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

Refer to NMFS No: WCRO-2021-01557

November 9, 2021

Oren M. Ruffcorn
Biologist, 408 Permission Section
U.S. Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, CA 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the City of Sacramento Pump Outfalls Replacement Project

Dear Mr. Ruffcorn:

Thank you for your letter of May 26, 2021, 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 City of Sacramento Pump Outfalls Replacement Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA,16 U.S.C. 1855(b)) for this action.

The enclosed biological opinion analyzes the effects of the City of Sacramento Pump Outfalls Replacement Project. This biological opinion is based on the final biological assessment for the project, and on the best available scientific and commercial information. The biological opinion concludes that the analyzed project is not likely to jeopardize the continued existence of the federally listed as endangered, Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), and the threatened California Central Valley steelhead (*O. mykiss*) Distinct Population Segment, and is not likely to destroy or adversely modify their designated critical habitats. NMFS has included an incidental take statement with reasonable and prudent measures, as well as 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 City of Sacramento Pump Outfalls Replacement Project on EFH for Pacific Coast salmon, designated under the MSA. 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 analysis concludes that the project would adversely affect the EFH of Pacific Coast salmon in the action area. The EFH consultation concludes with conservation recommendations.

Please contact Ally Bosworth at the California Central Valley Office of NMFS at (916) 930-5617 or via email at Allison.Bosworth@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for
California Central Valley Office

Enclosure

cc: ARN-151422-WCR2021-SA00084

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Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion [and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

City of Sacramento Pump Outfalls Replacement Project
NMFS Consultation Number: 2021-01557

Action Agency: United Stated Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central Valley spring-run Chinook Salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
Sacramento River winter-run Chinook salmon ESU (*O. tshawytscha*)	Endangered	Yes	No	NA	NA
California Central Valley steelhead DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies 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

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for California Central Valley Office

Date: November 9, 2021

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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

The National Marine Fisheries Service (NMFS) prepared the biological opinion and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), as amended, and implementing regulations at 50 CFR part 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 part 600.

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 (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2. Consultation History

- September 2020, on several occasions, Allison Bosworth with NMFS was contacted regarding technical assistance and confirming species presence within the project area.

- May 26, 2021, NMFS received a biological assessment from the U.S. Army Corps of Engineers (Corps) and a request for consultation.

- June 1, 2021, NMFS and the Corps had a phone conversation to discuss the proposed project and clarify the project description and type of consultation they were seeking. During this discussion it was determined that Sump 089 was being amended to a "no effect" for NMFS species and will not be included in the consultation.

- June 2, 2021, NMFS received clarification and updated information from the Corps that formal consultation was being sought, and consultation was initiated.

- September 22, 2021, NMFS requested an extension on the biological opinion, a mutually agreed upon 30-day extension was granted and the due date was extended to November 15, 2021.

1.3. Proposed Federal Action

Under the ESA, "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).

Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).]

The Project entails the complete replacement of the pump discharge for two drainage sump station facilities (Sumps 151 and 155). Complete discharge pipe replacements include replacement from the pump discharge across the levee to the outfall structure, including through the headwall. To remove pipes in the levee, trenches that are approximately twice the width of each pipe will be excavated from the landside to the waterside of the levee below the pipes. For pipes that are close together, one wider trench may be used to accommodate multiple pipes. Existing pipes will be lifted out of the trench. The fill beneath the pipes will be built back up to the bottom of the new pipes, which may be installed at a higher elevation than the removed pipes. Installation of positive closure vaults and/or sluice gate structures at the hinge point of the levee is required for Sumps 151 and 155, whereby the vault area will be excavated to the bottom of the levee, then built back up from the bottom to pour the vault. The vault is cast-in-place concrete and will be partially buried.

At Sump 155, an existing gate riser and sluice gate at the top of the levee hinge point will be replaced, and a retaining wall will be installed at the sump station. Varying amounts of asphalt will be installed or replaced at these three sites. At Sump 155, there are two pipes in a sloped, concrete apron that extends over the American River, and a third pipe extending from a typical concrete outfall structure further up the levee bank. There is gunite between the top of the concrete apron and the bottom of the upper outfall structure. The lower, sloped concrete apron has been undermined by the river and will be removed, and the two pipes extending from it will be relocated to the upper outfall structure. A positive closure vault will be installed at the waterside hinge point of the levee. To remove the concrete apron at Sump 155, the apron will be surrounded by a turbidity curtain placed in the river, demolished, then lifted up from upslope. No dewatering will occur within the turbidity curtain. The gunite below the upper outfall structure will be removed via excavation and replaced with Class 5 Rock Slope Protection (RSP). The RSP will be keyed into the excavated area. The upper outfall structure will be widened to accommodate the two relocated pipes from downslope. A total of 40 square feet of RSP will be placed below the closure vault.

For all sites, best management practices (BMPs) will be implemented to prevent debris from entering waterways and channels. Except where noted for Sump 155, project sites will be returned to their existing condition post-construction within 1 year. The Project includes proposed staging areas for each of the relevant sumps: one on La Riviera Drive just east of Howe Avenue, (La Riviera Staging Area), and one west of and adjacent to the southeast corner of Lathrop Way (Lathrop Staging Area). The La Riviera and Lathrop staging areas occur in fenced, cleared areas that are used for staging and stockpiling of construction materials under baseline conditions. The La Riviera staging area is located on La Riviera Drive just east of Howe Avenue, on a graveled area. The Lathrop staging area is located west of and adjacent to the southeast corner of Lathrop Way. For both sumps, work will be completed during the summer months outside the flood season. Up to four trees may need to be removed at Sump 155 depending on the proximity of excavation and concrete apron removal. Riparian vegetation may require minor trimming at 155 near the outfall structure, but is not expected to be needed at Sump 151. Construction is anticipated to take 4 months during one construction season.

Sump 151: Sump 151 is located adjacent to the American River above the floodplain area and wetted channel.

Sump 155: To remove and replace approximately 280 feet of two (2) 36 inch (") welded steel pipes with 36" high-density polyethylene pipes. To remove and replace approximately 110 feet of one (1) 42" Corrugated Metal Pipe with 42" Reinforced Concrete Pipe. Additional improvements include installing positive closure vaults, removing and replacing the existing outfall structure, constructing a retaining wall on the landside, installing stairs on the waterside levee slope, resurfacing the levee crown and maintenance access road, as well as removing and replacing the existing fence at the sump station near the landside toe. Both Sump 151 and 155 are located on the banks of the Lower American River below Howe Avenue.

Sump	Latitude & Longitude [1]
151	38.59587, -121.45773
155	38.57020, -121.42420

General Conservation Measures

The following avoidance and minimization measures are recommended at both sumps to reduce project-related impacts to riparian vegetation and other sensitive natural communities within the action area:

- Removal of trees and riparian vegetation will be minimized to the extent possible. Trees removed at Sump 155 will be replaced by willow stake plantings post-construction.
- To protect riparian forest, riparian scrub shrub, retained trees, and other sensitive natural communities prior to construction, environmentally sensitive area fencing or equivalent demarcation approved by the engineer will be placed along the limits of construction in the action area to exclude construction activities. Trucks and other vehicles will not be allowed to park beyond, nor shall equipment be stored beyond, the fencing. No vegetation trimming/mowing or ground-disturbing activities will be permitted beyond the fencing.
- For all sumps, the City will obtain a Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW) in compliance with Fish and Game Code Section 1602. The City and its contractor will be required to comply with terms of the Agreement and provide any required documentation of proof of compliance to CDFW.
- The Project will comply with the provisions of Title 9, Chapters 9.31 through 9.35 of the City of Sacramento Code (Grading, Erosion and Sediment Control Ordinance). Code compliance includes preparation of an Erosion and Sediment Control Plan.
- If required, the Project will obtain National Pollutant Discharge Elimination System (NPDES) coverage via the State Water Resources Control Board's (SWRCB) Construction General Permit, which requires preparation of a Stormwater Pollution Prevention Plan prior to construction.
- Best management practices to control soil erosion, sediment transport, and runoff pollution will be implemented during construction per the City's Administrative and

Technical Procedures Manual for Grading and Erosion and Sediment Control (City of Sacramento 2013).

- Construction activities on the waterside of the levee will not occur during the flood season, as determined by the Central Valley Flood Protection Board (CVFPB) – typically 1 November through 15 April or 15 July, as specifically determined by the CVFPB for each sump site. The Project will adhere to further Pump Outfalls Replacement Project 3/31/2021 23 work period restrictions in applicable permits and requirements from CDFW, USFWS, and NMFS, unless the applicable permitting agencies approve work window modification.
- Equipment will be refueled and serviced at designated construction staging areas. All construction material will be stored and contained in designated areas located away from aquatic resources to prevent transport of materials into adjacent waterways. Appropriate BMPs will be installed to collect any discharge, and adequate materials for spill cleanup will be kept on site. Construction vehicles and equipment will be properly maintained to prevent contamination of soil or water from external grease and oil or from leaking hydraulic fluid, fuel, oil, and grease.
- For sumps 151 and 155, the City will obtain an Encroachment Permit permission in compliance with Section 408 of the Section 14 of the Rivers and Harbors Act of 1899, 33 U.S.C. § 408 from the CVFPB. For Sumps 151 and 155, the City will obtain approval from U.S. Army Corps of Engineers for Project coverage under Nationwide Permits in compliance with Section 404 of the Clean Water Act and a Water Quality Certification from the Central Valley Regional Water Quality Control Board in compliance with Section 401 of the Clean Water Act. The City and its contractor will be required to comply with terms of all permits and provide any required documentation of proof of compliance to the permitting agencies.

The purpose of the construction is the rehabilitation of a stormwater outfall, which requires approval from the Corps to execute the construction. However, the operation of the stormwater outfall is not regulated by the Corps, and the operation of the stormwater outfall is not part of the Corp's proposed action in this consultation. The operation of the regional stormwater outfall is authorized and regulated by the U.S. Environmental Protection Agency (EPA) under Section 401 of the Clean Water Act.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would. The operation of the stormwater outfall would not occur but for the proposed action under consideration.

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, each Federal agency must ensure that its 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 provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If

incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably 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 definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat for Central Valley spring-run Chinook salmon ESU (CV spring-run) and California Central Valley steelhead CCV steelhead uses the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced 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 PCEs, PBFs, 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.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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, or (2) directly or

indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

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

Table 1. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit	Endangered, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016e), the status of the winter-run Chinook salmon ESU, the extinction risk has increased from moderate risk to high risk of extinction since the 2007 and 2010 assessments. Based on the Lindley et al. (2007a) criteria, the population is at high extinction risk in 2019. High extinction risk for the population was triggered by the hatchery influence criterion, with a mean of 66% hatchery origin spawners from 2016 through 2018. Several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and increased hatchery influence. Thus, large-scale fish passage and habitat restoration actions are necessary for improving the winter-run Chinook salmon ESU viability.

Species	Listing Classification and Federal Register Notice	Status Summary
Central Valley (CV) spring-run Chinook salmon ESU	Threatened, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016c), the status of the CV spring-run Chinook salmon ESU, until 2015, has improved since the 2010, 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear creeks) trending in the positive direction. However, more recent declines of many of the dependent and independent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk. Monitoring data showed continued sharp declines in adult returns from 2014 through 2018 (CDFW 2018).
California Central Valley (CCV) steelhead Distinct Population Segment (DPS)	Threatened, 71 FR 834; January 5, 2006	According to the NMFS 5-year species status review (NMFS 2016b), the status of steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was in danger of becoming endangered. Most natural-origin 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 steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin 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 steelhead. While updated data on steelhead in the American River is mostly based on Hatchery returns, other natural spawning populations within the Sacramento tributaries have fluctuated, but showed a steady decline in the past 10 years (Scriven et al. 2018).

Table 2. Description of critical habitat, Listing, and Status Summary.

Critical Habitat	Designation Date and Federal Register Notice	Description
Central Valley spring-run Chinook salmon ESU	September 2, 2005; 70 FR 52488	Critical habitat for 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, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water mark. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bank full elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for CV spring-run Chinook salmon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.
California Central Valley (CCV) steelhead DPS	September 2, 2005; 70 FR 52488	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bank full elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for steelhead critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

Current Limiting Factors

The following are current limiting factors for the listed species included in this consultation:

- Major dams blocking access to historical spawning habitat (for winter-run and spring-run Chinook salmon, approximately 90 percent of historic spawning and summer holding areas along with altering river flow regimes and temperatures are impacted).
- Water management/Diversions
- Loss of floodplain rearing habitat from levees and hard bank protection
- Low-flow barriers to passage
- Urbanization and rural development
- Logging
- Grazing
- Agriculture
- Mining – historic hydraulic mining from the California Gold Rush era
- Estuarine modified and degraded (reducing developmental opportunities for juvenile salmonids)
- Predation from non-native species
- Dredging and sediment disposal
- Contaminants
- Fishery related effects
- Hatcheries related effects
- 'Natural' factors (e.g. ocean conditions)
- Climate change exacerbating flow and water temperature related impacts

Global 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). Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006).

For winter-run Chinook salmon, the embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, so this run is particularly at risk from climate warming. Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson et al. 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley,

summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). The Anderson Cottonwood Irrigation Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected.

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. Action Area

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

The action area is located in the City of Sacramento. The Sump 155 location occurs along a major levee bordering the American River within the city limits. Sump 151 is located just downstream, though higher above the floodplain area than Sump 155 is. The elevation in the action area ranges from 7 to 52 feet above sea level. Land use surrounding the site on the landside of the levee generally consists of residential neighborhoods and commercial buildings. The site contains areas of nonnative annual grassland and developed land. The site has riparian forest habitat along the banks of the river. Temporary effects from construction activities will travel farther in water than initially included in the Action Area map depicted in the Corps 2021 BA. Action areas for the sump 155 with in water activities are expected to extend up to 1,000 feet upstream and down, and 250 feet out into the River.

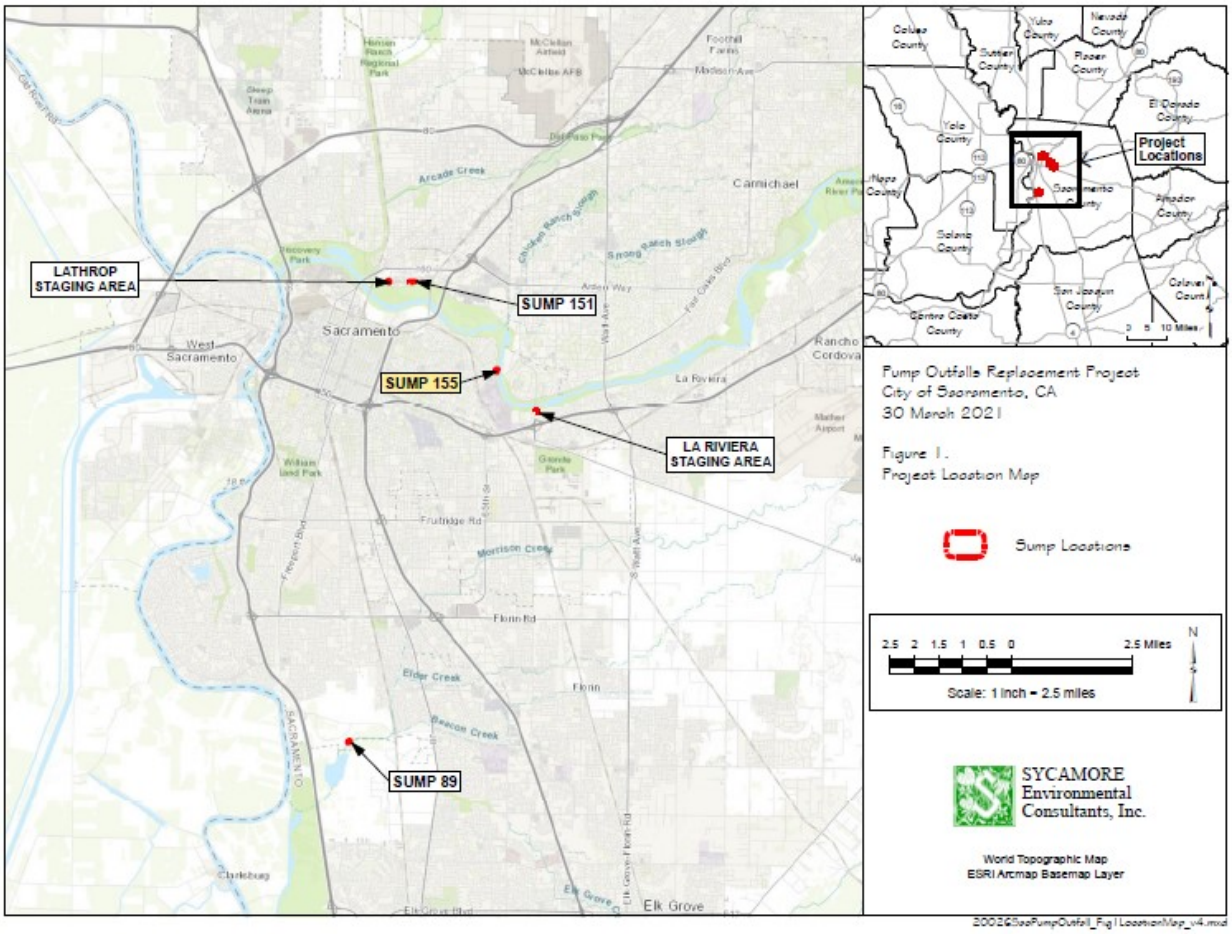

Figure 2. Demonstrating locations of sumps around the American River

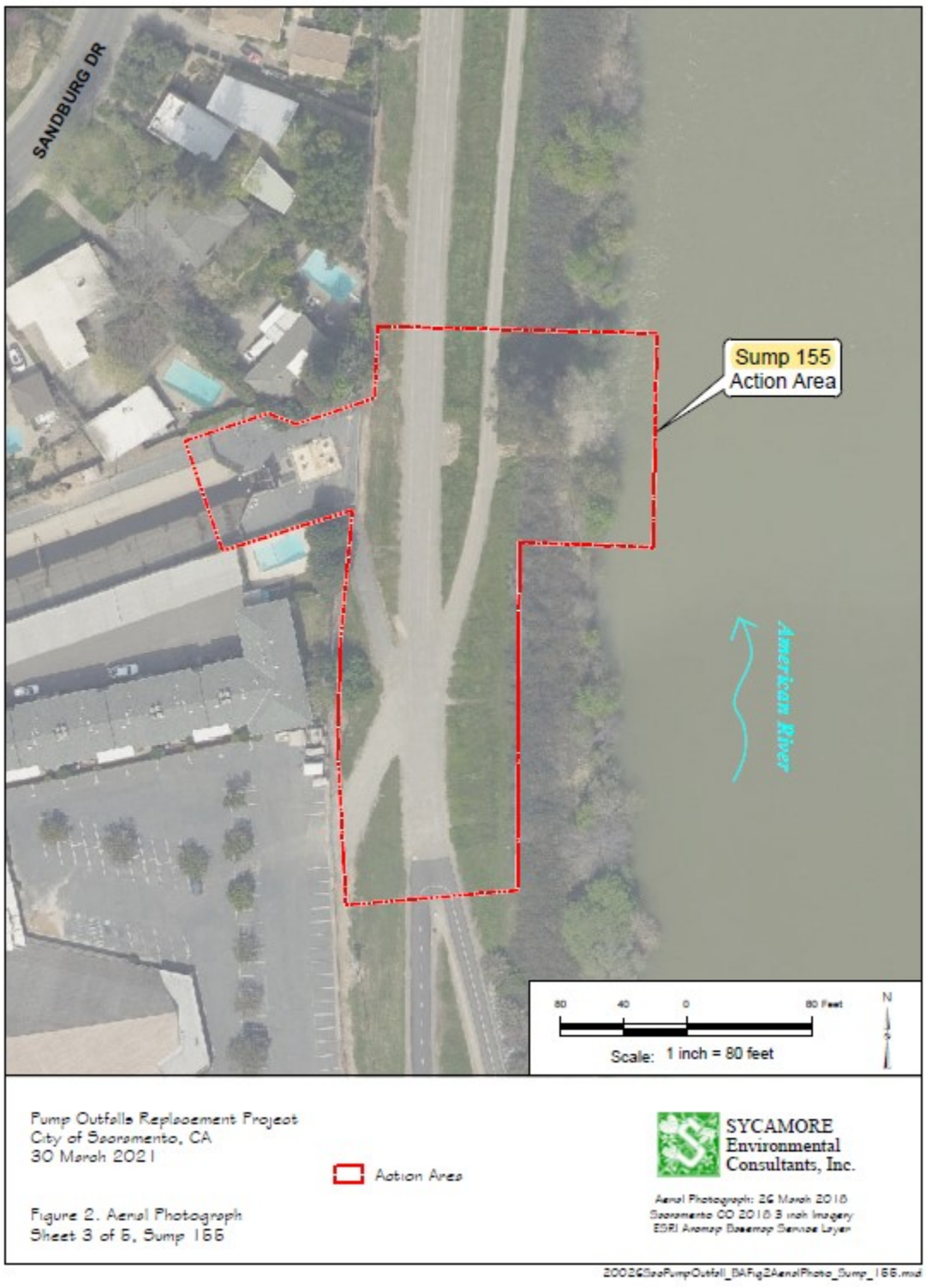

Figure 3. Taken from Corps biological assessment outlining estimated disturbance area from construction activities for Sump 155 (Corps 2021)

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

This section describes the physical conditions and general vegetation, wildlife, and fisheries resources present within the action area.

The Sacramento River watershed receives winter/early spring precipitation in the form of rain and snow (at higher elevations). Prior to the construction and operation of any reservoirs, winter rainfall events caused extensive flooding and spring snowmelt resulted in high flows during spring and early summer. Summer and fall flows were historically low. Currently, much of the total runoff is captured and stored in reservoirs for gradual release during the summer and fall months. High river flows occur during the winter and spring, but these are usually lower than during pre-European settlement times; summer and fall low flows are sustained by releases from upstream reservoirs.

Downstream from the American River confluence, the Sacramento River is moderately sinuous (average sinuosity of 1.3), with the channel confined on both sides by man-made levees enhanced by decades of man-made additions. The channel in this reach is of uniform width, is not able to migrate, and is typically narrower and deeper relative to the upstream reach due to scour caused by the concentration of shear forces acting against the channel bed (Brice 1977). Channel migration is similarly limited along the lower American River because of man-made levees and regulated flows from Folsom Dam.

The natural banks and adjacent floodplains of the American River is composed of silt- to gravel-sized particles with poor to high permeability. Historically, the flow regimes caused the deposition of a gradient of coarser to finer material, and longitudinal fining directed downstream (sand to bay muds). The deposition of these alluvial soils historically accumulated to form extensive natural levees and splays along the rivers, 5 to 20 feet above the floodplain for as far as 10 miles from the channel (Thompson 1961). The present-day channels consist of fine-grained cohesive banks that erode due to natural processes, as well as high flow events (Corps 2012).

Most existing habitat impacts are the result of development of the basin-wide flood control system, the Sacramento River Flood Control Project (SRFCP), and other human developments. The current system evolved from private efforts that were started in 1850 into the joint Federal-State SRFCP, which was essentially completed in 1960. Because the SRFCP removed large acreages of riparian floodplain and overflow basins from the river system, the natural regeneration of riparian woodland communities was negatively impacted. Additional effects

occurred to recruitment of large woody material to the river system, spawning and rearing of fish in floodplain and floodplain functions, and allochthonous (imported) input of nutrients and food to the aquatic system. The SRFCP largely eliminated the possibility of natural channel migration and habitat renewal over a considerable portion of the river system. Reaches throughout the action area historically provided both shallow and deeper water habitat. However, channel-confining levees and upstream reservoirs that maintain year-round outflow have eliminated much of the adjacent shallow water floodplain habitat. The existing levees influence the natural meander and ecosystem of the Sacramento and American Rivers, included in the action area. Many native fish species are adapted to rear in flooded, shallow water areas that provide abundant cover from prey. As a consequence of habitat alterations, and introduction of non-native species and pollutants, some native fish species are now extinct while most others are reduced in numbers (Moyle 2002).

The proposed action is occurring in the lower American River, which serves as rearing habitat and migratory corridors for listed winter-run Chinook salmon, spring-run Chinook salmon, and steelhead. As mentioned above, much of the American River watershed has been substantially altered from human activities, and this has dramatically reduced the habitat value of the watersheds for listed fish species. However, despite the impaired status of the watershed in the proposed action area, the value of the area for listed fish species is high, as it provides some of the last remaining critical habitat for listed fish. The lower American River is high value habitat for spring-run Chinook salmon, and steelhead.

Vegetation in the Action Area

The action area consists of primarily riparian forest, valley oak woodland, riparian scrub-shrub habitat, and typically non-native annual grassland. Scrub-shrub generally refers to areas where the woody riparian canopy is composed of young trees or shrubs less than 20 feet high. Species that are typically found in riparian forest, valley oak woodland, and scrub habitats include cottonwood, several willow species, sycamore valley oak, black walnut, Oregon ash, white alder, boxelder, blue elderberry, buttonbush, Himalaya blackberry, wild grape, and poison oak. Understory vegetation may consist of an herbaceous layer of sedges, rushes, grasses, and forbs.

Other cover types found in the action area include bare ground (areas devoid of vegetation), agricultural, ruderal vegetation (areas with sparse to moderate herbaceous plant cover dominated by weedy upland species), and urban (including structures, roads and parks, but are usually located on the landward side of the levee).

2.4.1. Previous Flood Management within the Action Area

The environmental baseline also includes past and present flood management actions within the action area. The action area is encompassed by levees built from around 1850 up through 1960. Several large-scale bank repair actions have occurred within the action area prior to this consultation. The largest are by far the Sacramento River Bank Protection Program (SRBPP) and the American River Common Features Program.

The SRBPP was originally authorized by the Flood Control Act of 1960, in order to protect levees and flood control facilities of the SRFCP from erosion damage. The SRBPP has been thus

far described in two phases: SRBPP Phase I and Phase II. Each phase includes flood risk management actions consisting mainly of bank protection and levee repairs to correct erosion problems and protect low-lying areas of the Sacramento Valley and Sacramento-San Joaquin Delta from damaging floods. Phase I was constructed from 1962 to 1975. Phase II was originally authorized in 1974 and consists of 405,000 linear feet (LF) of bank protection. An additional 80,000 LF was added to Phase II by the Water Resources Development Act (WRDA) of 2007, and 30,000 LF of this has been consulted on previously with NMFS.

The American River Common Features (ARCF) Program was consulted on in 2015 and has not yet been fully constructed. Based on timing information provided by the Corps, it is likely that substantial construction will be occurring concurrently with the proposed action. The ARCF will be constructing erosion repairs on the both sides of the lower American River in the 12 miles from the confluence of the Sacramento River and up, which encompasses the action area. The construction will require the removal of most of the riparian vegetation from the levee temporarily, with up to 66% permanent vegetation loss possible.

Although site-level impacts have been addressed from compensatory mitigation associated with the SRBPP and ARCF, ecosystem impacts have largely been left unaddressed. Levees constructed as part of the SRBPP have replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs, which historically provided a spectrum of complex habitats. Shallow water habitats had a broad range of depths, water velocities, riparian vegetation, fallen trees and woody materials (*i.e.*, IWM), and gave the river the ability to migrate across the floodplain to create additional complexity in the geometry of its cross section. Naturally flowing rivers were able to construct riverside benches and naturally formed levees during flood events. These benches could be up to 20 feet high and extended for considerable distances inland, creating suitable conditions for the establishment and successful development of structurally diverse riparian vegetation communities (The Bay Institute 1998). Large, continuous corridors of riparian forests and vegetation were present along major and minor rivers and streams in the Central Valley. Native fish species, including listed salmonids, evolved under these environmental conditions.

The construction of levees and the "reclamation" of floodplains eliminated these riparian areas. Only remnant riparian forests exist in the action area today, as many of the levees are extensively riprapped with stone armoring. Only in a few areas where waterside benches exist outside of the levee toe and vegetation is allowed to grow, does naturally established vegetation exist. These stands of riparian vegetation are discontinuous and frequently very narrow in width, providing a fraction of the ecological benefits of their historical predecessors.

2.4.2. Status of the Species in the Action Area and Recovery Criteria

The action area, which is described above, encompasses a small portion of the Lower American River, and all associated floodplains and riparian areas at and adjacent to the proposed construction site. This area functions as a rearing and migratory corridor for spring-run Chinook salmon, winter-run Chinook salmon, and steelhead. The action area is also used for rearing and adult feeding.

Presence of Sacramento River winter-run Chinook salmon in the Action Area

The temporal occurrence of Sacramento River winter-run Chinook salmon smolts and juveniles within the action area are best described by a combination of the salvage records of the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities and the fish monitoring programs conducted in the northern and central Delta. Based on salvage records at the CVP and SWP fish collection facilities, juvenile Sacramento River winter-run Chinook salmon are expected to be present in the mainstem Sacramento river, just downstream starting in December. Their presence peaks in March and then rapidly declines from April through June. A small portion of those winter-run juveniles will enter the action area during February through June. While no spawning population of winter-run exists within the American River, rearing juveniles have been captured at the screw traps at RM 9, and expected to be present within the Lower American River in similar time windows as their presence in the Sacramento River.

The action area contains individual CV winter-run Chinook salmon from the Basalt and Porous Lava Diversity group "Core 1" population (*i.e.*, mainstem upper Sacramento River below Keswick Dam), as identified in the NMFS Recovery Plan for the species (NMFS 2014). Core 1 watersheds possess the known ability or potential to support a viable population. For a population to be considered viable, it must meet the criteria for low extinction risk for Central Valley salmonids (Lindley et al. 2007). The criteria include population size, population decline, catastrophic decline and hatchery influence.

Presence of CV spring-run Chinook salmon in the Action Area

CVP/SWP salvage records and the northern and Central Delta fish monitoring data indicate that juvenile spring-run Chinook salmon first begin to appear in the action area in December and January, but that a significant presence does not occur until March and peaks in April (Aasen 2013). By May, the salvage of juvenile CV spring-run Chinook salmon declines sharply and essentially ends by the end of June. The data from the northern and central Delta fish monitoring programs indicate that a small proportion of the annual juvenile spring-run emigration occurs in January and is considered to be mainly composed of older yearling spring-run juveniles based on their size at date. Adult spring-run Chinook salmon may enter the action area in approximately January, as they have been reported to hold below Nimbus Dam. Low levels of adult migration are expected through early March. The peak of adult spring-run Chinook salmon movement through the action area is expected to occur between April and June with adults continuing to enter the system through the summer. Currently, all known populations of CV spring-run Chinook salmon inhabit the Sacramento River watershed, and are only expected in low numbers within the American River.

The action area contains individual CV spring-run Chinook salmon that may opportunistically use the habitat, from the Basalt and Porous Lava Diversity group populations, Northwestern California Diversity group population, and the Northern Sierra Nevada (NSN) Diversity group populations. Within the action area, there may be "Core 1," "Core 2," and "Core 3" populations of CV spring-run Chinook salmon, as identified in the NMFS recovery plan for the species (NMFS 2014). The Core 1 populations include Battle Creek, Clear Creek, Butte Creek, Deer Creek, and Mill Creek. Core 2 are of secondary importance to Core 1 populations, and meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. Individuals from Core 2 populations that may occur within the action area include the Mainstem Sacramento (below Keswick), Cottonwood/Beegum Creek, Yuba River, Big Chico Creek, and

Antelope Creek. These watersheds have lower potential to support viable populations, due to lower abundance and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest. Core 3 watersheds have populations that are present on an intermittent basis and require straying from other nearby populations for their existence. Individuals from these populations potentially within the action area are Thomes Creek and Stony Creek. These populations likely do not have the potential to meet the abundance criteria for moderate risk of extinction. Core 3 watersheds are important because, like Core 2 watersheds, they support populations that provide increased life history diversity to the ESU/DPS and are likely to buffer against local catastrophic occurrences that could affect other nearby populations. Dispersal connectivity between populations and genetic diversity may be enhanced by working to recover smaller Core 3 populations that serve as stepping stones for dispersal.

Presence of steelhead in the Action Area

The CCV steelhead DPS includes all naturally spawned populations of steelhead (and their progeny) downstream of natural and manmade barriers in the Sacramento River and its tributaries. CCV steelhead produced at Coleman National Fish Hatchery and Feather River Fish Hatchery are also included in this DPS. There is rearing and migration habitat present in the action area. Juveniles use rearing and migration habitat rear year-round in the mainstem American River. Juveniles and smolts are most likely to be present in the action area during their outmigration, which begins in November, peaks in February and March, and ends in June. Adults migrate upstream late August through November.

The action area contains steelhead from the NSN Diversity group. Within the action area, the American River is identified as a "Core 2" population, by the NMFS Recovery Plan for the species (NMFS 2014). Recovery Criteria for CCV steelhead DPS for the NSN Diversity group requires that 4 populations meet Core 1 standards for low extinction risk. Currently 3 populations within the NSN diversity group are designated as Core 1 populations.

Within the action area, the American River is a "Core 2" population of steelhead, as designated by NMFS Recovery Plan for the species (NMFS 2014). The action area contains individual steelhead that may opportunistically use the habitat, from the Basalt and Porous Lava Diversity group populations, Northwestern California Diversity group population, and the Northern Sierra Nevada (NSN) Diversity group populations. Within the action area, there may be "Core 1," "Core 2," and "Core 3" populations of steelhead, as identified in the NMFS recovery plan for the species (NMFS 2014). The Core 1 populations include Battle Creek, Clear Creek, Deer Creek, Antelope Creek, and Mill Creek. Core 2 are of secondary importance to Core 1 populations, and meet, or have the potential to meet, the biological recovery standard for moderate risk of extinction. Individuals from Core 2 populations that may occur within the action area include the Mainstem Sacramento (below Keswick), Cow Creek, Redding Area Tributaries, Putah Creek, Thomes Creek, Mokelumne River, Auburn Ravine, Feather River, Cottonwood/Beegum Creek, Yuba River, Butte Creek, and Big Chico Creek. These watersheds have lower potential to support viable populations, due to lower abundance and quality of habitat. These populations provide increased life history diversity to the ESU/DPS and are likely to provide a buffering

effect against local catastrophic occurrences that could affect other nearby populations, especially in geographic areas where the number of Core 1 populations is lowest. Core 3 watersheds have populations that are present on an intermittent basis and require straying from other nearby populations for their existence. Individuals from these populations potentially within the action area are Thomes Creek and Stony Creek. These populations likely do not have the potential to meet the abundance criteria for moderate risk of extinction. Core 3 watersheds are important because, like Core 2 watersheds, they support populations that provide increased life history diversity to the ESU/DPS and are likely to buffer against local catastrophic occurrences that could affect other nearby populations. Dispersal connectivity between populations and genetic diversity may be enhanced by working to recover smaller Core 3 populations that serve as stepping stones for dispersal.

2.4.3. Status of Critical Habitat within the Action Area

The action area is the lower American River below river mile 10. Designated critical habitat for spring-run Chinook salmon (September 2, 2005, 70 FR 52488) and steelhead (September 2, 2005, 70 FR 52488) occur in the action area.

The PBFs of critical habitat essential to the conservation of spring-run Chinook salmon and steelhead are physical habitat, water quality and quantity, available forage required to maintain habitat for spawning, larval and juvenile transport, rearing, and adult migration. Critical habitat for Chinook salmon and steelhead within the action area include freshwater rearing habitat PBFs and freshwater migration corridor PBFs. The PBFs essential to the conservation of spring-run Chinook salmon and steelhead include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, adequate forage, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by steelhead and Chinook salmon juveniles and smolts and for adult freshwater migration. Steelhead also utilize the parts of the American River within the action area for spawning habitat.

The substantial degradation over time of several of the PBFs in the action area has diminished the function and condition of the freshwater rearing and migration habitats in the area. The action area now only has rudimentary functions compared to historically. The channels of the lower American River have been replaced with coarse stone riprap on artificial levee banks and have been stabilized in place to enhance water conveyance through the system. The extensive riprapping and levee construction has precluded natural river channel migrations. The natural floodplains have essentially been eliminated, and the once extensive wetlands and riparian zones have been “reclaimed” and subsequently drained and cleared for agriculture.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its value remains high for the conservation of spring-run Chinook salmon, and steelhead.

The magnitude and duration of peak flows during the winter and spring are reduced by water impoundment in upstream reservoirs affecting listed salmonids in the action area. Instream flows

during the summer and early fall months have increased over historic levels for deliveries of municipal and agricultural water supplies. Generally, water management now reduces natural variability by creating more uniform flows year-round. Current flood control practices require peak flood discharges to be held back and released over a period of weeks to avoid overwhelming the flood control structures downstream of the reservoirs (*i.e.*, levees and bypasses). Consequently, managed flows in the mainstem of the river often truncate the peak of the flood hydrograph and extend the reservoir releases over a protracted period. These actions reduce or eliminate the scouring flows necessary to mobilize gravel and clean sediment from the spawning reaches of the river channel.

High water temperatures also limit habitat availability for listed salmonids in the lower Sacramento River watershed. High summer water temperatures in the lower Sacramento River can exceed 72ºF (22.2ºC), and create a thermal barrier to the migration of adult and juvenile salmonids (Kjelson 1982). In addition, water diversions for agricultural and municipal purposes have reduced in-river flows below the dams. These reduced flows frequently result in increased temperatures during the critical summer months which potentially limit the survival of holding/spawning adults, incubating eggs, emerging fry, and juvenile salmonids (Reynolds 1993). The elevated water temperatures compel many salmon juveniles to migrate out of the valley floor systems quickly and forgo adequate rearing time before summer heat creates temperatures unsuitable for salmonids. Those fish that remain either succumb to the elevated water temperatures, become more susceptible to diseases, or are crowded into river reaches with suitable environmental conditions.

Point and non-point sources of pollution resulting from agricultural discharge and urban and industrial development occur upstream of, and within the action area. The impacts of these are discussed further in the Cumulative Effects section. Environmental stressors as a result of low water quality can lower reproductive success and may account for low productivity rates in fish (Klimley 2002). Organic contaminants from agricultural drain water, urban and agricultural runoff from storm events, and high heavy metals concentrations may deleteriously affect early life-stage survival of fish in the Sacramento River (USFWS 1995). Principle sources of organic contamination in the Sacramento River are rice field discharges from Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough, and Jack Slough (USFWS 1995).

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The proposed action includes activities that are likely to adversely affect Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, California Central Valley steelhead. The proposed action includes activities that are likely to affect the critical habitats of both the Central Valley spring-run Chinook salmon and the California Central Valley steelhead. The following is an analysis of the potential effects to the species and their critical habitat that are reasonably certain to occur as a result of the implementation of this project.

2.4.4. Effects to Listed Fish Species

Physical Disturbance

Physical disturbance in aquatic habitat will occur during construction activities, such as placement of materials (rock, soils, etc.), which have the potential to affect the juvenile and adult life stages of salmonids through displacement, disruption of their normal behaviors, and direct injury or death from crushing during rock placement.

Instream construction activities may cause mortality and reduced abundance of benthic aquatic macroinvertebrates within the erosion footprint, due to the placement of rock over the existing streambed. These effects to aquatic macroinvertebrates are expected to continue long-term, as permanent bank armoring alters the natural streambed (USFWS 2004). The amount of food available for adult and juvenile salmonids in the action area is therefore expected to be permanently decreased in the areas where submerged riprap is being placed. For the area currently covered by gunite, that will be replaced by riprap, that area will continue to have similar effects that will be exacerbated by the replacement of a project that does not alleviate those stressors.

During construction activities, both juvenile and adult fish may be able to detect areas of active disturbance and avoid those portions of the project footprint where equipment is actively operated or a turbidity plume occurs, particularly adults. As a turbidity curtain will be placed around the construction zone, it is highly unlikely that any adults would be able to get into the area. Juveniles are unlikely to stay in the area, but may stay and hunker down in the activity zone. Occasionally, feeding juvenile salmonids may be attracted to activity stirring up sediment, but are generally expected to avoid areas disturbed by active equipment. Juveniles and adults will have opportunities to move to other portions of the channel where they can avoid potential injury or mortality when the turbidity curtain is being deployed. Some small level of injury and death from crushing by construction equipment and rock placement is expected, but will be reduced through avoidance and minimization measures.

It is expected that a small number of juveniles of each species will be injured or killed as a result of the physical disturbance and rock placement. As adults are more likely able to avoid small footprint of rock placement, it is highly unlikely that adults will be injured or killed from the placement.

Increased Turbidity, Suspended Sediment, and Toxic Substance Spills/Leakage

Proposed activities have the potential to temporarily increase turbidity and suspended sediment levels within the project work site and downstream areas. The re-suspension and deposition of instream sediments is an effect of construction equipment disturbances and rock entering the river. Increased exposure to elevated levels of suspended sediments have the potential to result in physiological and behavioral effects. The severity of these effects depends on the extent of the disturbance, duration of exposure, and sensitivity of the affected life stage.

Salmonids have been observed avoiding streams that are chronically turbid (Lloyd 1987b) or moving laterally or downstream to avoid turbidity plumes (Sigler et al. 1984a). Chronic exposure to high turbidity and suspended sediment may also affect growth and survival by impairing

respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995a).

Fish behavioral and physiological responses that are indicative of stress include gill flaring, coughing, avoidance, and increased blood sugar levels (Berg and Northcote 1985; Servizi and Martens 1992). Excessive sedimentation over time can cause substrates to become embedded, which reduces successful salmonid spawning and egg and fry survival (Waters 1995). Changes in turbidity and suspended sediment levels associated with water operations may negatively impact fish populations temporarily when deposition of fine sediments fills interstitial substrate spaces in food-producing riffles, reducing the abundance and availability of aquatic insects and cover for juvenile salmonids (Bjornn and Reiser 1991). Suspended solids and turbidity generally do not acutely affect aquatic organisms unless they reach extremely high levels (*i.e.*, levels of suspended solids reaching 25 mg/L). At these high levels, suspended solids can adversely affect the physiology and behavior of aquatic organisms and may suppress photosynthetic activity at the base of food webs, affecting aquatic organisms either directly or indirectly (Alabaster and Lloyd 1980; Lloyd 1987a; Waters 1995b).

Increased turbidity can also affect fish by reducing feeding efficiency or success and stimulating behavioral changes. Sigler et al. (1984b) found that turbidities between 25 and 50 Nephelometric Turbidity Units (NTU) reduced growth of juvenile Coho salmon and steelhead, and Bisson and Bilby (1982) reported that juvenile Coho salmon avoid turbidities exceeding 70 NTUs. Turbidity likely affects Chinook salmon in much the same way it affects juvenile steelhead and Coho salmon, because of similar physiological and life history requirements between the species. Newcombe and Jensen (1996) also found increases in turbidity could lead to reduced feeding rate and behavioral changes such as alarm reactions, displacement or abandonment of cover, and avoidance, which can lead to increased predation and reduced feeding. At high-suspended sediment concentrations for prolonged periods, lethal effects can occur.

Based on similar projects conducted by Department of Water Resources and the Corps (*i.e.*, levee repair work and placement of riprap), construction activities are expected to result in periodic increases in localized turbidity levels up to or exceeding 75 NTUs. In the past, levee protection work on the Sacramento River has produced turbidity plumes that travel for several hundred feet downstream of the activity. However, once construction stops, water quality is expected to return to background levels within a few hours, depending on how high the percentage of fines in the material are. Adherence to erosion control measures and avoidance and minimization measures will minimize the amount of disturbed sediment from construction activities and will minimize the potential for post-construction turbidity changes should precipitation events occur after construction has been completed.

Operation of power equipment, such as an excavator, in or near aquatic environments increases the potential for toxic substances to enter the aquatic environment and have negative effects on ESA-listed anadromous fish species (Feist et al. 2011). Spills of toxic substances could negatively affect fish in similar ways as described above for turbidity and stress, up to and including death depending on the chemical spilled.

Equipment refueling, fluid leakage, and maintenance activities within and near the stream channel pose some risk of contamination and potential impacts to listed fish species. The

proposed action does describe a spill prevention plan but does not elaborate well on daily inspections of all heavy equipment for leaks. Without a well-developed spill prevention plans or daily inspections, the likelihood of spills resulting in adverse effects are considered higher as they would be less likely to be caught early before aquatic impacts would be caused. For these reasons, we assume a small amount from leaking equipment would occur, and cause stress, avoidance, injury, and/or death to juvenile and adult fish.

Generally, we expect that most fish will actively avoid the elevated turbidity plumes when possible, during construction activity. For those fish that do not or cannot avoid the turbid water, exposure is expected to be brief (*i.e*., minutes to hours) and is not likely to cause injury or death from reduced growth or physiological stress. This expectation is based on the general avoidance behaviors of salmonids and the requirement to suspend construction when turbidity exceeds Central Valley Regional Water Quality Control Board standards (2021 Corps BA). However, some juveniles that are exposed to turbidity plumes may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish move past the turbid water, normal feeding and migration behaviors are expected to resume. Small increases in turbidity are expected to result in minor, brief localized behavioral disturbances, and not expected to cause any injury or mortality to species.

Acoustic Impacts during Construction Activities

Noise, motion, and vibrations produced by heavy equipment operation are expected. The use of heavy equipment will occur outside the active channel, in addition to the infrequent, short-term use of heavy equipment directly adjacent to the wetted channel. Most listed fishes will be expected to move away and avoid interaction with instream machinery by temporarily relocating either upstream or downstream into suitable habitat adjacent to the worksite. As a result, we anticipate minimal localized effects to listed fishes from instream machinery acoustic impacts. Due to the large span of the project, the aggregated acoustic effects are expected to have adverse effects to listed fish.

The excavation and placement of rock below the waterline will produce noise and physical disturbance, which could displace juvenile and adult fish into adjacent habitats. Similarly, construction activities carried out in close proximity to the river channel have the potential to transfer kinetic energy through the adjoining substrates, disturb the water column, and cause behavioral changes to fish in the nearby area. These effects are expected to occur during construction activities and to cease once construction is completed.

Multiple studies have shown responses in the form of behavioral changes in fish due to human produced noise (Wardle et al. 2001, Slotte et al. 2004, Popper and Hastings 2009). Instantaneous behavioral responses may range from slight variations, a mild awareness, to a startle response. Fish may also vacate their normally occupied positions in their habitat for short or long durations. Depending on the behavior that is being disrupted, the short- and long-term negative effects could vary. Behavioral effects are likely to affect juvenile fish more than adults, as there are essential behaviors to their maturation and survival, such as feeding and sheltering, as adults generally use the action area only for migration and potentially spawning. Overall, construction could disrupt behavior in some instances, but the proposed timing of activities resulting in underwater noise disturbances would be high when the fewest fish and least sensitive life stages

are present. As the small number of fish present are expected to avoid the work area, effects from construction noise are expected to be minimal.

Effects of Other Activities also caused by the proposed action

The purpose of these replaced outfalls is to discharge treated stormwater runoff for the City of Sacramento. Effects associated with the continued operation of the outfalls for stormwater discharge are other activities that would not occur but for the *Proposed Action*.

Adult steelhead that spawn in the American River are expected to pass by the outfall location anytime from July through March for steelhead pre-spawn adults and kelts, depending on flow and water temperature. The rainfall season (during which the outfall is projected to operate) normally starts in October and extends until April. Outfall discharge timing is therefore expected to overlap with a majority of the adult steelhead salmon migration schedules. The American River in very low flow conditions during summer months is around 800 cfs (CDEC), and during flood conditions when stormwater runoff is expected to be present, is substantially higher. In normal water years, flows can easily exceed 10,000 cfs, with stormwater outfalls usually discharging less than 100 cfs. Given the large size of the American River, it is highly unlikely that stormwater discharge during wet conditions would be a noticeable flow change from the large volume of water adult salmonids in the American River are already exposed to in an average year. Therefore, this added water source is not expected to adversely affect adult CCV steelhead.

The analyses of effects on juvenile salmonids will occur together for the consideration of the effects of long-term operation of the stormwater outfalls, due to the similarities in their life history patterns, timing and use of the action area, the limitations of their physiology, and reactions to environmental perturbations.

Juvenile CCV steelhead, CV spring-run Chinook salmon, and SR winter-run Chinook salmon are expected to travel through the area after departing their natal tributaries from February through June for steelhead, and approximately November through May for CV spring-run Chinook salmon. This timing overlaps with the spring rainfall season and therefore the expected timing of outfall operation and discharges. It is assumed that some level of exposure to the area where the stormwater is entering the water will occur by a small portion of individuals by all species. During storm events when water is being discharged from the outfalls, plunging water will be entering into the American River and may interact with fish causing potential for temporary disorientation. This disorientation is likely to occur to a very small portion of fish, as the American River is a very large river, and the outfalls are not located within the thalweg of the river. Those fish would have the opportunity to move to adjacent habitat, and this behavioral change is not expected to affect their ability to feed or shelter.

Water quality of stormwater discharge is regulated by the NPDES permitting system, which is implemented through the SWRCB issuance of Clean Water Act 401 certification that stipulates limits on some aquatic life criteria. The water being discharged through these outfalls is also already treated by the City of Sacramento prior to being discharged into the American River. While treatment does not remove all the concerns of toxins such as: fertilizers, herbicides, insecticides, and sediments (landscaping/agriculture); oil, grease, polyaromatic hydrocarbons

(PAHs), and other toxic compounds from motor vehicle operations (roads and parking lots); pathogens, bacteria, and nutrients (pet/dairy wastes, faulty septic systems); toxic metals and metalloid like aluminum, arsenic, copper, chromium, lead, mercury, nickel, and zinc (from building decay, manufacturing or industry byproducts); and the atmospheric deposition onto impervious surfaces from other surrounding land uses (manufacturing industry, freight and trucking exhaust, agriculture field treatments), it does significantly alleviate the addition of many of the pollutants into the water. In summary, the continued discharge of treated stormwater from these locations is not expected to have an adverse effect on juvenile salmonids as they exit the American River.

2.4.5. Effects to Designated Critical Habitat

Critical habitat has been designated within the action area for spring-run Chinook salmon and steelhead. The general PBFs of critical habitat within the action area are rearing and migratory corridors.

Placement of Riprap

The continual input of riprap into the American rivers will permanently alter critical habitat in the system. Garland et al. (2002) found that juvenile salmonids are significantly less likely to be found in riprap habitats versus unaltered habitats. The study found that as substrate size decreased, likelihood of fish presence increased (until reaching sand substrate). Placement of riprap is expected to adversely affect the value of freshwater migratory and rearing habitat PBFs for juvenile salmonids and reduce the amount of useable rearing habitat. Instream rock placement will cause impacts to rearing habitat quality from reduced abundance of benthic aquatic macroinvertebrates within the footprint of the repairs, due to the placement of rock over the existing streambed. Increased sediment size also creates more habitat for predators to hide and ambush prey from, causing an increase in juvenile predation. These effects to aquatic macroinvertebrates are expected to be long-term as permanent bank armoring alters the natural streambed (USFWS, 2004). The PBFs for rearing and migration available for adult and juvenile salmonids in the action area is therefore expected to be permanently decreased (habitat quantity and quality) by 40 square feet (less than 0.01 acre) where submerged riprap is placed.

Toxic Substance Spills/Leakage

Operation of power equipment, such as an excavator, in or near aquatic environments increases the potential for toxic substances to enter the aquatic environment and have negative effects on ESA-listed anadromous fish species and designated critical habitat (Feist et al. 2011). Spills of toxic substances could negatively affect the freshwater migratory corridor and freshwater rearing habitat PBFs.

Equipment refueling, fluid leakage, and maintenance activities within and near the stream channel pose some risk of contamination and potential impacts to listed fish species. The proposed action does describe a spill prevention plan but does not elaborate well on daily inspections of all heavy equipment for leaks. Without a well-developed spill prevention plans or daily inspections, the likelihood of spills resulting in adverse effects are considered higher as they would be less likely to be caught early before aquatic impacts would be caused. For these

reasons, we assume a small amount from leaking equipment would occur, outside of flowing water.

Loss of Riparian Habitat Functions and Vegetation

During the development of the NMFS 2014 Recovery Plan, loss of riparian habitat and instream cover was identified as a primary stressor affecting the recovery of the species. This threat primarily affects the PBFs of juvenile rearing and outmigration of these species, from the upper reaches of their watershed of origin through the Delta.

Woody debris and overhanging vegetation within shaded riverine aquatic habitat provide escape cover for juvenile salmonids from predators as well as thermal refugia. Aquatic invertebrates are dependent on the organic material provided be a healthy riparian habitat and many terrestrial invertebrates also depend on this habitat. Studies by CDFW as reported in NMFS (National Marine Fisheries Service 1997) demonstrated that a significant portion of juvenile Chinook salmon diet is composed of terrestrial insects, particularly aphids which are dependent on riparian habitat.

The proposed action will remove and reduce a small portion of riparian habitat within designated critical habitat for spring-run Chinook and salmon steelhead in the action area. While not all habitat within the action area will be disturbed during project activities, the majority will be at least temporarily disturbed or permanently impacted. These modifications to designated critical habitat are expected to reduce the PBFs of rearing habitat (reduced quantity and quality, increased predation, reduced cover, and reduced benthic invertebrate production), and will also adversely affect the PBFs of migratory habitat by decreasing the habitat quality. The project will continue to reduce the ability of the natural riparian habitat to regrow within the area where the gunite is being replaced with riprap, prolonging the reduction of the rearing and migratory habitat PBFs within the area.

Degradation of rearing and migratory corridor PBFs of critical habitat will occur, resulting from riparian habitat loss within the entirety of the action area. As the action area is a small section of aquatic habitat (40 square feet), though the PBFs will continue to be reduced within that area, the construction is highly unlikely to be an effect that would be measureable within the surrounding habitat.

Increased Mobilization of Sediment

Proposed activities have the potential to temporarily increase turbidity and suspended sediment levels within the project work site and downstream areas. The re-suspension and deposition of instream sediments are expected to occur from construction equipment and rock entering the river. The deposition of sediment is expected to temporarily reduce food availability and feeding efficiency due to the natural substrate being coated with a new layer of sediment. Short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact rearing habitat PBFs temporarily through reduced availability of food and reduced feeding efficiency. Short-term increases in turbidity and suspended sediment will also disrupt the ability of rearing habitat to support feeding fish resulting in avoidance or displacement from preferred habitat.

Incorporation of the use of a turbidity curtain as proposed is expected to minimize the extent of adverse effects to critical habitat PBFs to a minimal level. While small increases in turbidity may cause some short-term, localized disturbances to habitat, it is not expected to cause any long-term impacts to habitat.

Effects of Other Activities to Critical Habitat

Direct pollutants in stormwater runoff from the outfall will add to, and compound with, other pollutants already present in the water in ways that adversely affect the amount of food available for juvenile salmonids by injuring or killing their prey, thus reducing the amount of energy available to meet the physiological demands of rearing and migration. As the water from the outfalls is being treated before being release into the American, this effect is expected to be minimal.

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 and 402.17(a)). 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.

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 2.4).

2.5.1. Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill multiple life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5% of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid reproductive success and survival rates (Daughton 2002; Dubrovsky et al. 1998).

2.5.2. Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1 million late fall-run Chinook salmon, 0.25 million winter-run Chinook salmon, and 2 million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habitats that have already been permanently lost as a result of dam construction. The loss of this available habitat resulted in dramatic reductions in natural population abundance, which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations.

The high level of hatchery production in the CV can result in high harvest-to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations, which is an issue in the American River. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fishes, predation of hatchery fishes on wild fishes, and increased fishing pressure on wild stocks as a result of hatchery production.

Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler et al. 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.5.3. Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the action area. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the

invertebrate forage base required for the survival of juvenile salmonids moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.5.4. Global Climate Change

The world is about 1.3°F warmer today than a century ago, the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide, and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2ºC and +7ºC by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Stewart 2005), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the CV from a spring and summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal

tolerances for juvenile and adult salmonids (*i.e.* winter-run Chinook salmon and steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.

2.5.5. Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the American River watershed. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the proposed action.

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 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

In order to estimate the risk to steelhead, spring-run Chinook salmon, and winter-run Chinook salmon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is summarized in the *Status of the Species* section of this opinion. We then consider how the populations in the action area are affected by the proposed action, as described in the *Environmental Baseline* section. Effects on individuals are summarized, and the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

2.6.1. Summary of the Environmental Baseline and Cumulative Effects

Salmon and steelhead use the action area as an upstream and downstream migration corridor and for rearing. Within the action area, the essential features of freshwater rearing and migration habitats for salmon and steelhead have been transformed from a meandering waterway lined with a dense riparian vegetation, to a highly leveed system under varying degrees of constraint of riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the American River. Severe long-term riparian vegetation losses have occurred in this part of the river, and there are large open gaps without the presence of these essential features due to the high amount of riprap. The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation, contribution from the riparian vegetation into the aquatic system, and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon and steelhead in the action area.

The *Cumulative Effects* section of this biological opinion describes how continuing and future effects, such as the discharge of point and non-point source chemical contaminant discharges, aquaculture and hatcheries, increased urbanization, and increased installation of rock revetment affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

2.6.2. Summary of Effects of the Proposed Action

The proposed action is expected to adversely affect low numbers of adult of juvenile salmonids through the degradation of PBFs of critical habitat. Placement of riprap is expected to adversely affect the value of freshwater migratory and rearing habitat PBFs for juvenile salmonids and reduce the amount of useable rearing habitat. Instream rock placement will cause impacts to rearing habitat quality from reduced abundance of benthic aquatic macroinvertebrates within the footprint of the repairs, due to the placement of rock over the existing streambed. Increased sediment size also creates more habitat for predators to hide and ambush prey from, causing an increase in juvenile predation. These effects to aquatic macroinvertebrates are expected to be long-term as permanent bank armoring alters the natural streambed (USFWS, 2004). The PBFs for rearing and migration available for adult and juvenile salmonids in the action area is therefore expected to be permanently decreased (habitat quantity and quality) by 40 square feet (less than 0.01 acre) where submerged riprap is placed.

2.6.3. Summary of the Status of the Species and Critical Habitat

In our *Rangewide Status of the Species* section, NMFS summarized the current status and likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA. These factors include past and present human activities, climatological trends, and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover.

Summary of the Sacramento River winter-run Chinook salmon

Best available information indicates that the Sacramento River winter-run Chinook salmon ESU remains at a high risk of extinction. Key factors upon which this conclusion is based include: (1) the ESU is composed of only one population, which has been blocked from its entire historic spawning habitat; and (2) the ESU has a risk associated with catastrophes, especially considering the remaining population's dependency on the cold-water management of Shasta Reservoir (Lindley et al. 2007). The most recent 5-Year Status Review for winter-run Chinook salmon demonstrated that the ESU had further declined, and that continued loss of historical habitat and the degradation of remaining habitat continue to be major threats (NMFS 2016a). NMFS concludes that the Sacramento River winter-run Chinook salmon ESU remains at high risk of extinction.

The Sacramento River winter-run Chinook Salmon ESU was first listed as threatened in 1989 under an emergency rule. In 1994, NMFS reclassified the ESU as an endangered species. This

ESU is also listed as "endangered" under the State of California's endangered species law (California Endangered Species Act or CESA). Currently, there is only one population, spawning downstream of Keswick Dam, making this species particularly vulnerable to environmental pressures. This vulnerability manifested during the recent drought when warm water releases from Shasta Reservoir contributed to egg-to-fry mortality rates of 85% in 2013, 94% in 2014, and 96% in 2015, the highest levels since estimates of that statistic began in 1996. Mortality decreased after the drought ended (76% and 56% mortality in 2016 and 2017, respectively), but the recovery criteria for this species, as written in the Central Valley Salmon and Steelhead Recovery Plan (National Marine Fisheries Service 2014), include re-establishing populations into historical habitats in Battle Creek and upstream of Shasta Dam to reduce extinction risk due to compromised spatial structure.

The progeny of a captive broodstock from Livingston Stone National Fish Hatchery were reintroduced to Battle Creek in 2017 and 2018 (U.S. Fish and Wildlife Service 2018). This "Jumpstart Project" is expected to continue until a "Transition Plan" is developed that merges the Jumpstart Project with the Reinitiation Plan (U.S. Fish and Wildlife Service 2018). The watershed currently has limited capacity to support a winter-run Chinook salmon population due to effects of a non-federal hydropower facility on habitat quantity and quality. However, Reclamation proposes a commitment of $14 million over ten years to accelerate the implementation of the Battle Creek Salmon and Steelhead Restoration Project. This project and Reclamation's commitments are expected to reestablish approximately 42 miles of prime salmon and steelhead habitat on the creek and another 6 miles on its tributaries. NMFS expects that this effort will support a second spawning population, improving the spatial structure of the ESU as anticipated in the recovery plan.

Summary of the Central Valley Spring-run Chinook Salmon

NMFS listed the CV spring-run Chinook salmon ESU as a threatened species in 1999 and reaffirmed the species' status in 2005 and 2016. The Central Valley technical recovery team estimated that there were once 18 or 19 independent populations along with a number of dependent populations within four distinct diversity groups: the northwestern California diversity group, the basalt and porous lava diversity group, the northern Sierra Nevada diversity group, and the southern Sierra Nevada diversity group (Lindley et al. 2004). The latter is no longer a functioning diversity group, but each one of the diversity groups supported multiple spring-run Chinook salmon populations historically, spreading risk within and among several Central Valley ecotypes.

Major concerns for this ESU are low numbers, poor spatial structure, and low diversity. At this time, demographically independent populations persist only in the northern Sierra Nevada diversity group (Mill, Deer, and Butte creeks, which are tributaries to the upper Sacramento River) (National Marine Fisheries Service 2014).

(National Marine Fisheries Service 2016a) concluded that run sizes are declining over time in most of the CV spring-run Chinook salmon populations. Exceptions are the populations in Clear Creek, Battle Creek, and Butte Creek, which have seen recent growth. In particular, the number of spawners in the Battle Creek population, which was extirpated for decades, has increased 18% over the last decade and is trending towards a low to moderate risk of extinction. The population

in Clear Creek has been increasing and is composed mostly of natural-origin fish, although (Lindley et al. 2004) classified this population as a dependent population (not expected to exceed the low-risk population size threshold of 2,500 fish). The Butte Creek spring-run Chinook salmon population has increased in part due to extensive habitat restoration and the accessibility of floodplain habitat in the Sutter-Butte Bypass for juvenile rearing in most years (Williams et al. 2016).

Based on the severity of the recent drought and the low escapements, as well as increased pre-spawn mortality in Butte, Mill, and Deer creeks in 2015, these CV spring-run Chinook salmon strongholds could deteriorate into high extinction risk in the coming years based on the population size or rate of decline criteria (National Marine Fisheries Service 2016a). This predicted trend was validated in recent years through escapement data collected by CDFW for Mill and Deer creeks (California Department of Fish and Wildlife 2019). With adult returns below 500 individuals for the fourth consecutive year (2015-2018), these populations are at an increased risk of extinction (Lindley et al. 2007b).

The recovery plan (National Marine Fisheries Service 2014) listed a number of threats to the recovery of the Central Valley spring-run Chinook salmon ESU. Of these, passage barriers at Keswick and Shasta dams that block access to historical habitat in the upper Sacramento River watershed and barriers on Deer and Mill creeks that impede passage to existing habitats are ranked as very high stressors. The loss of rearing habitat in the lower and middle sections of the Sacramento River and the Delta and entrainment and predation in the Delta are also described as highly ranked stressors that are affected by the proposed action. Other threats include, but are not limited to, operation of antiquated fish screens, fish ladders, and diversion dams; inadequate flows; and levee construction and maintenance projects that have greatly simplified riverine habitat and disconnected rivers from the floodplain (National Marine Fisheries Service 2016a). The effects of the proposed action on individuals from this ESU include the reduction in quality of rearing habitat in the lower and middle sections of the Sacramento River resulting in increased predation.

Summary of Central Valley Spring-run Chinook Salmon Designated Critical Habitat

The geographical range of designated critical habitat for 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 downstream to the Delta, as well as portions of the northern Delta ((70 FR 52488 2005); September 2, 2005).

The proposed action area (the Lower American River) is within the designated critical habitat for CV spring-run Chinook salmon. While there is no spawning population within the American River, it is used as rearing, migratory, and holding habitat.

Critical habitat for CV spring-Chinook salmon is highly degraded due to the effects of past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of physical and biological features and slow or limit development of these features, although restoration actions will counteract these effects to some degree. Climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of

flood flows, overall drier conditions, and altered estuarine habitats. Proposed water management actions are expected to reduce some of these impacts by increasing water storage that can be released during summer months.

Summary of California Central Valley Steelhead DPS

NMFS listed the CCV steelhead DPS as a threatened species in 1998 and reaffirmed the species' status in 2005 and 2016. Before dam construction, water development, and other watershed perturbations, steelhead were found from the upper Sacramento and Pit rivers (now inaccessible due to Shasta and Keswick dams) south to the Kings and possibly the Kern River systems, and in both east- and west-side Sacramento River tributaries (National Marine Fisheries Service 2014). There may have been at least 81 independent populations, distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin rivers. Currently, steelhead spawn in the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, and Tuolumne rivers and tributaries, including Cottonwood, Antelope, Deer, Clear, Mill, and Battle creeks. Spawning likely occurs in other streams, but the lack of a comprehensive Central Valley steelhead monitoring program makes the amount and extent of spawning difficult to know. Major concerns across the range include passage impediments and barriers, warm water temperatures for rearing, hatchery effects, limited quantity and quality of rearing habitat, predation, and entrainment.

Many watersheds in the Central Valley are experiencing decreased abundance of steelhead (National Marine Fisheries Service 2016d). Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting the DPS as observers have reported unclipped (naturally produced) steelhead in recent years. However, adult numbers are still low, a large percentage of the historical spawning and rearing habitat is lost or degraded, and smolt production is dominated by hatchery fish. Many planned restoration and reintroduction efforts have yet to be implemented or completed. Most natural-origin steelhead populations 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 and drought (National Marine Fisheries Service 2016d).

Summary of California Central Valley Steelhead Designated Critical Habitat

The geographical extent of designated critical habitat includes, but is not limited to, the following: Sacramento, Feather, and Yuba rivers; Clear, Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries; and the waterways of the Delta. The PBFs for CCV steelhead critical habitat include (1) freshwater spawning sites, (2) freshwater migratory corridors, (3) freshwater rearing sites, and (4) estuarine habitat.

Critical habitat for steelhead in the American River is highly degraded, due to the effects of past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of physical and biological features and slow or limit development of these features, with the exception of restoration actions, which may counteract these effects to some degree.

2.6.4. Synthesis

Project Effects to Species ESUs/DPSs as a Whole

The effects of the proposed action is expected to exacerbate stressors/threats to spring-run Chinook salmon, winter-run Chinook salmon, and steelhead. Through on-site revegetation, these impacts are expected to be minimized. With the nature and potential duration of the effects, we expect the proposed action to temporarily reduce the productivity of small a portion of each species during construction exposed to a project site and for the first few years as re-vegetation occurs. However, at the ESU/DPS level, the proposed action is not expected to reduce appreciably the likelihood of both the survival and recovery of the listed species.

Currently the CCV steelhead DPS is at moderate risk of extinction (National Marine Fisheries Service 2016d). However, there is considerable uncertainty with regard to the magnitude of that risk, due in large part to the general lack of information and uncertainty regarding the status of many of its populations. Here, the combined risk to individual populations is evaluated to determine the risk to the DPS as a whole.

As described above, the risk to steelhead posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the proposed action and are also reasonably certain to occur. The action area is within the migratory corridor and rearing habitat that is used by both adults and juvenile CCV steelhead, upstream of the action area is spawning habitat as well. The permanent replacement of the outfall structure with rock will continue the lack of the riparian habitat on that bank and throughout the Lower American River overall.

The action area is the migratory corridor and rearing habitat that is used by both adults and juveniles CV spring-run Chinook salmon.

NMFS salmonid Recovery Plan (National Marine Fisheries Service 2014) included at least one element of the proposed action that are aligned with or directly implement recovery actions identified in the recovery plan. Examples include, but are not limited to:

- Implement projects that promote native riparian (*e.g.*, willows) species including eradication projects for nonnative species (*e.g.*, Arundo, tamarisk).

Because the winter-run Chinook salmon ESU is composed of one population, the effects of, and risks associated with, the proposed action at the population level also represent the risks at the ESU level. As the single population is within the Sacramento River, any reduction in habitat quality can be highly detrimental. The action area is not within winter-run critical habitat, but is in an area used as rearing habitat by the species. Any loss of quality to this habitat that effects other species of salmonids in the area (steelhead or spring-run Chinook), will be expected to have similar effects rearing to winter-run as well.

Project Effects on Critical Habitat at the Designation Level

Within the action area, the general relevant PBFs of the designated critical habitat for listed salmonids are spawning habitat, migratory corridors, and rearing habitat.

The proposed action is likely to affect a small portion of the migration and rearing habitat within designated critical habitat for CV spring-run Chinook salmon and CCV steelhead. Although NMFS expects implementation of the proposed action will result in temporary diminished function of PBFs related to rearing and migration within designated critical habitat in the action area, the proposed conservation measures are expected to minimize diminished habitat function within the action area such that, on the whole, the function of physical and biological features of critical habitat will not be appreciably reduced.

Although the proposed action is expected to temporarily reduce the quality of 0.01 acres of habitat for rearing and migrating juvenile salmonids, it is not expected to appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

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, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and California Central Valley steelhead or destroy or adversely modify designated critical habitat for spring-run Chinook salmon or 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 ITS.

2.8.1. Amount or Extent of Take

In the biological opinion, NMFS determined that implementation of the proposed action is reasonably certain to result in the incidental take of individual juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Incidental take associated with the proposed action is expected to be in the form of mortality, harm, or harassment of a small number of individuals of the identified life stages of these species as they migrate through the action area. NMFS does not anticipate the incidental take of any spawning fish, or the eggs, fry, or larval life stages of any of the listed species considered in this opinion.

It is not possible to quantify or track the amount or number of individual listed fish that are expected to be incidentally taken per species as a result of the proposed action, due to the variability associated with the response of listed species to the effects of the action, the varying population size of each species, annual variations in the timing of migration, uncertainties regarding individual habitat use within the action area, and difficulty in observing injured or dead fish. However, it is possible to estimate the extent of incidental take by designating the following ecological surrogates that are practical to quantify and monitor to determine the extent of incidental take that is occurring:

1. Take in the form of harm to rearing and migrating juveniles is expected within the 0.01 acres project footprint for areas being permanently impacted by rock placement within the channel. The ecological surrogate is based on the amount of rock placement being used to cover the original substrate that was there prior to the proposed action. This is expected to result in injury or death to a small number of juvenile fish in the action area where placement is occurring below the waterline. Incidental take to rearing juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead will be limited to a total habitat impact of 0.01 acres. Therefore, incidental take will be exceeded if total permanent impacts exceed 0.01 acres.

2. Take in the form of harm to juvenile and adult salmonids is expected within the project footprint from toxic substance spills. This is expected to result in injury or death to a small number of juvenile and/or adult fish in the action area where construction is occurring near or below the waterline. Incidental take to rearing juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead will be limited to the area contained within the turbidity curtain, which is expected to contain the 0.01 acres of salmonid habitat impact plus a reasonable buffer. Therefore, incidental take will be exceeded if any take occurs from toxic substance spills outside of the turbidity curtain.

2.8.2. Effect of the Take

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

2.8.3. Reasonable and Prudent Measures

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

The following RPMs are necessary and appropriate to minimize the impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead:

1. Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the biological assessment (BA) and this biological opinion.

2. Measures shall be taken to monitor incidental take of listed fish and provide all necessary reporting of repair status.

2.8.4. Terms and Conditions

The Corps or any applicant must comply with the terms and conditions described below in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (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: *"Measures shall be taken to ensure that contractors, construction workers, and all other parties involved with these projects implement the projects as proposed in the BA and this BO"*:

    a) The Corps shall provide a copy of this biological opinion and the BA, or similar documentation, but specifically emphasizing the proposed avoidance and minimization measures and Terms and Conditions, to the prime contractor. The prime contractor shall be responsible for implementing all applicable requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirements of the BA and this BO. A notification that all contractors have been supplied with this information shall be provided to the reporting address below.

    b) A well-developed hazardous materials and spill prevention plan shall be provided to all onsite workers to ensure any potential risk for contamination of aquatic habitat is minimized. The plan shall be submitted to NMFS within 30 days prior to starting construction activities.

    c) A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to federally listed fish, their critical habitat, an overview of the life history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the conservations measures in the BA, and relevant terms and conditions of this BO. Written documentation of the training shall be submitted to NMFS within 30 days of the completion of training.

2. The following terms and conditions implement reasonable and prudent measure 2: *"Measures shall be taken to monitor incidental take of listed fish and all necessary reporting of repair status."*

    a) The Corps shall provide to NMFS a report on the incorporation of the proposed avoidance and minimization measures and Terms and Conditions no later than December 31st of that year the measures were used.

b) The Corps shall submit a report to NMFS of any incidental take that occurs as part of the project. This report shall be submitted within 48 hours of take occurring.

c) All reports for NMFS shall be sent to:

Cathy Marcinkevage
California Central Valley Office
National Marine Fisheries Service
ccvo.consultationrequests@noaa.gov (email is 1st preference)
650 Capitol Mall, Suite 5-100
Sacramento California 95814
FAX: (916) 930-3629
Phone: (916) 930-3600

2.9. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.

2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair-in-place actions should pursue landside levee repairs instead of waterside repairs.

3. The Corps should use all of their authorities, to the maximum extent feasible to implement high-priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High-priority actions related to flood management include setting levees back from riverbanks, increasing the amount and extent of riparian vegetation along reaches of the Sacramento River Flood Control Project.

2.10. Reinitiation of Consultation

This concludes formal consultation for the City of Sacramento Pump Outfalls Replacement Project.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service 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 ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological

opinion, 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 Response

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA , EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). 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) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plan developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The geographic extent of freshwater EFH is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014). In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed project occurs in the area identified as "freshwater EFH", as it is above the tidal influence where the salinity is below 0.5 parts per thousand.

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine

and estuarine SAV. HAPCs that occur within the proposed project area are (1) complex channels and floodplains, and (2) thermal refugia.

3.2. Adverse Effects on Essential Fish Habitat

The proposed action is considered to have multiple activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). The following aspects of the proposed action are expected to have adverse effects on the freshwater EFH in the action area of the project:

1) Bank Stabilization and Protection – The proposed project has components that will entail bank stabilization and protection activities in the action area which includes freshwater EFH. These activities include placement of rock armoring and removal of riparian vegetation. The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. These activities are expected to adversely affect HAPCs for (1) complex channels and floodplains, and (2) thermal refugia.

3.3. Essential Fish Habitat Conservation Recommendations

The Corps should implement the following conservation measures to minimize the adverse effects described in section 3.2 above. In order to avoid or minimize the effects to HAPCs (1) and (2) described above, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP:

1) *Bank Stabilization and Protection*

- Minimize the loss of riparian habitats as much as possible.
- Re-vegetate sites to resemble the natural ecosystem community.
- Replace in-stream fish habitat by providing root wads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
- Promote restoration of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands and invasive species management.

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

3.4. Statutory Response Requirements

As required by section 305(b)(4)(B) of the MSA, the Corps 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 the measures proposed by the agency for avoiding,

minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

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

3.5. Supplemental Consultation

The Corps 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. Data Quality Act Documentation and Pre-Dissemination Review

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the City of Sacramento Department of Utilities. Individual copies of this opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2. 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.

4.3. 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 part 600.

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

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

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

5. REFERENCES

Federal Register Cited

FR 52488. September 2, 2005. Final Rule: Endangered and Threatened Species: Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Federal Register, Volume 70, pp. 52487- 52627.

70 FR 37160-37204. June 28, 2005. Final Rule: Endangered and Threatened Species: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Federal Register, Volume 70:37160-37204.

Literature Cited

Alabaster JS, Lloyd R. 1980 Water Quality Criteria for Freshwater Fish. Butterworths, London.

Beckman, B. R., B. Gadberry, P. Parkins, K. L. Cooper, and K. D. Arkush. 2007. State-Dependent Life History Plasticity in Sacramento River Winter-Urn Chinook Salmon (Oncorhynchus Tshawytscha): Interactions among Photoperiod and Growth Modulate Smolting and Early Male Maturation. Canadian Journal of Fisheries and Aquatic Sciences, 64:256-271.

Berg, L. and Northcote, T.G., 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (Oncorhynchus kisutch) following short-term pulses of suspended sediment. Canadian journal of fisheries and aquatic sciences, 42(8):1410-1417.

Bisson, P.A. and Bilby, R.E., 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management, 2(4):371-374.

Bjornn, T.C. and Reiser, D.W., 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication, 19(837):138.

Brice, J., 1977. Lateral migration of the middle Sacramento River, California (Vol. 77, No. 43). US Geological Survey, Water Resources Division.

California Department of Fish and Wildlife. 2018. GrandTab, unpublished data. CDFGs California Central Valley Chinook Population Database Report.

California Department of Fish and Wildlife. 2018. Unpublished data - Fish Salvage website. Available at: ftp://ftp.dfg.ca.gov/salvage/

Daughton, C. G. 2002. Cradle-to-Cradle Stewardship of Drugs for Minimizing Their Environmental Disposition While Promoting Human Health. Rationale for and Avenues toward a Green Pharmacy. Environmental Health Perspectives, 111(5):757-774.

Dettinger, M.D., D.R. Cayan, M.K. Meyer, and A.E. Jeton. 2004. Simulated hydrological responses to climate variations and changes in the Merced, Carson, and American River basins, Sierra Nevada, California, 1900-2099. Climatic Change, 62:283-317.

Dubrovsky, N. M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water Quality in the Sacramento River Basin. U.S. Geological Survey Circular 1215. United States Geological Survey.

Feist, B.E., Buhle, E.R., Arnold, P., Davis, J.W. and Scholz, N.L. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. PLoS One, 6(8), p.e23424.

Garland, R.D., Tiffan, K.F., Rondorf, D.W. and Clark, L.O. 2002. Comparison of subyearling fall Chinook salmon's use of riprap revetments and unaltered habitats in Lake Wallula of the Columbia River. North American Journal of Fisheries Management, 22(4):1283-1289.

Hayhoe, K.D. Cayan, C.B. Field, P.C. Frumhoff, E.P. Maurer, N.L. Miller, S.C. Moser, S.H. Schneider, K.N. Cahill, E.E. Cleland, L. Dale, R. Drapek, R.M. Hanemann, L.S. Kalkstein, J. Lenihan, C.K. Lunch, R.P. Neilson, S.C. Sheridan, and J.H. Verville. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America, 101(34):12422-12427.

Herren, J.R. and Kawasaki, S.S. 2001. Inventory of water diversions in four geographic areas in California's Central Valley. Fish bulletin, 179:343-355.

Huang, B. and Z. Liu. 2000. Temperature Trend of the Last 40 Years in the Upper Pacific Ocean. Journal of Climate, 4:3738–3750.

Intergovernmental Panel on Climate Change (IPCC). 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. 881 pages.

Lindley, S. T., R. S. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2004. Population Structure of Threatened and Endangered Chinook Salmon Esus in California's Central Valley Basin. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-360.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science, 5(1):26.

Lloyd, D.S. 1987. Turbidity As a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management, 7:34–45.

Moyle, P.B. 2002. Inland fish of California, 2nd edition. University of California Press, Berkeley, California.

National Marine Fisheries Service (NMFS). 1996. Factors for decline: a supplement to the notice of determination for West Coast steelhead under the Endangered Species Act. NMFS, Protected Species Branch, Portland, Oregon and NMFS, Protected Species Management Division, Long Beach, California.

National Marine Fisheries Service (NMFS). 2014. Central Valley Recovery Plan for Winter-Run Chinook Salmon, Central Valley Spring-Run Chinook Salmon and California Central Valley Steelhead. West Coast Region, Sacramento, CA. 427 pp.

National Marine Fisheries Service (NMFS). 2016a. California Central Valley Recovery Domain 5-year Status Review: Summary and Evaluation of Sacramento River Winter-run Chinook salmon Evolutionarily Significant Unit. U.S. Department of Commerce, NMFS West Coast Region, Sacramento, CA. 41 pages. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016-12-12_5-year_review_report_sac_r_winter-run_chinook_final.pdf.

National Marine Fisheries Service (NMFS). 2016b. Central Valley Recovery Domain 5-Year Status Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit. U.S. Department of Commerce, NMFS, West Coast Region, Sacramento, CA 41 pages. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cv-spring-run-chinook.pdf

National Marine Fisheries Service (NMFS). 2016c. Central Valley Recovery Domain 5-Year Status Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. U.S. Department of Commerce, NMFS, West Coast Region, Sacramento, CA 44 pages. http://www.westcoast.fisheries.noaa.gov/publications/status_reviews/salmon_steelhead/2016/2016_cv-steelhead.pdf

Newcombe, C.P. and Jensen, J.O. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management, 16(4):693-727.

Noakes, D. J. 1998. On the coherence of salmon abundance trends and environmental trends. North Pacific Anadromous Fishery Commission Bulletin, :454-463.

Northwest Power and Conservation Council (NPCC), 2003. Columbia River Basin Fish and Wildlife Program. Available at http://www.nwcouncil.org/library/2003/2003-20/default.htm.

Peterson, J. H. and J. F. Kitchell. 2001. Climate regimes and water temperature changes in the Columbia River: Bioenergetic implications for predators of juvenile salmon. Canadian Journal of Fisheries and Aquatic Sciences. 58:1831-1841.

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Popper, A.N. and Hastings, M.C., 2009. The effects of anthropogenic sources of sound on fishes. Journal of fish biology, 75(3):455-489.

Scriven, C., J. Sweeney, K. Sellheim, and J. Merz. 2018. Lower American River monitoring, 2018 steelhead (*Oncorhynchus mykiss*) spawning and stranding surveys. Central Valley Project, American River, California, Mid-Pacific Region. Cramer Fish Sciences, Sacramento, CA.

Servizi, J. A., and D. W. Martens. 1992. “Sublethal Responses of Coho Salmon (Oncorhynchus- Kisutch) to Suspended Sediments.” Canadian Journal of Fisheries and Aquatic Sciences 49(7):1389–1395.

Sigler, J. W., T. C. Bjournn, and F. H. Everest. 1984. “Effects of Chronic Turbidity on Density and Growth of Steelhead and Coho Salmon.” Trans. Am. Fish. Soc. 113: 142–150.

Slotte, A., Hansen, K., Dalen, J. and Ona, E., 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. Fisheries Research, 67(2):143-150.

Stachowicz, J. J., J. R. Terwin, R. B. Whitlatch, and R. W. Osman. 2002. Linking climate change and biological invasions: Ocean warming facilitates non-indigenous species invasions. PNAS, 99:15497–15500.

Stewart, I. T., D. R. Cayan, and M. D. Dettinger. 2005. Changes toward earlier streamflow timing across western North America. Journal of Climate, 18:,1136-1155.

The Bay Institute. 1998. From the Sierra to the Sea: The Ecological History of the San Francisco Bay-Delta Watershed, San Francisco.

Thompson, K. 1961. Riparian Forests of the Sacramento Valley, California. Pages 294–315 in R.S. Platt (ed.), Annals of the Association of American Geographers 51(3).

U.S. Army Corps of Engineers. 2012. Standard Assessment Methodology for the Sacramento River Bank Protection Project, 2010–2012 Certification Update, Final. Prepared for U.S. Army Corps of Engineers, Sacramento District by Stillwater Sciences, Berkeley, California. Contract W91238-09-P-0249 Task Order 3.

U.S. Army Corps of Engineers (Corps). 2021. Biological Assessment on the City of Sacramento Pump Outfalls Replacement Project: March 2021.

U.S. Fish and Wildlife Service (USFWS). 2004. Endangered Species Section 7 Consultation for the U.S. Army Corps of Engineers' Proposed Bank Protection, Under the Sacramento River Bank Protection Project, at River Mile 56.7 Left on the Lower Sacramento River. File Number 1-1-04-F-0237. August 18, 2004.

U.S. Fish and Wildlife Service (USFWS). 2018. Summary of Actions to Jumpstart the Reintroduction of Sacramento River Winter-run Chinook Salmon to Battle Creek, 2017 – 2018. August 2018.

U.S. Fish and Wildlife Service (USFWS). 2020. A plan to manage the Transition from the Jumpstart Project to the Winter-run Chinook Salmon Reintroduction Plan. April 2020.

Van Rheenen, N.T., A.W. Wood, R.N. Palmer, D.P. Lettenmaier. 2004. Potential implications of PCM climate change scenarios for Sacramento-San Joaquin river basin hydrology and water resources. Climate Change, 62:257-281.

Wardle, C.S., Carter, T.J., Urquhart, G.G., Johnstone, A.D.F., Ziolkowski, A.M., Hampson, G. and Mackie, D. 2001. Effects of seismic air guns on marine fish. Continental shelf research, 21(8-10):1005-1027.

Waters, T. F. 1995. “Sediment in Streams: Sources, Biological Effects, and Control.” American Fisheries Society, Monograph. 7.

Williams, T. H., et al. 2016. Viability Assessment for Pacific Salmon and Steelhead listed under the Endangered Species Act: Southwest. National Marine Fisheries Service: 1-53.

Windell, S., Brandes, P.L., Conrad, J.L., Ferguson, J.W., Goertler, P.A., Harvey, B.N., Heublein, J.C., Israel, J.A., Kratville, D.W., Kirsch, J.E. and Perry, R.W. 2017. Scientific framework for assessing factors influencing endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) across the life cycle.

70 FR 52488. 2005. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California. Pages 52488-52627 *in* National Marine Fisheries Service, editor. Office of the Federal Register.

Aasen, G. 2013. Chinook Salmon Loss Estimation for Skinner Delta Fish Protective Facility and Tracy Fish Collection Facility.4.

Alabaster, J. S., and R. Lloyd. 1980. Water Quality Criteria for Freshwater Fish. Butterworths London.

Beckman, B. R., B. Gadberry, P. Parkins, K. A. Cooper, and K. D. Arkush. 2007. State-dependent life history plasticity in Sacramento River winter-run chinook salmon (Oncorhynchus tshawytscha): interactions among photoperiod and growth modulate smolting and early male maturation. Canadian Journal of Fisheries and Aquatic Sciences 64(2):256-271.

Berg, L., and T. G. Northcote. 1985. Changes in Territorial, Gill-Flaring, and Feeding-Behavior in Juvenile Coho Salmon (Oncorhynchus-Kisutch) Following Short-Term Pulses of Suspended Sediment. Canadian Journal of Fisheries and Aquatic Sciences 42(8):1410-1417.

Bigler, B. S., D. W. Welch, and J. H. Helle. 1996. A review of size trends among North Pacific salmon (Oncorhynchus spp). Canadian Journal of Fisheries and Aquatic Sciences 53(2):455-465.

Bisson, P. A., and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile coho salmon. North American Journal of Fisheries Management 2(4):371-374.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19:83-138.

California Department of Fish and Wildlife. 2018. GrandTab Spreadsheet Chinook Salmon Escapement in the Central Valley. Fisheries Branch.

California Department of Fish and Wildlife. 2019. GrandTab Spreadsheet of Chinook Salmon Escapement in the Central Valley.

Cohen, S. J., K. A. Miller, A. F. Hamlet, and W. Avis. 2000. Climate change and resource management in the Columbia River basin. Water International 25(2):253-272.

Daughton, C. G. 2002. Cradle-to-Cradle Stewardship of Drugs for Minimizing Their Environmental Disposition While Promoting Human Health. Rationale for and Avenues toward a Green Pharmacy. Environmental Health Perspectives 111(5):757-774.

Dettinger, M. D., and D. R. Cayan. 1995. Large-Scale Atmospheric Forcing of Recent Trends toward Early Snowmelt Runoff in California. Journal of Climate 8(3):606-623.
Dubrovsky, N. M., and coauthors. 1998. Water quality in the Sacramento River basin. U.S. Geological Survey Circular 1215. United States Geological Survey, editor.
Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. Academic Press:393-411.
Klimley, A. P. 2002. Biological assessment of green sturgeon in the Sacramento-San Joaquin watershed. A proposal to the California Bay-Delta Authority.
Lindley, S. T., and coauthors. 2004. Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin. Pages 1-56 *in* U.S. Department of Commerce, editor.
Lindley, S. T., and coauthors. 2007a. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1):26.
Lindley, S. T., and coauthors. 2007b. Framework for assessing viability of threatened and endangered chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1):26pp.
Lloyd, D. S. 1987a. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management 7(1):34-45.
Lloyd, D. S. 1987b. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries Management Vol. 7(1):34–45.
McClure, M. 2011. Climate Change. Pages 307 *in* M. J. Ford, editor. Status Review update for Pacific Salmon and Steelhead listed under the ESA: Pacific Northwest., NMFS-NWFCS-113, 281 p.
McClure, M. M., and coauthors. 2013. Incorporating climate science in applications of the U.S. endangered species act for aquatic species. Conservation Biology 27(6):1222-33.
Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles.
National Marine Fisheries Service. 1997. NMFS Proposed Recovery Plan for the Sacramento River Winter-run Chinook Salmon. Pages 1-340 *in*, Long Beach, California.
National Marine Fisheries Service. 2014. Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. Pages 427 *in*. NMFS, Sacramento, California.
National Marine Fisheries Service. 2016a. 5-Year Review: Summary and Evaluation of Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit. Pages 41 *in* National Marine Fisheries Service, editor.
National Marine Fisheries Service. 2016b. 5-Year Review: Summary and Evaluation of the California Central Valley Steelhead Distinct Population Segment. Pages 43 *in* U.S. Department of Commerce, editor, West Coast Region.
National Marine Fisheries Service. 2016c. 5-Year Review: Summary and Evaluation of the Central Valley Spring-run Chinook Salmon Evolutionarily Significant Unit. Pages 41 *in* U.S. Department of Commerce, editor, West Coast Region.

National Marine Fisheries Service. 2016d. 5-Year Status Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. Pages 44 *in* Department of Commerce, editor, Sacramento, California.
National Marine Fisheries Service. 2016e. 5-Year Status Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon ESU. Pages 41 *in* U.S. Department of Commerce, editor, West Coast Region.
Newcombe, C. P., and J. O. T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management 16(4):693-727.
Northwest Power and Conservation Council (NPCC). 2003. Columbia River Basin Fish and Wildlife Program.
Reynolds, F. L., T. J. Mills, R. Benthin, and A. Low. 1993. Restoring Central Valley streams: a plan for action. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.
Servizi, J. A., and D. W. Martens. 1992. Sublethal Responses of Coho Salmon (Oncorhynchus-Kisutch) to Suspended Sediments. Canadian Journal of Fisheries and Aquatic Sciences 49(7):1389-1395.
Sigler, J. W., T. Bjornn, and F. H. Everest. 1984a. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113(2):142-150.
Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984b. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113(2):142-150.
The Bay Institute. 1998. From the Sierra to the Sea: The ecological history of the San Francisco Bay-Delta watershed, San Francisco.
Thompson, L. C., and coauthors. 2011. Water management adaptations to prevent loss of spring-run Chinook salmon in California under climate change. Journal of Water Resources Planning and Management 138(5):465-478.
U.S. Fish and Wildlife Service. 2018. Summary of Actions to Jumpstart the Reintroduction of Sacramento River Winter-run Chinook Salmon to Battle Creek, 2017 – 2018. Pages 47 *in* U.S. Fish and Wildlife Service, and Northern Central Valley Fish and Wildlife Office, editors., Red Bluff, California.
USFWS. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Anadromous Fish Restoration Program Core Groups for the U.S. Fish and Wildlife Service, Stockton, California.
Wade, A. A., and coauthors. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology 50(5):1093-1104.
Waters, T. F. 1995a. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society.
Waters, T. F. 1995b. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7.
Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4(3):416.
Williams, T. H., and coauthors. 2016. Viability Assessment for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Southwest. U. S. D. o. Commerce, editor.

Windell, S., and coauthors. 2017. Scientific Framework for Assessing Factors influencing Endangered Sacramento River Winter-run Chinook salmon (Oncorhynchus tshawytscha) Across the Life Cycle. Pages 57 *in* U.S. Department of Commerce, editor.