion, impacts to surface waters, and in-stream habitat. To better address the recent increase in sediment load and potential impact to fish habitat and infrastructure in the watershed, and to better understand the overall sediment dynamic in Battle Creek, the Battle Creek Watershed Conservancy (BCWC), in coordination with the Central Valley Water Board, have begun the initial phases of a multi-phased Watershed Based Plan (WBP; USEPA 2008) that will describe and make recommendations for how to best manage water quality problems that are attributed to controllable (i.e., management related) sources of fine sediment. The BCWC is currently finalizing a Watershed Assessment and Data Collection Plan (Plan) which will identify sediment sources and factors influencing sediment production, and quantify the relative contribution of each sediment source to overall sediment production. This Plan will help to fulfill elements identified in the WBP (USEPA 2008). It is estimated that a draft of the WBP will be available for public comment in early 2018, with the final plan being completed by summer of 2018 (Shane Edmunds 2017).

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.

This 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 SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, and the magnitude, timing, frequency, and duration of effects of the proposed action to these listed species. Specifically, the assessment will consider the potential impacts related to these species resulting from the continued operations of the Battle Creek Hydroelectric Project after completing implementation of Phase 2 of the Battle Creek Restoration Project, including 1) Migration impacts at dams; 2) Restoration Project flows; 3) Outages; and 4) Monitoring. Additionally, the assessment will consider the potential impacts to critical habitat as well as beneficial effects. In general, the continued operation of the Battle Creek Hydroelectric Project following implementation of Phase 2 of the Restoration Project is expected to result in long-term benefits to homing success, migration, flow, temperature, entrainment, habitat, food availability and predation, while continuing to cause some adverse effects to listed species and critical habitat in the Battle Creek watershed.

Due to the life history timing of SR winter-run and CV spring-run Chinook salmon, and CCV 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: adults migrating, holding, and spawning; incubating eggs; and rearing and emigrating juveniles.

2.4.1 Effects to Listed Species

The BC Hydroelectric Project consists of five developments that divert water from North and South Fork Battle Creek and a number of tributaries and springs for power generation at Volta, Volta 2, South, Inskip, and Coleman Powerhouses. Project facilities include the Volta Development, Volta 2 Development, South Development, Inskip Development, and Coleman Development. Volta and Volta 2 developments will remain after Phase 2 of the Restoration Project is completed. South Development will have some components remain, including the lower portion of Cross Country Canal, Bramlett-Bristol-Benton Canal and Dam, Upper Ripley Creek Feeder, Union Canal, South Intake and Penstock, and South Powerhouse. Some components were modified under Phase 1A or Phase 1B, including a new fish ladder and fish screen at North Battle Creek Feeder Dam, and other components will be modified as a result of Phase 2, including removal of South Dam and South Canal, and removal of Soap Creek Feeder and Dam. Inskip Development has components that will remain after Phase 2, including the Inskip Powerhouse and Penstock. Modifications that were completed under Phase 1A and 1B include a new fish ladder and fish screen at Eagle Canyon Canal and Dam, Eagle Canyon Canal Pipeline, and the Inskip Powerhouse Bypass. Modifications for Phase 2 will include a South Powerhouse Tailrace Connector tunnel and dike, a new fish ladder and fish screen at Inskip Canal and Dam, and removal of Lower Ripley Creek Feeder and Dam. Coleman Development has components that will remain after Phase 2, including Pacific Power Canal, Asbury Pipe, and Coleman Canal, Forebay, Intake, Penstocks, and Powerhouse. Modifications as part of Phase 1A and 1B include the removal of Wildcat Canal and Dam, Inskip Powerhouse Tailrace Connector, and installation of a fish barrier at Asbury Dam. Modifications for Phase 2 will include removal of Coleman Dam. More details are available in the Battle Creek Phase 2 Final FERC Application for License Amendment (PG&E 2015).

2.4.1.1 *Migration Impacts at Dams*

Migration habitat includes the specific pathways that support the movement of adult Chinook salmon and steelhead between ocean and freshwater habitats. Delay and multiple attempts at passing the BC Hydroelectric Project dams may reduce the survival of adults because of injury and exhaustion. Following delays or failed attempts at passing dams, adults may remain downstream of the barriers, where survival to spawning may be reduced, as well as survival of eggs, which may be reduced by warmer water temperature (Jones & Stokes 2005).

2.4.1.1.1 *Dam Removal/ladders*

Under Phase 2, Coleman Diversion and South Diversion dams will be removed, and a fish screen and ladder at Inskip Dam will be constructed, all on the South Fork. Maintaining Phase 2 Restoration Project flows is expected to provide adults with unimpeded access over four natural barriers and access to more than 22 miles of spawning and rearing habitat in South Fork Battle Creek upstream of the confluence of North Fork and South Fork Battle Creek. Flows and related water temperature effects as a result of the project are discussed below under section 2.4.1.2.

The removal of diversion dams on Soap and Ripley creeks (South Fork tributaries) during Phase 2, and the increase in flow (i.e., greater than zero) will provide spawning and rearing habitat that would support additional CCV steelhead and possibly Chinook salmon, contributing to the beneficial effects identified above. Although the contribution has not been quantified, it has been estimated (Table 2), and the increased flow and available area would provide spawning and rearing habitat for salmonids that did not exist under environmental baseline conditions, especially for CCV steelhead (Kier Associates 1999).

Under Phase 2, further gains in available spawning and rearing habitat area would occur on the South Fork in addition to the habitat gains on the North Fork under Phases 1A and 1B. From environmental baseline conditions post-Phase 1A and 1B to after completion of Phase 2, available spawning habitat area is predicted to increase by an additional 3.85 acres for steelhead, 2.41 acres for CV spring-run and SR winter-run Chinook salmon, and 2.2 acres for late fall–run Chinook salmon. Rearing habitat area is predicted to increase by approximately 14.32 acres for CCV steelhead, 10.44 acres for CV spring-run Chinook salmon, 10.93 for SR winter-run Chinook salmon, and 10.93 acres for late fall–run Chinook salmon (PG&E 2015). Although Phase 1A components have been completed, listed salmonids have not yet benefited due to delays in construction, hydraulic concerns at North Fork Feeder Dam which has resulted in PG&E and Reclamation not allowing fish to use the downstream new ladder at Eagle Canyon Dam to access further habitat, and PG&E not providing Project Flows. Additionally, the current schedule is for construction of Phase 2 to be completed in 2020, but Phase 2 will then need to undergo testing, which is expected to extend the period before Phase 2 is fully operational until the end of 2021; therefore, even if no further delays occur, salmonids will not experience all expected benefits from the Restoration Project for several years.

The Battle Creek Hydroelectric Project, post-Phase 2, will continue to operate the remaining dams with diversions with the new screens and ladders. Diversions will be screened using designs that meet or exceed criteria established by NMFS and CDFW, and will therefore be expected to prevent entrainment, except during maintenance and emergency outages (described below in section 2.4.1.4). Fish screens will have sensors that continuously monitor screen performance. If a malfunction is detected, the automated monitoring system will signal an alarm, and the appropriate operating headquarters will close the canal diversions. Key hydraulic parameters will be monitored at each fish screen for the term of the AMP (through the current FERC license – 2026). Possible fish entrainment into diversion canals will be assessed visually, especially at times when canals are dewatered. Adaptive management responses, including potential modification of fish screens, may be implemented if fish screen criteria change, facilities do not perform as designed, or fish injury or entrainment is evident. Detailed monitoring, operation, and maintenance plans have been developed for the proposed fish screens and bypass facilities and are described in further detail in the draft Facility Monitoring Plan for the Battle Creek Hydroelectric Project and the Restoration Project Adaptive Management Plan. The likelihood of juvenile entrainment is expected to decrease as a result of the proposed action.

Additionally, unimpeded fish passage at the newly constructed fish ladders is expected to be provided under Project Flows to upstream habitat. Fish passage will be monitored and analyzed as described in the Restoration Project AMP. Video monitoring will be conducted for a minimum of three years following construction to assess passage of adult Chinook salmon and steelhead at the new fish ladders. The resource agencies propose to use radio telemetry to assess movement of Chinook salmon and steelhead within the project area and, as part of this study, fish will be tagged to determine the number of fish using the ladder and duration of passage through the fish ladder. Monitoring activities also will include assessing adults using the ladders for evidence of injury, monitoring concentrations of adults below dams (which might suggest the dams and fish ladders are creating migration delays), and monitoring evidence of unintended downstream movement of upstream-migrating fish. Detailed monitoring and operation and maintenance plans for the proposed ladders under the Restoration Project will be included in the draft Facility Monitoring Plan for the BC Hydroelectric Project, and the AMP (PG&E 2015, Terraqua 2004); however, the Facility Monitoring Plan has not been finalized, and the AMP has not begun implementation. In summary, the removal of dams and construction of fish ladders and fish screens on remaining dams, is expected to provide salmonids access to additional upstream habitat, which is expected to improve conditions for salmonids.

2.4.1.1.2 *Predation/Food Availability*

Reduction of predation-related mortality is likely to occur as a result of removing dams and improving fish ladders. The dams and associated fish ladders present under environmental baseline conditions are assumed to maintain predation above levels that would occur in the absence of dams. While the existing ladders at dams may stop the upstream migration of predatory species such as Sacramento pikeminnow (Whitton et al. 2010), juvenile salmonids passing over the dams may be vulnerable to predation as a result of being disoriented by turbulent flow conditions below the dams. High pikeminnow concentrations that coincide with the downstream migration of juvenile salmonids are assumed to increase predation losses (Jones & Stokes 2005). A one-year study of the distribution of large-bodied fishes in Battle Creek prior to the commencement of the Restoration Project did not find predatory species (Sacramento pikeminnow and smallmouth bass) in the immediate vicinity of the North Fork diversion dams (Wildcat and Eagle Canyon; the survey did not include North Battle Creek Feeder) nor in the reach between Wildcat and Eagle Canyon Diversion Dams (Whitton et al. 2010). Sacramento pikeminnow were found somewhat downstream of Coleman Diversion Dam on the South Fork but were not found above Coleman Diversion Dam in the reach between there and the confluence with Ripley Creek (Whitton et al. 2010). Common predators (Sacramento pikeminnow and smallmouth bass) generally were most common in the mainstem and the lower portions of the North Fork and South Fork Battle Creek. Removal of Coleman and South diversion dams, and the improved fish ladder on Inskip Dam, would minimize disorientation of juveniles, which could reduce potential predation risk for downstream migrating juvenile Chinook salmon and steelhead in the South Fork.

Fish species that prey on juvenile Chinook salmon and steelhead will continue to occur throughout Battle Creek, and could conceivably enter upstream of Coleman Dam in greater numbers once it is removed, but are likely to be more concentrated in the lower mainstem reaches where warmer water temperatures support known predators, including smallmouth bass, green sunfish, and Sacramento pikeminnow (Whitton et al. 2010). The predator populations that occur in lower mainstem Battle Creek are unlikely to be greatly affected by the Restoration Project (Jones & Stokes 2004).

Food availability is expected to increase as a result of increased access to habitat, as well as increased flows (flows are discussed further below). Prey abundance affects growth rate and the survival of individual fish. The quantity of habitat available for the production of periphyton and aquatic macroinvertebrates is a function of stream surface area. Periphyton is a key component of the aquatic food web, and aquatic macroinvertebrates are a primary food item for fish, especially juvenile Chinook salmon and steelhead. Prey abundance may increase in response to increased stream surface area and a subsequent increase in primary productivity. Minimum instream flows would increase under the Restoration Project, potentially increasing the abundance of food for fish.

2.4.1.2 *Restoration Project Flows*

One of the primary impacts of the BC Hydroelectric Project affecting salmonid spawning success and survival in Battle Creek is streamflow. Environmental baseline conditions include minimum instream flow requirements under the current FERC license at only five cfs in South Fork Battle Creek, and three cfs in North Fork Battle Creek (and tributaries at zero). Although Phase 1A was completed in 2013, issues with the fish screen/ladder on North Fork Battle Feeder Diversion Dam has resulted in PG&E not accepting the facility, and not providing project flows or fish passage at Eagle Canyon Dam.

Although the final FERC order for Phase 1A was issued in 2009, PG&E continues to supply additional flows through the Interim Flow Agreement (30 cfs in the South Fork and North Fork) rather than providing prescribed minimum instream flows related to Phase 1A as described earlier. Table 2 above describes the "project flow" requirements as part of the FERC license amendment for Phase 2, which will increase flows on the South Fork to provide for an increase in suitable rearing and spawning habitat, food availability, cooler temperatures, and passage over natural barriers to additional critical habitat. As part of the Restoration Project AMP, if observed fish habitat use does not match expectations, verification studies will be conducted, new habitat suitability criteria may be developed, and changes to instream flows may be recommended. Habitat quantity, fish use of habitat, and advancements of science or modeling of instream flows will be monitored and analyzed.

Acres of available rearing and spawning habitat have been calculated for environmental baseline conditions as well as post-Phase 2 for the South Fork (Jones and Stokes 2005a,b). Rearing habitat would be increased by 10 acres for steelhead, and just over 20 acres for CV spring-run and SR winter-run Chinook salmon. Spawning habitat would be increased by just over 5 acres for steelhead, and nearly 4 acres for CV spring-run and SR winter-run Chinook salmon. Habitat availability is calculated based on flow, and does not take into account water temperatures, which likely will preclude SR winter-run Chinook salmon from successfully spawning in the South Fork, and may preclude successful CV spring-run Chinook salmon spawning in some years. North Fork habitat contains preferred spawning temperatures for CV spring-run and SR winter-run Chinook salmon, so Project Flows for Phase 1A would likely provide most of the habitat benefits.

2.4.1.2.1 *Temperatures*

The higher instream flow requirements of the Restoration Project described above (and in Table 2) are expected to, in general, result in cooler water temperatures in Battle Creek, especially during the warmer months (June through September). Project flow increases will also extend this cooling into downstream reaches, including mainstem Battle Creek, during the warmer months. The Restoration Project will have minimal effect on water temperatures during October through May, when ambient water temperatures are relatively cool. Cooler temperatures are expected to specifically increase survival during adult holding, and egg incubation, and decrease risk of disease, pre-spawn mortality, and predation (Myrick and Cech 2000).

Potential beneficial effects of increased flows on water temperatures in each reach from June through September were estimated using the SNTEMP model described in the EIS/EIR and used by the GBCWG Biological Team. A general indication of the magnitude of beneficial water temperature effects over all months of the year is presented using the Warming Model for unspecified runoff and climate conditions described in the EIS/EIR (Jones and Stokes 2005a,b). Both approaches illustrate that during summer months higher flows associated with the Restoration Project substantially reduce water temperatures in most of the affected reaches in Battle Creek.

The AMP for the Restoration Project recognizes the uncertainty associated with prediction of water temperature regimes and survival rates for different life stages under various environmental conditions. The AMP includes measures to improve modeling efforts during the post-project period, ways to apply those improvements to real time temperature management in the project area, and measures to provide necessary improvements through the Water Acquisition Fund.

However, there are two short segments in South Fork Battle Creek where environmental baseline conditions provide cooler summertime temperatures than what will be provided by the Restoration Project after Phase 2 is completed. Under environmental baseline conditions, Inskip and South powerhouses release cooler North Fork water into South Fork Battle Creek. During the summer months, releases from the Inskip Powerhouse can result in a 15°F cooling of the water temperature immediately upstream of the Coleman Diversion Dam and downstream into the Coleman reach. Similar releases from the South Powerhouse can result in a 6°F cooling of the water temperature immediately downstream of the powerhouse to Inskip Diversion Dam and into the upstream segment of the Inskip reach. This release of cooler North Fork water into the South Fork by the Inskip and South Powerhouses will be discontinued when Phase 2 is complete, resulting in temperatures as much as 8°F warmer than environmental baseline conditions below Coleman Diversion Dam and as much as 4°F warmer than environmental baseline conditions in the 1-mile stream segment below Inskip Diversion Dam (PG&E 2015). Although the Restoration Project will not provide the cooler powerhouse releases noted as part of the environmental baseline conditions after Phase 2 is completed, it will result in a steadily changing and more natural temperature gradient (averaging around 0.6–0.8°F per river mile in the warmer months), as well as stabilizing the overall temperature regime by eliminating current fluctuations in streamflow associated with hydroelectric outages. Under environmental baseline conditions, the powerhouses do not reliably release cooler water, primarily because canal and turbine outages can occur at unpredictable times, thereby producing substantial temperature fluctuations that reduce habitat value compared to the more stabilized conditions that will occur after Phase 2 is completed. In spite of the warming that will occur immediately downstream of Coleman Diversion Dam, the lower segments of the Coleman reach may be cooler under the Restoration Project because minimum flows in this reach will be higher with the Project Flows, compared to environmental baseline conditions.

Based on SNTEMP modeling, water temperature reductions in June in the South Diversion Dam reach of the South Fork would increase SR winter-run Chinook salmon egg survival from 0% to 50–85% along the lower 4 miles of this reach. Based on SNTEMP modeling, water temperature reductions in August in the Wildcat and Eagle Canyon reaches on the North Fork, and the lower segments of Inskip and Coleman reaches on the South Fork, would benefit over-summering adults the most. Temperature reductions in the Wildcat and Eagle Canyon reaches on North Fork Battle Creek and South reach on South Fork Battle Creek will have the most benefits for spring-run Chinook salmon egg survival. Limited benefits to spring-run Chinook salmon egg survival would occur in the remaining reaches of Battle Creek. Based on results of the Warming Model, the Restoration Project would benefit winter- and spring-run Chinook salmon egg survival the most, with limited benefits for fall- and late fall–run Chinook salmon egg survival. Based on SNTEMP modeling, water temperature reductions in the South reach of South Fork Battle Creek would benefit smolts the most in June.

Although the South Fork Battle Creek may experience some warming of water temperatures as a result of implementation of Phase 2, and continued BC Hydroelectric Project operations, the section below describes why no longer mixing North Fork water into the South Fork improves habitat overall for listed salmonids.

2.4.1.3 *Outages (maintenance – emergency)*

Planned powerhouse and canal outages occur as part of annual maintenance. Additionally, emergencies can cause an unplanned outage at any time, for any amount of time, though usually limited to a few hours, which will result in flow changes in Battle Creek downstream of the BC Hydroelectric Project facilities affected. High flows occurring as a result of planned and unplanned outages will gradually be reduced as the power plants and canals come back on line. In addition, the proposed action includes PG&E coordinating with the Fish Agencies when timing the planned outages to occur at a time that will be least likely to result in impacts to listed fish, when feasible (e.g., usually August for Coleman Power House outage).

Since maintenance or emergency outages of Battle Creek Hydroelectric facilities result in increased flows downstream of the facility, listed fish may be injured or killed as a result. In some cases an outage will result in North Fork water diverting into the South Fork, and although the frequency of this occurring will significantly decrease after completion of Phase 2, extensive delays will result in at least five more years of mixing. Rapid increases in flow and mixing, can impact several life stages of salmonids, including juveniles, incubating eggs/pre-emergent fry, and adults.

The effects of rapid or unnatural flow fluctuations on fish and aquatic invertebrates are well documented in the literature. The level of benefit associated with eliminating or reducing flow and temperature fluctuations is difficult to quantify because it depends on the extent of stream affected by the outages, the magnitude of the flow spills, and the frequency and duration of the powerhouse outages. However, it is expected that the connectors and bypasses would reduce the influence of powerhouse outages on fish in the South Fork (Jones & Stokes 2005).

2.4.1.3.1 *Outage Impacts to Juvenile Salmonids*

Juveniles may be displaced from their rearing location during rapid increases in flows and turbidity due to an outage, resulting in increased predation, decreased feeding, injury or death due to gill clogging/abrading, and increased risk of entrainment into unscreened diversions and at fish screens. Additionally, juveniles may become stranded after outage flows recede. To reduce the risk of juvenile fish stranding during return to normal flows after an outage, through discussions with the Fish Agencies, PG&E agreed to incorporate ramping rates, which were written into the MOU (Reclamation et al 1999) as well as in the project description for operations post-Phase 2. Ramping rates of 0.10 foot/hour will be implemented and monitored during scheduled outages. Evidence of fish stranding will be monitored throughout the term of the AMP and, depending on the particular trigger and outcome of diagnostic studies, more appropriate ramping rates or threshold flow triggers may be recommended as an adaptive management response. Currently, a 460 cfs (or less) threshold to trigger ramping has been established for South Fork Battle Creek, and future studies conducted under the AMP potentially will identify a threshold for North Fork Battle Creek and mainstem Battle Creek near Coleman Powerhouse. The AMP provides more detail, including a ramping rate model and description of the habitat objective to minimize stranding during outages (Terraqua, Inc. 2004). If direct evidence of an adverse fish response to leakages or discharges from the BC Hydroelectric Project is observed, or if facilities monitoring identifies significant discharges from the water conveyance system, actions will be taken to restore the isolation of water in the conveyance system from the South Fork Battle Creek as prescribed in the AMP (Terraqua, Inc. 2004). Juvenile winter- and spring-run Chinook salmon and steelhead may become stranded and die as these increased flows recede. The ramping rates during outages, required at 460 cfs (or less), are expected to significantly reduce the risk of stranding mortality; however, some take of listed species may still occur.

2.4.1.3.2 *Outage Impacts to Incubating Eggs/Pre-emergent Fry*

If outages occur during spawning timing, any redds already created could potentially be buried by sediment flushed from the higher flows, or scoured, thus killing the developing eggs, or pre-emergent fry. Additionally, fish may create redds during the higher flows, which may result in redds becoming dewatered once flows recede. Due to the unknown timing of emergency outage (season or duration), it is necessary to make some frequency and timing assumptions, in order to analyze the likely impacts, by basing them on historical occurrences and opinions of experienced personnel (Table 3).

2.4.1.3.3 *Outage Impacts to Adult Salmonids*

If outages occur during SR winter-run or CV spring-run Chinook salmon adult migration, fish may be falsely attracted to follow higher flows into less suitable habitat. Additionally, if North Fork water mixes into the South Fork and increases flows in the South Fork, fish may get confused following their homing cues, such that fish intending to return to the North Fork will end up in the South Fork where temperatures will likely become less suitable during holding, spawning, and egg incubation timing. Adult fish that stray into the South Fork as a result of an outage may experience high temperatures resulting in pre-spawn mortality, and increased predation due to decreased holding habitat. This is exacerbated by delays to completing the Restoration Project (Phase 2), as Coleman Diversion Dam currently blocks fish from upstream habitat on the South Fork, and Project Flows are not scheduled to begin until completion of the Restoration Project. Proportion of redds observed in South Fork Battle Creek has varied (5 to nearly 45 percent), and has typically been higher than the proportion in North Fork Battle Creek (zero to 15 percent). Delays also continue the mixing of North Fork water into the South Fork during outages. Considering North Fork Battle Creek habitat conditions (e.g., temperature) are preferable, the higher proportion returning to the South Fork may be a result of false attraction/reduced homing success from annual outages (high flows and mixing of North Fork water into South Fork).

2.4.1.4 *Monitoring and Maintenance*

Annual maintenance of facilities occurs throughout the Battle Creek watershed (described in Section 1.3.6 above), which typically results in an outage and flow fluctuations. Effects due to outages were discussed above (2.4.1.3). Additionally, operations of facilities may include automated systems that occasionally or habitually result in flow fluctuations, which may also result in impacts to fish and/or habitat. PG&E anticipates routine maintenance of existing and new facilities (including powerhouses, canals, new fish screens, and new ladders) to potentially result in the need to dewater, which may entrain or entrap listed salmonids. Additionally, emergency repairs may also require dewatering, but are expected to occur less frequently (once every 5 years). Dewatering activities would include fish capture and relocation, which would likely result in adverse effects such as stress, injury, or death. Because maintenance activities would be coordinated with Fish Agencies to be timed to minimize periods of peak migration of salmonids, numbers of impacted fish are expected to remain low.

PG&E will be responsible for monitoring fish passage at the newly constructed fish ladders, flows provided below dams, and reporting of observations described in the AMP (Terraqua 2004). Video monitoring will be conducted for a minimum of three years following construction to assess passage of adult Chinook salmon and steelhead at the new fish ladders. The resource agencies may propose to use radio telemetry to assess movement of Chinook salmon and steelhead within the project area and, as part of this study, fish will be tagged to determine the number of fish using the ladder and duration of passage through the fish ladder. Monitoring activities also will include assessing adults using the ladders for evidence of injury, monitoring concentrations of adults below dams (which might suggest the dams and fish ladders are creating migration delays), and monitoring evidence of unintended downstream movement of upstream-migrating fish. Detailed monitoring of operation and maintenance for the proposed ladders under the Restoration Project are included in the draft Facility Monitoring Plan for the BC Hydroelectric Project (PG&E 2015).

2.4.2 Effects to Critical Habitat

Some adverse effects to critical habitat and PBFs (described above in section 2.2) are likely to occur during continued operations of the Battle Creek Hydroelectric Project after implementation of Phase 2. Continued effects of operations may include increased temperatures and decreased flows due to water diversions, which may lead to decreased access to and decreased suitability of critical habitat (increased predation, decreased food availability). Short-term adverse effects will occur through planned and unplanned outages of the Battle Creek Hydroelectric Facilities. Outages cause flows to increase in certain sections of the creek, which may increase turbidity or sediment mobilization, which may displace rearing habitat, or disturb spawning habitat. The migration corridor may also be affected such that juveniles may be displaced or stranded, and adults may follow the higher flows, lose the homing signal and move to areas less suitable for holding and spawning.

In addition to the effects of continued operations after completion of Phase 2, described above, delays in construction of the Restoration Project components have resulted in delays to habitat improvements for Chinook salmon and steelhead. Although the long-term effects are expected to provide substantially improved habitat conditions for listed species and are expected to greatly enhance the conservation value of designated critical habitat in Battle Creek, the current schedule is such that improvements will not be realized until after project completion, which is scheduled to be the end of 2021. These include: re-opening access to critical habitat; increasing flows, resulting in decreased temperatures, and improving the migratory corridor for juveniles and adults; decreasing predation; and increasing food availability. Additionally, by ceasing the majority of mixing of North Fork Battle Creek water into the South Fork, straying will decrease so that SR winter-run and CV spring-run Chinook salmon homing to the North Fork, where there is cooler water, will reach the North Fork as intended.

Overall the proposed action is expected to eventually improve PBFs (described above in the "Status of the Species and Critical Habitat" section 2.2), such as the migratory corridors, spawning habitat and rearing habitat, through fish passage and increased flows, for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead.

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 are described below.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section.

2.5.1 Aquaculture and Fish Hatcheries

Mount Lassen Trout Farms, Inc. consists of nine private trout-rearing facilities located within the Battle Creek Watershed. This operation rears rainbow and brown trout for stocking in private ponds and lakes throughout California. Although the facilities are located above the anadromous habitats of Battle Creek, some facilities are located near the BC Hydroelectric Project canals. These facilities have been certified as disease free for many years and the potential for fish or disease to escape from these facilities into Battle Creek is considered very small. No such impacts have ever been documented from these facilities and such impacts are not expected to occur in the future.

Darrah Springs Fish Hatchery is located on Baldwin Creek, a tributary to mainstem Battle Creek. It is a key hatchery of CDFW's inland fisheries program and raises catchable trout for recreational fisheries. It is possible that fish or disease could escape the hatchery into Battle Creek, but again, no such impacts have ever been documented and such impacts are not expected to occur in the future.

2.5.2 Agricultural Practices

The primary agricultural practices in the Battle Creek Watershed consist of low density livestock grazing and small timber harvests. These practices have not produced measurable adverse impacts to salmonids or salmonid habitat in Battle Creek (Reclamation 2003). There are no current plans to modify the type or intensity of agricultural practices in the watershed and therefore any such changes are not considered reasonably certain to occur. The next section describes conservation easements and agreements that are being pursued along the riparian corridors of the Battle Creek Watershed, providing further assurance that future agricultural and other human practices will not be likely to adversely affect salmonids or salmonid habitat.

2.5.3 Conservation Agreements and Easements

The Battle Creek Watershed Conservancy and The Nature Conservancy have been working together in developing conservation agreements and easements throughout the riparian corridors and uplands of the Battle Creek Watershed (efforts separate from the Restoration Project). Several agreements and easements have already been established and several more are being pursued. More specifically, TNC has purchased approximately 7,000 acres of conservation easements on ranches within Battle Creek's watershed. They have also purchased in fee the 1,844 acre Wildcat Ranch on North Fork Battle Creek. This ranch provides access for the Restoration Project's removal of Wildcat Dam. TNC continues to negotiate for the purchase of new easements along both forks of Battle Creek. All TNC easements on Battle Creek prohibit development and other land uses that threaten salmonids. Implementation of these agreements and easements are expected to, at a minimum, maintain the current high quality of riparian and aquatic habitat in Battle Creek, and could potentially improve the condition of these habitats for salmonids.

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 BO 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) appreciably diminish the value of designated or proposed critical habitat for the conservation of a listed species.

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

The Status of the Species are described above in section 2.2, and the action area currently has a returning population of CV spring-run Chinook salmon and CCV steelhead, and is expected to have returning SR winter-run Chinook salmon in the near future, once implementation of the recently completed Battle Creek Winter-run Chinook Salmon Reintroduction Plan is underway (ICF International 2016).

Populations of SR winter-run and CV spring-run Chinook salmon and CCV 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; Williams et al. 2016). 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 SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead could be at risk. Current extinction risk for each species was described in section 2.2 above, concluding an increase for SR winter-run Chinook salmon, a slight decrease for CV spring-run Chinook salmon 2011 to 2014, but with concerns for 2015 to 2018 due to effects of severe drought, and a continued high risk of extinction for CCV steelhead.

As described in the effects section above (2.4), the impacts of continued operation of the BC Hydroelectric Project include outages resulting in rapid increases of flows which could potentially result in injury or death to all life stages depending on timing. If outages occur during adult migration, fish may be falsely attracted to follow higher flows into less suitable habitat. If outages occur during adult spawning, any redds already created could potentially be buried by sediment flushed from the higher flows, or scoured, thus killing the developing eggs, or pre-emergent fry. Fish may also create redds during the higher flows, which may result in redds becoming dewatered once flows recede. Juveniles may be displaced from their rearing location during rapid increases in flows and turbidity due to an outage, resulting in increased predation, decreased feeding, injury or death due to gill clogging/abrading, and increased risk of entrainment into unscreened diversions and at fish screens. Other impacts to adult salmonids may also include delays in migration and over-exertion from multiple attempts at passing the BC Hydroelectric Project dams, reducing overall survival due to injury and exhaustion. Following delays or failed attempts at passing dams, adults may remain downstream of the barriers, where survival to spawning may be reduced.

The removal of diversion dams associated with Phase 2, and the increases in flow per the proposed action, are expected to increase survival of listed salmonids in Battle Creek. Although the new fish ladders should result in improved fish passage, they may have the potential to delay migration. Monitoring will be conducted in order to: (1) assess adults using the ladders for evidence of injury, (2) document concentrations of adults below dams (which might suggest the dams and fish ladders are creating migration delays), and (3) look for evidence of unintended downstream movement of upstream-migrating fish.

Completion of Phase 2 of the Restoration Project is expected to result in long term benefits to listed fish, including fish passage at dams (which is also expected to decrease predation and increase food availability), improved passage over natural barriers through increased flows, and increased survival of incubating eggs due to improved water temperatures. These benefits to fish are expected to result in increases in population abundances and productivity, as well as improving spatial structure and diversity. However, the expected delays in the implementation of Phase 2 will delay these benefits to listed salmonids.

2.6.2 Status and effects to critical habitat

As described above in Section 2.2 *Rangewide Status of the Species and Critical Habitat*, listed Central Valley salmonid species have experienced significant degradation of all their respective PBFs of designated critical habitat. As described above in Section 2.3 *Environmental Baseline*, although Phase 1A of the Restoration Project was to return access to prime critical habitat, as well as provide additional flow to listed salmonids on North Fork Battle Creek, this has not occurred to date due to decisions by PG&E and project delays. Therefore, salmonids continue to be blocked from approximately 8 RMs of critical habitat on North Fork Battle Creek, and continue to experience lower stream flows. Salmonids also are currently blocked from nearly 20 RMs of critical habitat and experience lower flows on South Fork Battle Creek (Proposed Action: Phase 2).

The Proposed Action is expected to result in continued periodic powerhouse outages causing flows to increase in certain sections of the creek, which may increase turbidity or sediment mobilization, which may displace fish from rearing habitat, or disturb spawning habitat. Additionally, the migration corridor may be affected such that juveniles may be displaced or stranded, and adults may follow the higher flows, lose the homing signal and move to areas less suitable for holding and spawning. Furthermore, because Phase 2 of the Restoration Project is not expected to be completed until at least the end of 2020, which will then require testing and is expected to extend the period before facilities become fully operational until 2021. Therefore, critical habitat of listed salmonids will not experience the full benefits of Phase 2 until then, some critical habitat will continue to remain inaccessible until then, and critical habitat will continue to experience lower flows, higher water temperatures, and mixing of North Fork water into the South Fork during outages which creates false attraction into less suitable habitat until then.

After completion of Phase 2 of the Restoration Project, providing access to critical habitat upstream of current dams and increased flows, the conservation value of the PBFs of critical habitat (migration habitat, spawning habitat, and rearing habitat) for CV spring-run Chinook salmon, and CCV steelhead in Battle Creek are expected to improve and increase.

2.6.3 Summary

Timely completion of the Restoration Project has been identified as a high priority recovery action in the Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014b). The “Effects of the Action” section acknowledges and analyzes the potential effects of the continued operations of the BC Hydroelectric Project after implementation of Phase 2. Some potential effects of the continued operations of the project are expected to result in incidental take of listed anadromous fish in the action area, such as impacts from outages. These potential impacts include migration delays, false attraction, pre-spawn mortality, temperature effects, and rapid changes in flows that may result in redd dewatering, juvenile stranding, and increased turbidity. Although the long-term effects of BC Hydroelectric Project for Phase 2 will be to improve overall conditions for listed salmonids by increasing and improving spawning and rearing habitat, and re-opening access to critical habitat under increased flows and decreased water temperatures, delays in completion will delay these benefits until after completion of Phase 2, which is currently scheduled for the end of 2021.

Because of the expected long-term benefits of the proposed action, improving VSP parameters and PBFs, and the nature of temporary adverse effects until completion of Phase 2, the adverse effects that are anticipated to result from the proposed action are not the type or magnitude that are expected to appreciably reduce the likelihood of both the survival and recovery of the affected listed species in the action area, or at the ESU/DPS level. Nor are any adverse effects of the proposed action to critical habitat expected to appreciably reduce the value of designated critical habitat for the conservation of the species. VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be appreciably reduced, either before or after completion of Phase 2; in contrast, implementing this proposed action is expected to improve these parameters through increases in habitat quantity and enhancements to habitat quality, which will be necessary for the Battle Creek populations to reach a viable status. The Central Valley Salmon and Steelhead Recovery Plan has identified the Battle Creek populations as the highest priority, or "Core 1" for recovery of the SR winter-run Chinook salmon ESU, CV spring-run Chinook salmon ESU, and CCV steelhead DPS (NMFS 2014b). It is important to note that delays to benefits to listed species and critical habitat from the proposed action may result in impacts to the listed species and their critical habitat. The severe decline in Central Valley salmonid populations over many years and the degraded environmental baseline demonstrate 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 SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead could be at risk. Overall, considering the status of the species, the environmental baseline, and cumulative effects, NMFS expects that any adverse effects of the proposed action will be outweighed by the long-term benefits to species. These benefits would be derived through increases in abundance, productivity, and spatial structure resulting from restoration activities that both expand and improve the available habitat (including the migration corridor and spawning and rearing habitat) in Battle Creek. Further, implementation of the Battle Creek Winter-run Chinook Salmon Reintroduction Plan (ICF International 2016) will improve the diversity of Chinook salmon in Battle Creek.

2.7 Conclusion

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

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 BO, NMFS determined that incidental take is reasonably certain to occur as follows: CV spring-run Chinook salmon, SR winter-run Chinook salmon, and CCV steelhead may be killed through continued operations of the BC Hydroelectric Project (post-Phase 2). Additionally, incidental take is likely to occur as a result of delays of Restoration Project completion at least until the end of 2021, the current schedule for project completion. Specifically, NMFS anticipates that incubating eggs, fry, juvenile, and adult CV spring- and SR winter-run Chinook salmon and CCV steelhead may be killed, injured, or harassed during continued operations of the BC Hydroelectric Project for Phase 2.

Aspects of the continued operations that are likely to result in incidental take include both the interim period prior to completion of the Restoration Project (through Phase 2), as well as after completion. The following activities and effects are likely to result in incidental take of listed species: (1) Outages, which could result in dewatering Inskip fish screen/ladder/canal and the need to capture and release salmonids, adults being falsely attracted to less suitable habitat during higher outage flows (leading to adult pre-spawn mortality/predation), redds/incubating eggs getting buried, scoured, or dewatered (leading to death), and juvenile stranding (leading to death) or displaced (leading to predation/entrainment); and (2) Delays in implementation are expected to result in inaccessible critical habitat and preferred habitat, decreased flows, increased temperatures in the warmer months, and increased impacts due to outages (Table 9, except for incidental take as a result of dewatering Inskip fish screen/ladder/canal and the need to capture and release salmonids, which is discussed in the next paragraph). Although outages are expected to decrease in frequency, magnitude, and duration, through implementation of the Restoration Project, the Restoration Project is not scheduled for completion at least until the end of 2021; therefore, incidental take due to outages is expected to continue to occur more frequently until completion of Phase 2 as described below.

Anticipated take is expected during maintenance and repair outages which result in the need to dewater facilities, resulting in fish becoming entrained or entrapped and the need to capture and relocate these fish to adjacent flowing water. Although the actual quantity of salmonids entrained into the new fish screen/ladder or canal areas during maintenance cannot be estimated at this time, due to the variability and uncertainty associated with the population size of each species, annual variations in the timing of spawning and migration, and individual habitat use within the action area, PG&E provided an appropriate surrogate using numbers from another system, based on length of the facility, and based on frequency of maintenance. Based on these numbers provided, NMFS estimates that approximately 500 juvenile salmonids could remain during dewatering of the area for regular annual maintenance at Inskip Diversion Dam, and would need to be relocated back to the creek. Likewise, every 5 years, PG&E indicated anticipation of the need for repair of a component of the Inskip screen/ladder/canal that would result in another 500 juvenile salmonids needing to be relocated. NMFS expects mortality to be low (less than 10 percent) due to the very short time from the capture location to adjacent release location.

Table 9. Listed Species Exposure to Outages and Delays in Restoration Project Completion, and Response and Incidental Take associated by impact and life stage. The life stages below apply to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead individuals.

Project Impact: Outages	Exposure (rapid flow increases, ramped receded flows)	Response/ Form of Take	Project Impact: Delay in Restoration Project completion	Exposure (higher temperatures/ lower flows)	Response/ Form of take
Adults	False attraction	Pre-spawn mortality	**Adults**	Decreased habitat, critical habitat (and more suitable habitat) blocked resulting in less suitable habitat available	Decreased survival
Eggs	Buried by sediment	Death	**Eggs**	Less suitable habitat available	Decreased survival
	Scoured by high flows	Death			
	Deposited during higher flows which recede (redd becomes dewatered) prior to emergence	Death			
Juveniles	Stranding (during receding flows)	Death	**Juveniles**	Less suitable habitat available	Decreased survival
	Displacement (during high flows), leading to predation or entrainment	Death			

It is impossible to quantify and track the amount or number of individuals that are expected to be incidentally taken per species as a result of the proposed action due to the variability and uncertainty associated with the response of listed species to the effects of the proposed action, the varying population size of each species, annual variations in the timing of spawning and migration, and individual habitat use within the action area.

However, it is possible to designate as ecological surrogates those elements of the proposed action that are expected to result in incidental take, that are also somewhat predictable and/or measurable, with the ability to monitor those surrogates to determine the level of incidental take

that is occurring. The most appropriate thresholds for incidental take are ecological surrogates of temporary habitat disturbance during planned or unplanned power house and canal outages, described below. The most appropriate thresholds for incidental take due to delays of project implementation/completion are ecological surrogates of Interim Flows provided downstream of diversion dams on South Fork Battle Creek. Delays will also result in continuous mixing of North Fork water into South Fork, which is likely to result in false attraction, until completion of Phase 2, including the passage and flow benefits described. The behavioral modifications or fish responses that result from the habitat disturbance are also described below. There are not stronger ecological surrogates based on the information available.
In addition to the incidental take described above during maintenance and repair outages which result in the need to dewater facilities, resulting in fish becoming entrained or entrapped and the need to capture and relocate these fish to adjacent flowing water, NMFS anticipates annual incidental take will be limited to:

1. Incidental take in the form of prespawn mortality of adult SR winter-run and CV spring-run Chinook salmon, from temporary disturbance to habitat during outages resulting in high flows in the South Fork, and mixing of North Fork water into the South Fork. Chinook salmon migrating to holding/spawning habitat may be falsely attracted to less suitable habitat and/or non-natal habitat during an outage. When the high flows recede, fish will likely remain in the South Fork, which will reduce suitable habitat by increasing temperatures to lethal levels resulting in pre-spawn mortality.
2. Take in the form of death to incubating eggs from CCV steelhead, SR winter-run and CV spring-run Chinook salmon during outages. Outages will result in higher flows downstream, which may result in entombment from sediment mobilization, scour of redds, or redds becoming dewatered when flows recede (as outages come back online).
3. Take in the form of death to juvenile CCV steelhead, SR winter-run and CV spring-run Chinook salmon, from temporary disruption of habitat during outages. During sudden high flows juveniles may become displaced which can lead to reduced survival, decreased feeding, increased predation risk, and an increase in entrainment. Additionally, as flows recede, juveniles may become stranded.
4. Take in the form of decreased survival due to listed fish being limited to less suitable habitat due to delays in project completion. The schedule for completion of construction of Phase 2 is currently the end of 2020, with testing occurring after construction is complete, which is expected to extend the period before Phase 2 is fully operational until the end of 2021; therefore, flow and passage benefits to fish may not be fully realized until that time.

If outages occur at a different timing, frequency, and duration as described in Table 3 of this BO (unless approved by NMFS), or if the Interim Flows are not maintained until the flow and passage benefits under the proposed action are realized on South Fork Battle Creek, the proposed action will be considered to have exceeded anticipated take levels.

2.8.2 Effect of the Take

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

2.8.3 Reasonable and Prudent Measures

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

1. Measures shall be taken by FERC to ensure that PG&E will minimize impacts due to planned or unplanned outages and maintenance.
2. Measures shall be taken by FERC to ensure that PG&E will minimize impacts to spawning and rearing habitat of listed fish due to Restoration Project delays, and to ensure that PG&E will provide measurable contributions to the Battle Creek Adaptive Management Plan to meet the Program's population, habitat, and fish passage objectives.
3. Measures shall be taken by FERC to ensure that PG&E will monitor effects of continued operations, and provide monitoring reports.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and FERC or PG&E must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). FERC or PG&E 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) FERC shall require PG&E to meet annually with NMFS, CDFW, and USFWS (Fish Agencies) to reach agreement on planned outage timing, and again prior to each outage if desired by the Fish Agencies, to ensure minimal impacts to listed fish. This includes making efforts to avoid timing of adult migration, spawning, egg incubation, and juvenile outmigration. Also, FERC shall require PG&E to contact the Fish Agencies during any unplanned outage (as soon as practicable) to reach agreement on any additional minimization measures needed for implementation.
    b) FERC shall require PG&E to develop and implement a plan to provide adequate flows (up to 60 cfs) below Coleman Dam during any outage in the summer holding period (May through August) to minimize prespawn mortality in the event that adult Chinook salmon follow false attraction cues into the South Fork due to high flows and/or North Fork water entering South Fork. In addition, the plan shall include flows adequate to meet flow and temperature requirements during any outage in the

spawning and egg incubation period (May through November) in the event that eggs are deposited in redds during the higher flows of an outage, to be maintained through incubation and emergence, coordinating with USFWS for timing. This plan shall cover the interim period between the issuance of the FERC order amending the license for Phase 2 and completion of all elements of Phase 2. PG&E shall provide a draft of this plan to NMFS for review and concurrence within 6 months of issuance of the FERC order amending the license for Phase 2.

c) FERC shall require PG&E to develop and implement a plan to avoid or minimize effects of releasing North Fork Battle Creek water into South Fork Battle Creek during any planned or unplanned outage, or maintenance at Coleman, Inskip, and South powerhouses, as well as Coleman and Inskip canals, for when timing occurs during the adult migration period for winter-run and/or spring-run Chinook salmon (December through mid-August). This plan shall cover the period after completion of all elements of Phase 2. PG&E shall provide a draft of this plan to NMFS for review and concurrence within one year of issuance of the FERC order amending the license for Phase 2. The plan shall include annual meetings with the Fish Agencies to provide specific details for the year, with concurrence of the Plan for each year.
d) FERC shall require PG&E to coordinate with USFWS at CNFH and Red Bluff Office during unplanned outages that result in the necessity for CNFH to use their emergency Intake 2. If the outage cannot be ended within a two day period during outmigration of listed fish, FERC shall require PG&E to assist USFWS in juvenile entrainment salvage operations.
e) FERC shall require PG&E to apply the 0.10 ft/hr ramping rate criteria to all planned and unplanned outages as well as to facility operations and maintenance that result in flow fluctuations.
    a. FERC shall require PG&E to contact NMFS if it is anticipated that the ramping rate criteria cannot be met due to insufficient base flows. FERC shall require PG&E to stay as close to the criteria as practicable, not to exceed 0.15 ft/hr.

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

a) FERC shall require PG&E to maintain instream flow releases related to Phase 2 upon completion of installation of the appropriate facilities to provide and monitor these instream flow releases.
b) FERC shall require PG&E to include in the Facility Monitoring Plan a description of the equipment and methods that will be used to provide and monitor instream flow releases related to Phase 2, including a schedule for completion of facilities to provide and monitor instream flow releases.
c) FERC shall require PG&E to file an annual report with FERC and NMFS regarding progress toward completion of installation of facilities to provide and monitor instream flow releases related to Phase 2 as described in the Facility Monitoring Plan each year until installation of such facilities are complete.
d) FERC shall require PG&E to form the Adaptive Management Policy Team and Adaptive Management Technical Team within six months of issuance of the FERC order amending the license for Phase 2.

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

    a) FERC shall require PG&E to file the Facility Monitoring Plan for FERC approval within 6 months of issuance of the FERC order amending the license for Phase 2, including providing a draft of the Facility Monitoring Plan to the Fish Agencies for comment and addressing any comments. FERC shall require PG&E to begin immediate implementation of the Facility Monitoring Plan upon FERC approval of the plan.
    b) FERC shall require PG&E to provide an annual report, by October 31 of each year, documenting the effects of continued Project operations on listed species and critical habitat in the action area, including a summary of any outages and the effects of any outages on listed species and critical habitat in the action area.
    c) FERC shall require PG&E to provide their real-time 15-minute flow and temperature data as well as historic data, to NMFS, CDFW, and USFWS.
    d) FERC shall require PG&E to monitor ramping rates during flow fluctuations due to operations and maintenance, which shall be coordinated with the Fish Agencies to assess effectiveness of criteria to minimize juvenile stranding to a discountable level.

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) FERC should require PG&E to develop and implement a plan to open the Eagle Canyon Ladder/Screen facilities and allow for listed fish to use the ladder to move upstream. Listed fish do not currently have access to habitat upstream of Eagle Canyon Dam. This should occur with agreement on timing from Fish Agencies.

2) FERC should encourage PG&E to contribute funds towards fish passage at natural barriers on Battle Creek in coordination with the Fish Agencies, to offset the delay of Restoration Project completion and thereby delays in benefits to listed fish.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Battle Creek Hydroelectric Project (FERC 1121), Phase 2 License Amendment.

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 BO, (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 BO, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. 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 FERC/PG&E and descriptions of EFH for Pacific Coast Salmon (PFMC 2014) 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 Battle Creek as EFH, which consists of four major components: spawning and incubation habitat; juvenile rearing habitat; juvenile migration corridors; adult migration corridors; and adult holding habitat (Pacific Fishery Management Council 2014). Additionally, the Action Area contains the following designated Habitat Areas of Particular Concern (HAPC): (1) Complex Channels and Floodplain Habitats; (2) Thermal Refugia – North Fork and South Fork Battle Creek are fed from cool water springs; and (3) Spawning Habitat – mainstem Battle Creek as well as both forks contain suitable spawning habitat. The other two HAPCs for Pacific Coast 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

Consistent with the ESA portion of this document which determined that aspects of the proposed action will result in impacts to pacific coast salmon and critical habitat, we conclude that aspects of the proposed action would also adversely affect EFH for these species. We conclude that the following adverse effects on EFH designated for Pacific Coast Salmon are reasonably certain to occur:

1) Juvenile forage habitat availability will decrease in the short-term during flow fluctuations due to outages; juvenile rearing habitat may be decreased as juveniles are displaced during high flows, or become stranded as flows recede.
2) Spawning and egg incubation habitat may be scoured or buried with sediment from high flows during outages, or redds may become dewatered when flows recede, or temperatures may increase to a lethal level.
3) Adults may be falsely attracted to less suitable habitat during high flows from outages, and when North Fork water mixes into South Fork water; impacts occur after flows recede and temperature increases and/or habitat availability decreases.
4) Delays in completing the Restoration Project will result in inaccessible preferred habitat.

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 effect 1 listed above (HAPC #1), NMFS recommends that FERC adopt term and condition (T&C) 1(e) above to minimize effects of outages on juveniles.
2) For effect 2 listed above (HAPC #3), NMFS recommends that FERC adopt T&C 1(b) above to minimize impacts to eggs.
3) For effect 3 listed above (HAPC #3), NMFS recommends that FERC adopt T&C 1(b) and 1(c) above to minimize impacts to adults.
4) For effect 4 listed above (HAPC #1,#2,#3), NMFS recommends that FERC adopt Conservation Recommendations 1 and 2 above to minimize effects to spawning and rearing habitat due to delays of Restoration Project implementation.

Fully implementing the above listed EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 50 acres of designated EFH for Pacific Coast Salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, FERC 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

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

4. FISH AND WILDLIFE COORDINATION ACT

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

The following recommendation apply to the proposed action: On any BC Hydroelectric Project site that experiences foot traffic to the action area, FERC or PG&E 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.

5. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the BO addresses these DQA components, documents compliance with the DQA, and certifies that this BO 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 BO is the FERC and PG&E. Other interested users could include the USFWS and CDFW. Individual copies of this BO were provided to the FERC and PG&E. This BO 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 BO 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 implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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