UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404-4731

October 16, 2020 **Refer to NMFS No:** WCRO-2020-01183

Cristin Hallissy
California Department of Transportation, District 4
P.O. Box 23660, MS-1A
Oakland, California 94623-0660

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the State Route 12 Bridge Scour Mitigation Project: Sonoma Creek and Hooker Creek Bridge Replacement (EA: 04-4H050)

Dear Ms. Hallissy:

On April 23, 2020, NOAA's National Marine Fisheries Service (NMFS) received the California Department of Transportation's (Caltrans) request for formal consultation under Section 7 of the U.S. Endangered Species Act of 1973 (ESA)(16 U.S.C. 1531 et seq.). That request concerns the Route 12 Scour Mitigation Project at Sonoma and Hooker Creeks. The proposed action is within the range of the threatened Central California Coast (CCC) Distinct Population Segment (DPS) of steelhead (*Oncorhynchus mykiss*) and designated critical habitat for the species. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

NMFS also received 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 (16 U.S.C. 1855(b)) for this action. NMFS has reviewed the proposed action for potential effects and determined that the proposed action would adversely affect EFH for Pacific Coast Salmon, which is managed under the Pacific Coast Salmon Fishery Management Plan. While the proposed action will result in adverse effects to EFH, the proposed action contains measures to minimize, mitigate, or otherwise offset the adverse effects; thus, no EFH Conservation Recommendations are included in this opinion.

The biological opinion concludes that the proposed action is not likely to jeopardize the continued existence of the threatened CCC DPS of steelhead or destroy or adversely modify its designated critical habitat. NMFS believes the proposed action is likely to result in incidental take of steelhead, therefore, the attached incidental take statement includes the amount and extent of anticipated incidental take with reasonable and prudent measures and non-discretionary terms and conditions to minimize and monitor incidental take of threatened steelhead.

Please contact Jess Adams at jessica.adams@noaa.gov or (562) 533-6813 if you have a question concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: Robert Blizard, Caltrans District 4, Oakland, CA (robert.blizard@dot.ca.gov)
John Wooster, NMFS, Santa Rosa, CA (john.wooster@noaa.gov)
Copy to E-File: ARN 151422WCR2020CC00109

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

State Route 12 Bridge Scour Mitigation Project: Sonoma Creek and Hooker Creek Bridge Replacement

NMFS Consultation Number: WCRO-2020-01183
Action Agency: California Department of Transportation

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 California Coast steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No

Essential Fish Habitat and NMFS' Determinations:

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	No

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: October 16, 2020

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1 INTRODUCTION

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

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (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.), and implementing regulations at 50 CFR 402, as amended.

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

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 NMFS' California Coastal Office, Southern California Branch in Long Beach, California.

1.2 Consultation History

On April 23, 2020, NMFS received from the California Department of Transportation (Caltrans) a written request for formal consultation under Section 7 of the ESA for the SR-12 Bridge Scour Mitigation Project at Sonoma and Hooker creeks. Caltrans' written request included the related biological assessment (BA) describing effects of the proposed action on the threatened Central California Coast Distinct Population Segment of steelhead (*Oncorhynchus mykiss*) and designated critical habitat for this species in Sonoma Creek and Hooker Creek. Also, Caltrans requested consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action. Because the description of the proposed action was insufficient, NMFS requested more information from Caltrans in a letter dated May 20, 2020. In addition, NMFS and Caltrans discussed possible alternatives to the bridge design at Hooker Creek including correcting the bridge skew to address the scour issue, or lengthening the bridge to prevent crowding of the creek, and incorporating large woody debris (LWD) and boulders to deflect the creek thalweg further upstream of the bridge crossing than proposed. On May 29, 2020, NMFS received Caltrans' letter responding to our letter dated May 20, 2020, with additional information, though their letter only addressed the proposed design changes regarding the LWD and boulders. Following further discussions with Caltrans, including clarification of the placement of the boulders and LWD and effects determination, consultation was initiated on June 22, 2020.

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).

1.3.1 Overview of Proposed Action

Caltrans proposes to replace the SR-12 bridges at Hooker Creek (Bridge No. 20-0030; PM 33.31) and Sonoma Creek (Bridge No. 20-0027; PM 25.82) with precast/pre-stressed full-span bridges. Channel design at Hooker Creek includes straightening the channel, moving the gravel bar, and armoring the left side of the channel with longitudinal-peaked-stone-toe protection (LPSTP). Construction will occur during three seasons, with instream construction being confined to June 1 to October 31 of a given year. One season is proposed for Hooker Creek and two seasons are proposed for Sonoma Creek. Best-management practices (BMP) are incorporated into the proposed action and will be implemented when bridge construction activities are undertaken.

1.3.2 Proposed Activities to Prepare the Work Area for Construction

To prepare for construction in dry conditions, the work areas will be temporarily isolated from surface flow and steelhead within the affected area will be relocated. The proposed action lacks a description of the protocols for capturing and relocating steelhead, including decision criteria for selecting relocation sites.

At Hooker Creek an approximately 140 feet reach will be dewatered (estimated 0.0573 acreas) using a temporary a cofferdam and diversion-pipe system, extending from 100-feet upstream of the bridge to about 6 feet downstream of the bridge. No pumps are proposed. Caltrans will access the in-channel work area near the southeast side of the bridge. Fifty-one trees may be removed, totaling 0.311 acres of temporary riparian impacts and 0.007 acres of permanent impacts due to installing the new guardrail. No falsework is proposed because the bridge deck will be placed on the abutments from the roadway. The cofferdams and pipes will be removed at the end of the construction season. Equipment to be used includes backhoes, excavators, concrete cutters, front loader, drill rig, cranes, pavement grinder, concrete mixer trucks and pump trucks, pavers, jackhammers, compaction equipment, asphalt-concrete paver, and roller.

At Sonoma Creek a temporary water-diversion system consisting of a gravel-bag cofferdam and a 48-inch-diameter pipe will be installed each construction season, dewatering a 90-foot reach of creek (estimated 0.056 acres). Caltrans will access the in-channel work area near the southeast corner of the bridge. Up to eight trees will be removed including five valley oaks (*Quercus lobata*) and three willow trees (*Salix spp.*) resulting in 0.091 acres temporary riparian impacts and 0.009 acres of permanent impacts. No falsework is proposed because the bridge deck will be placed on the abutments from the roadway. The diversion will be removed at the end of each construction season. Equipment to be used includes backhoes, excavators, concrete cutters, drill

rig, cranes, concrete mixer trucks and pump trucks, jackhammers, compaction equipment, asphalt-concrete paver, and roller.

The proposed action includes the following BMPs to minimize take of steelhead and adverse effects to critical habitat during capture-relocation and dewatering activities:

- A fish capture and relocation plan will be developed prior to construction and will be provided to NMFS for review and comment.
- Before beginning construction, Caltrans will conduct an education program for all project construction personnel that includes a description of CCC steelhead and their threatened status under the ESA.
- Prior to construction, a qualified biologist will survey the action area for steelhead.
- A Stormwater Pollution Prevention Plan will be developed and erosion control BMPs implemented to minimize wind and water-related erosion. At a minimum, protective measures will include the following:
    - Prohibit discharge of pollutants from vehicle and equipment cleaning into storm drains or watercourses.
    - Servicing vehicles and construction equipment, including fueling, cleaning, and maintenance, will occur at least 50 feet from aquatic habitat unless separated by a topographic or engineered drainage barrier.
    - Collect and dispose of concrete wastes and water from curing operations in appropriate washouts, located at least 50 feet from watercourses.
    - Maintain spill containment kits onsite at all times during construction operations, staging, and fueling of equipment.
    - Use water trucks and dust palliatives to control dust in unvegetated areas, and cover temporary stockpiles when weather conditions require.
    - Protect graded areas from erosion using a combination of silt fences and fiber rolls along toes of slopes or along edges of designated staging areas, and erosion control netting as appropriate on sloped areas.
    - Establish permanent erosion-control measures such as bio-filtration strips and swales to receive stormwater discharges from impervious surfaces to the maximum extent practicable.
- Certify that borrow material is non-toxic and weed free, to the maximum extent practicable.
- Materials and equipment will be stored at an approved location.
- Maintain equipment to prevent fluid leaks and develop a Spill Response Plan. Hazardous materials will be stored in sealable containers in a designated location at least 50 feet from aquatic habitats.
- Vegetation will be cleared only where necessary and will be cut above soil level except in areas that will be permanently affected or excavated. This will allow plants that reproduce vegetatively to re-sprout after construction. Clearing and grubbing of woody vegetation will occur by hand or mowers, backhoes, and excavators.

1.3.3 Proposed Construction Activities

At Hooker Creek, the bridge will be replaced with a wider, full span bridge. The new bridge will be 5.5-feet longer and 12-feet wider than the existing arch bridge. The new bridge will convey a greater maximum streamflow though no changes to water surface elevation or velocity are expected. The abutments will be made up of twelve 24-inch cast-in-drill-hole (CIDH) piles placed outside of the creek up to 25-feet deep and the bridge deck will be lowered on the piles by crane. The existing bridge will be removed to scour depth that will allow abandonment of the remaining existing bridge footings. The scour pool where the creek flows into the northern upstream abutment will be removed and the embankment footprint will be 5-feet wider on each side of the roadway than the existing bridge. Upstream of the bridge, 100 feet of Hooker Creek will be realigned to direct flow under the bridge centerline and reinforced with LPSTP.

Placed in the channel along the north bank, the LPSTP consists of a bioengineered system that involves placing a berm of stone in front of the creek bank. The area between the LPSTP and the existing bank will be backfilled with engineered-streambed material or native-stream material and soil to establish a floodplain bench. Woody riparian vegetation such as alder will be planted on the floodplain bench to stabilize the backfill and establish riparian habitat. The LPSTP will be 100-feet long, 4-feet high, and 8-feet across at a 1:1 slope. Three rootwads will be embedded into the LPSTP to provide instream habitat and to direct creek flow towards the center of the channel. Caltrans will also place LWD and boulders farther upstream of the bridge to aid in directing the flow to the center of the channel and to increase channel roughness. Material from the gravel bar across the channel from the LPSTP will be removed and used to backfill the space between the LPSTP and the existing north bank.

The realigned channel will have bottom width of 18-20 feet and bankfull width of 28-30 feet, and a floodplain bench ranging from 2 to 16-feet wide. The creek bed will be sloped at 5% toward the center of the channel to establish a low-flow channel. The existing thalweg length is 94.8 feet; the realigned length will be 82.3 feet. The habitat loss due to placement of the LPSTP is expected to be 348 ft^2 (0.008 acres), loss due to the filled floodplain bench will be 131 ft^2 (0.003 acres), and habitat gain due to the removal of the gravel bar will be 305 ft^2 (0.007 acres) of creek. Bridge construction will occur in one season – one month for the bridge, and the remaining season for realigning the creek and constructing the LPSTP.

At Sonoma Creek, the bridge will be replaced with a wider, full-span bridge and the existing pier will be completely removed. Removing the pier will result in 17 ft^2 (0.0004 acres) of critical habitat restored in the creek. The new bridge will be 9-feet wider than the existing bridge producing 305 ft^2 (0.007 acres) of increased shade over Sonoma Creek. The new design will result in water surface elevation reduction of 0.13 feet and 0.16 feet at 50- and 100-year discharges, respectively, and an average increase in cannel velocity of 0.5 fps at both flows. The abutments use CIDH piles placed outside of the creek and the bridge deck will be lowered on the piles by crane. Each side of the bridge will be replaced in stages to maintain traffic though the work area. Sixteen-foot wingwalls will be added to the corner of each bridge, parallel to the roadway. An additional wingwall segment will be installed on the upstream side of abutment one to deter future scour. The creek bed will be restored to adjacent grade and backfilled with

native creek bed material. Engineered creek bed material may be used if the availability of native material is insufficient. The sediment accumulation behind abutment two will be removed and may be reincorporated into the creek and channel banks. An additional 12 ft on both sides of the creek will be affected due to the wider bridge.

1.3.4 Proposed Post-Construction Activities

Caltrans will restore temporarily disturbed areas. Exposed slopes and bare ground will be reseeded with native grasses and shrubs to stabilize and prevent erosion. Where disturbance includes the removal of trees and woody shrubs, native species will be replanted, based on the local species composition.

After completion of the proposed action, all materials used to maintain flow and divert water from the work area during the construction period, including any cofferdams, pipe, filter fabric, and gravel, will be removed. All excess soil will be disposed at an approved upland site. Sonoma Creek will be revegetated after the second year of construction.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not.

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 ITS that specifies the impact of any incidental taking and includes non-discretionary 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 designation(s) of critical habitat for (species) use(s) 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 threatened steelhead 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.

2.2.1 Status of the Species

The threatened central California Coast (CCC) Distinct Population Segment (DPS) of steelhead includes steelhead in coastal California streams from the Russian River to Aptos Creek, and the drainages of Suisun Bay, San Pablo Bay, and San Francisco Bay. The decline of the species prompted listing of the CCC DPS of steelhead as threatened on January 5, 2006 (71 FR 834).

Historically, approximately 70 populations[1] of steelhead existed in the CCC steelhead DPS (Spence et al. 2008; Spence et al. 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt et al. 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McLeay et al. 1987; Bjorkstedt et al. 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in this DPS in the mid-1960s, including 50,000 fish in the Russian River - the largest population within the DPS (Busby et al. 1996). Near the end of the 20th century the population of wild CCC steelhead in the Russian River was estimated to be between 1,700- 7,000 fish (Busby et al. 1996; Good et al. 2005). Recent estimates for the Russian River population are unavailable. Abundance estimates for smaller coastal streams in the DPS indicate low population levels that are slowly declining, with recent estimates (2011/2012) for several streams (Redwood, Waddell, San Vicente, Soquel, and Aptos creeks) of individual run sizes of 50 fish or less.[2] Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt et al. 2005). Similar losses in genetic diversity in the Napa River may have resulted from out-of-basin and out-of-DPS releases of steelhead in the Napa River basin in the 1970s and 80s. These transfers included fish from the South Fork Eel River, San Lorenzo River, Mad River, Russian River, and the Sacramento River. In San Francisco Bay streams, reduced population sizes and fragmentation of habitat has likely also led to loss of genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see Busby et al. (1996); Good et al. (2005); Spence et al. (2008); Williams et al. (2011).

CCC steelhead have experienced dramatic declines in abundance and long-term population trends suggest a negative growth rate. This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead immigrants to support dependent

[1] Population as defined by McElhany et al. (2000); and Bjorkstedt et al. (2005) as, in brief summary, a group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group. Such fish groups may include more than one stream. These authors use this definition as a starting point from which they define four types of populations (not all of which are mentioned here).
[2] Nature Conservancy. 2013. California Salmon Snapshots. Date Accessed: May 30, 2014. http://www.casalmon.org/.

populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead remain present in most streams throughout the DPS, roughly approximating the known historical range, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid DPSs or ESUs in worse condition. In 2005, a status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good et al. 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

In the San Francisco Bay region (both Interior San Francisco Bay and Coastal San Francisco Bay strata) data for steelhead remain limited. Many of the populations in the Coastal San Francisco Bay and Interior San Francisco Bay diversity strata including Walnut Creek, San Pablo Creek, San Lorenzo Creek, Alameda Creek, and San Mateo Creek are likely at high risk of becoming endangered due to the loss of the majority of the historical spawning habitat behind impassible barriers, and the heavily urbanized nature of most of these watersheds downstream of barriers. More detailed information on trends in CCC steelhead abundance, can be found in Busby et al. (1996); Good et al. (2005); Spence et al. (2008); Williams et al. (2011); Spence et al. (2012); and Williams et al. (2016).

A 2008 viability assessment of CCC steelhead concluded that populations in watersheds that drain to San Francisco Bay are highly unlikely to be viable, and that the limited information available did not indicate that any other CCC steelhead populations could be demonstrated to be viable (Spence et al. 2008). Monitoring data from the last ten years of adult CCC steelhead returns in Lagunitas and Scott creeks show steep declines in adults in 2008/2009. The 2011 status update found that the status of the CCC steelhead DPS remains "likely to become endangered in the foreseeable future" (Williams et al. 2011), as new and additional information available since Good et al. (2005), does not appear to suggest a change in extinction risk. On December 7, 2011, NMFS chose to maintain the threatened status of the CCC steelhead (76 FR 76386). In the most recent status review, Williams et al. (2016) found that there is little evidence to suggest that the extinction risk for this DPS has changed appreciably in either direction since the publication of the last viability assessment (Williams et al. 2011). After reviewing the status reviews. NMFS made no change in the listing of CCC steelhead as a threatened species (81 FR 33468).

A final recovery plan for CCC steelhead was prepared by NMFS in October 2016 (NMFS 2016). The plan describes key threats, actions needed to achieve recovery, and measurable criteria by which NMFS will determine when recovery has been reached. Recovery plan actions are primarily designed to restore ecological processes that support healthy steelhead populations, and address the various activities that harm these processes and threaten the species' survival. The recovery plan calls for a range of actions including the restoration of floodplains and channel structure, restoring riparian conditions, improving stream flows, restoring fish passage, protecting and restoring estuarine habitat, among other actions.

NMFS cites many reasons (primarily anthropogenic) for the decline of steelhead (Busby et al. 1996). The foremost reason for the decline in these anadromous populations is the degradation and/or destruction of freshwater and estuarine habitat. Additional factors contributing to the decline of these populations include: commercial and recreational harvest, artificial propagation, natural stochastic events, marine mammal predation, and reduced marine-derived nutrient transport.

2.2.1.1 General Life History of Steelhead

O. mykiss possesses an exceedingly complex life history (Behnke 1992). Distinctly different than other Pacific salmon, steelhead adults can survive their first spawning and return to the ocean to reside until the next year to reproduce again. For returning adults, the specific timing of spawning can vary by a month or more among rivers or streams within a region, occurring in winter and early spring. The spawning time frames depend on physical factors such as the magnitude and duration of instream flows and sand-bar breaching. Once they reach their spawning grounds, females will use their caudal fin to excavate a nest (redd) in streambed gravels where they deposit their eggs. Males will then fertilize the eggs and, afterwards, the females cover the redd with a layer of gravel, where the embryos (alevins) incubate within the gravel. Hatching time can vary from approximately three weeks to two months depending on surrounding water temperature. The young fish (fry) emerge from the redd two to six weeks after hatching. As steelhead begin to mature, juveniles or "parr" will rear in freshwater streams anywhere from 1-3 years. Juvenile steelhead can also rear in seasonal coastal lagoons or estuaries of their natal creek, providing over-summering habitat.

Juvenile steelhead emigrate to the ocean (as smolts) usually in late winter and spring and grow to reach maturity at age 2-4, but steelhead can reside in the ocean for an additional 2-3 years before returning to spawn. The timing of emigration is influenced by a variety of parameters such as photoperiod, temperature, breaching of sandbars at the river's mouth and streamflow. Extended droughts can cause juveniles to become landlocked, unable to reach the ocean (Boughton et al. 2006).

Through studying the otolith (ear stone) microchemistry of *O. mykiss*, researchers further understand the complex and intricate life history of steelhead. Specifically, resident rainbow trout can produce steelhead progeny; likewise, steelhead can yield resident rainbow trout progeny (Zimmerman and Reeves 2000). Additionally, evidence indicates that sequestered populations of steelhead (e.g., above introduced migration barriers) can exhibit traits that are the same or similar to anadromous specimens with access to the ocean. Examples include inland resident fish exhibiting smolting characteristics and river systems producing smolts with no regular access for adult steelhead. This evidence suggests the ecological importance of the resident form to the viability of steelhead and the need to reconnect populations upstream and downstream of introduced migration barriers. The loss or reduction in anadromy and migration of juvenile steelhead to the estuary or ocean is expected to reduce gene flow, which strongly influences population diversity (McElhany et al. 2000).

2.2.1.2 Steelhead Habitat Requirements

Habitat requirements of steelhead generally depend on the life history stage. Steelhead encounter several distinct habitats during their life cycle. Water discharge, water temperature, and water chemistry must be appropriate for adult and juvenile migration. Suitable water depth and velocity, and substrate composition are the primary requirements for spawning. Furthermore, dissolved oxygen concentration, pH, and water temperature are factors affecting survival of incubating embryos. The presence of interspatial spaces between large substrate particle types is important for maintaining water-flow through the nest as well as dissolved oxygen levels within the nest. These spaces can become filled with fine sediment, sand, and other small particles. Additionally, juveniles need abundant food sources, including insects, crustaceans, and other small fish. Habitat must also provide places to hide from predators, such as under logs, root wads and boulders in the stream, and beneath overhanging vegetation. Steelhead also need places to seek refuge from periodic high-flow events (side channels and off channel areas), and may occasionally benefit from the availability of cold-water springs or seeps and deep pools during summer. Estuarine habitats can be utilized during the seaward migration of steelhead, as these habitats have been shown to be nurseries for steelhead. Estuarine or lagoon habitats can vary significantly in their physical characteristics from one another, but remain an important habitat requirement as physiology begins to change while juvenile steelhead become acclimated to a saltwater environment.

2.2.1.3 Influence of a Changing Climate on the Species

Impacts from global climate change are currently occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Milanes et al. 2018). Snow melt from the Sierra Nevada has declined, with an increasing amount of the precipitation falling as rain rather than snow (Milanes et al. 2018). California precipitation patterns have become more variable in recent decades, with increasingly drier conditions, and multiple years of severe to extreme drought (Milanes et al. 2018). Steelhead and designated critical habitat for this species may have already experienced detrimental impacts from climate change.

The threat to CCC steelhead from global climate change will increase in the future. Modeling of climate change impacts in California suggests that increases in average summer air temperatures are expected to continue (Lindley et al. 2007; Moser et al. 2012). Heat waves are expected to occur more often, and heat-wave temperatures are likely to be higher (Hayhoe et al. 2004; Moser et al. 2012). Total precipitation in California may decline; critically dry years may increase (Hayhoe et al. 2004; Lindley et al. 2007; Moser et al. 2012). Wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011; Moser et al. 2012). In the San Francisco Bay region, high temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue into September (Cayan et al. 2012). Interior portions of San Francisco Bay are projected to experience a threefold increase in the frequency of hot daytime and nighttime temperatures (heat waves) from the historical period (Cayan et al. 2012). Climate simulation models also project that the San Francisco region will maintain its Mediterranean climate regime, but experience a higher degree

of variability of annual precipitation during the next 50 years and years that are drier than the historical annual average during the middle and end of the twenty-first century. The greatest reduction in precipitation is projected to occur in March and April, with the core winter months remaining relatively unchanged (Cayan et al. 2012). For Northern California, most models project heavier and warmer precipitation. Extreme wet and dry periods are projected, increasing the risk of both flooding and droughts. Estimates show that snowmelt contribution to runoff in the Sacramento/San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern et al. 2011). Many of these changes are likely to further degrade steelhead habitat by, for example, reducing stream flows during the summer and raising summer water temperatures. Increasing water temperatures has recently been shown to increase the prevalence of blackspot infections in steelhead in Northern California (Schaaf et al. 2017). Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia et al. 2002; Ruggiero et al. 2010; Cloern et al. 2011). Cloern et al. (2011) estimated that the salinity in San Francisco Bay could increase by 0.30-0.45 practical salinity unit per decade due to the confounding effects of decreasing freshwater inflow and sea level rise. In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Feely et al. 2004; Brewer and Barry 2008; Osgood 2008; Turley 2008; Abdul-Aziz et al. 2011; Doney et al. 2011). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007; Santer et al. 2011).

2.2.2 Designated Critical Habitat

Critical habitat was designated for CCC steelhead on September 2, 2005 (70 FR 52488). For CCC steelhead, PBFs include estuarine areas free of obstruction and excessive predation with the following essential features: (1) water quality, water quantity and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (2) natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (3) juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation (70 FR 52488).

2.2.2.1 Status of Critical Habitat

The condition of CCC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of streambank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased streambank erosion, loss of shade (higher water temperatures) and loss of nutrient

inputs (70 FR 52488; Busby et al. 1996). Water development has drastically altered natural hydrologic cycles in many of the streams in the DPS. Alteration of flows results in migration delays, loss of suitable habitat due to dewatering and blockage; stranding of fish from rapid flow fluctuations; entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids. Overall, current condition of CCC steelhead critical habitat is degraded, and does not provide the full extent of conservation value necessary for the recovery of the species.

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 proposed action will take place in Hooker Creek and Sonoma Creek, both of which are designated critical habitat for threatened CCC steelhead. The action area includes the linear extent (upstream and downstream) of the SR-12 bridges at Sonoma and Hooker creeks and encompasses the riparian corridor to the top of the bank. The Sonoma Creek Bridge is located at: 38°25′39″N, 122°33′34″W and the Hooker Creek Bridge is located at: 38°20′17″N, 122°29′36″W. For Hooker Creek, the action area extends 100 feet upstream of the bridge centerline and 500 feet downstream of the diversion where temporary sedimentation effects due to the proposed action are anticipated to cease. The approximate length of Hooker Creek in the action area is 640 feet. For Sonoma Creek, the action area extends just upstream of the bridge centerline and 500 feet downstream of the diversion where temporary sedimentation effects due to the proposed action are anticipated to cease. The approximate length of Sonoma Creek in the action area is 590 feet. Both of these sections of creek are expected to be dry during a portion of the construction season due to the intermittent nature of the creeks.

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).

2.4.1 Status of Steelhead in the Action Area

Steelhead are anticipated to be in low abundance within the action area. Surveys within the Sonoma watershed in 1993 observed 0-17 steelhead at various locations with densities estimated at 5-30 individuals per 30 m (Leidy et al. 2005). Locations nearest to the Hooker Creek confluence had estimated densities of 5 steelhead per 30 m and the location nearest the SR-12

crossing on Sonoma Creek had estimated densities of 25 steelhead per 30 m. In 2017, Caltrans rescued and relocated about 25 juvenile steelhead in the existing scour pool at the SR-12 crossing. The sections of creeks within the action area are intermittent and typically dry by mid-July. During wetter years that sustain flow in Sonoma and Hooker creeks there is potential for steelhead to migrate through the action area. Allowing for a 50 percent variation in inter-annual population abundance and allowing for up to 90 feet of channel at Sonoma Creek and 140 feet of channel at Hooker Creek to be dewatered, NMFS estimates that there may be up to 35 juvenile steelhead in the action area of Sonoma Creek each year and 38 juvenile steelhead in the action area of Hooker Creek if water is present. Adult steelhead are not expected to be present within the action area during the time of construction (June 1 to October 31).

2.4.2 Status of Critical Habitat in the Action Area

Sonoma Creek is a 33.4 mile-long stream with headwaters that originate from Sugarloaf Ridge State Park, which discharges into San Pablo Bay within the Napa-Sonoma-Russian River Valleys ecoregion (Omernik and Griffith 2014). Hooker Creek is approximately 5-miles long with headwaters consisting of two small perennial to intermittent tributaries that flow to the confluence with Sonoma Creek (Leidy et al. 2005) and regularly has not surface creek flow during the anticipated construction period. Both creeks are between Sonoma Mountain and Hood Mountain. Within the each of the action areas, the creeks are intermittent in summer, and channelized areas contain mixed-sized gravel, little turbidity, and no overhanging vegetation. Both creeks are likely used primarily for migration and rearing for short periods annually.

2.4.3 Factors Affecting Species Environment in the Action Area and Vicinity

2.4.3.1 Road Encroachment

Highway 12 traverses both Sonoma Creek and Hooker Creek in the action area. The location of the roads likely results in runoff from the road surfaces entering the creeks during rainstorms, and a related reduction in water quality within the action area to an unknown degree. Runoff from road surfaces can contain dirt, oils, automotive fluids, and petro chemicals that are harmful to aquatic life, including steelhead (Spence et al. 1996). Road development located along the creeks within the action area and rural development located along the creek in with the action area have contributed to the confinement of the creek channels and diminished the breadth of riparian vegetation.

2.4.3.2 Agricultural Development

Cultivated fields and vineyards adjacent to the action areas at Sonoma Creek and Hooker Creek represent sources of threats to instream habitat. There is potential for increased turbidity or nutrient loading due to runoff from agriculture areas adjacent to the creeks. High turbidity concentrations can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg and Northcote 1985; McLeay et al. 1987; Gregory and Northcote 1993; Velagic 1995). Agricultural runoff can transfer nutrients and pesticides to the creek, which can lower dissolved-oxygen levels by increasing algae growth in streams and decreasing forage for steelhead (Spence et al. 1996).

2.5 Effects of the Action

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).

2.5.1 Effects of the Action on Critical Habitat

2.5.1.1 Temporary Dewatering

Installing the water diversions in each of the work areas is expected to temporarily prevent about 140 feet of Hooker Creek (approximately 0.573 acres) and 90 feet of Sonoma Creek (approximately 0.056 acres) from serving as a freshwater migration corridor and freshwater rearing area for threatened steelhead for up to five months during the dry season (June 1 through October 31). The temporary loss of habitat is expected to have at least a few consequences for designated critical habitat, described as follows.

The temporary loss of habitat is expected to translate into temporary loss of aquatic macroinvertebrate forage within the action area. Aquatic insects provide a source of food for fish and may represent a substantial portion of food items consumed by juvenile steelhead. Effects to aquatic macroinvertebrates resulting from diversions and dewatering will be temporary because construction activities will be short lived, and rapid recolonization (about one to two months) of the restored channel area by macroinvertebrates is expected following re-watering (Cushman 1985; Thomas 1985; Harvey 1986). In addition, the effect of macroinvertebrate loss as a food source is expected to be negligible because food from upstream sources would be available downstream of the isolated area via drift. Consequently, the temporary loss of aquatic macroinvertebrates is not expected to adversely affect forage opportunities within the area over the long term.

The temporary loss of habitat represents loss of a freshwater migration corridor and freshwater rearing area, which are essential for the growth and survival of juvenile steelhead (the life stage expected to be present at the time the proposed action is implemented). As a result, the habitat cannot fulfill the intended conservation role for the species. The quality and availability of habitat in the action area has already been diminished and reduced due to a number of anthropogenic factors (see our discussion in the Environmental Baseline section of this biological opinion). Therefore, the loss of habitat due to dewatering represents further loss of habitat.

There are at least a few reasons to expect that the dewatering and related loss of service to designated critical habitat will not have a lasting, detectable impact. First, the diversion will be removed and the work areas allowed to rewater following completion of the proposed action. Second, the installation of LWD and boulders in Hooker Creek is expected to increase channel

roughness and, by extension, habitat complexity in the dewatered reach. Additional habitat will be restored at Sonoma Creek with the removal of the pier.

Overall, the loss of aquatic habitat associated with the water diversion is expected to be temporary, and no long-term diminishment in the physical capacity of the habitat to serve the intended functional role for steelhead is anticipated.

2.5.1.2 Disturbance to the Creek bed

Although manipulation and disturbance of the creek bed can result in changes to channel morphology and hydraulic conditions that may create impediments to steelhead migration, review of the proposed action indicates the footprint and alignment of the new bridges and LPSTP are only expected to result in minor changes to channel morphology. As a result the habitat characteristics and conditions that are important to maintain freshwater rearing areas and freshwater migration corridors in the action areas are expected to remain the same.

Elimination of the center pier on the Sonoma Creek bridge will eliminate an unnatural structure in the creek and allow the localized channel (17 ft^2 of critical habitat) to attain equilibrium with the bedload and flow dynamics. Although a net loss of 12.5 linear feet (174 ft^2, 0.004 acres) of critical habitat of is expected at Hooker Creek due to alteration of the channel alignment, installation of the LPSTP, and removal of the gravel bar, additional habitat features (rootwads, large woody debris, boulders) will be added to the channel. These specific habitat features are expected to promote an increase in habitat complexity.

The increase of the embankment footprints are along the edge of the channels and are not expected to result in a loss of aquatic habitat. The existing rearing conditions in the action area are influenced by the lack of pools during the dry season due to the intermittent nature of the creeks, based on our observations of the action area. Rootwads and LWD will be incorporated into the LPSTP, increasing roughness and creating habitat for when water is present. Therefore, the increase of armoring along the creek bank is not expected to diminish the overall functional value of rearing habitat within the action area. The creek bed will also be restored to pre-project conditions. Based on these findings, the proposed action is not anticipated to appreciably reduce the functional value of the action areas as sites of freshwater migration or rearing.

2.5.1.3 Alteration of Water Quality

Acute or chronic water-quality effects in Sonoma or Hooker creeks because of increases in sedimentation and turbidity levels resulting from construction activities are expected to be minimal and temporary, for at least a few reasons.

First, the proposed action includes a number of sediment and erosion-control measures to reduce the likelihood that sediment would be introduced to the wetted area. The success of these measures has been documented during other similar projects, based on NMFS' observations and experience.

Second, the proposed BMPs that are intended to preclude equipment leaks from reaching the creek channel are expected to be effective in this regard. As a result, we don't expect water-

quality alterations due to equipment leaks. Although accidental spills of chemical contaminants are speculative, the proposed action incorporates measures to prevent a spill reaching the creek channel.

2.5.1.4 Disturbance to Streamside Vegetation

The proposed action is expected to cause a discrete loss of shade along Sonoma Creek and Hooker Creek. This loss has the potential to translate into increased water temperatures (Mitchell 1999; Opperman and Merenlender 2004) and decreased water quality (Lowrance et al. 1985; Welsch 1991). However, the loss of vegetation as a result of the proposed action is expected to be temporary and confined to a small localized area. In addition, riparian vegetation will be replanted throughout the disturbed areas to minimize impacts from project construction. Based on NMFS' experience observing the response of riparian vegetation to human-made disturbances, the riparian zone is expected to recover from the project one to two years following the completion of construction. Notwithstanding this expectation, the proposed action does not include monitoring the replanted areas within the action area following completion of the project or other provision to notify NMFS of the performance of the proposed plantings over time.

2.5.2 Effects of the Action on Threatened Steelhead

The expected effects of the action on threatened steelhead are related to the proposed dewatering in Sonoma Creek and Hooker Creek within the action area to facilitate construction in the dry, and physical alterations to the creek banks and channels. What follows is a discussion of these effects, including discussion of the expected effects due to the proposed capture and relocation of steelhead.

2.5.2.1 Dewatering Consequences for Juvenile Steelhead

The dewatering is expected to have two principal consequences: (1) a loss of service to juvenile steelhead through the loss of living space, and (2) stresses related to handling and crowding owing to the capture and relocation. Each of these is explained for more fully as follows.

Loss of Living Space.—The temporary loss of habitat owing to dewatering could translate into an adverse effect on juvenile steelhead, chiefly through the short-term loss of a freshwater rearing area and displacement of steelhead, presuming presence of this species. This could increase densities of steelhead in neighboring reaches of the creek outside the action area. However, based on our observations of the creeks upstream and downstream of the action area, and our general familiarity of steelhead abundance, we anticipate that number of steelhead experiencing a loss of service will be low. In addition, these portions of Sonoma and Hookers creeks are expected to be dry for several months during the summer and therefore dewatering represents a relatively minor extension of the natural dewatering. Should water be present, the diversion will contain pipes that are expected to allow steelhead movement between habitats upstream and downstream of the isolated area; the habitat in those areas appear to be similar quality as the affected area. Overall, we anticipate the presence of the water diversion would affect only a small number of steelhead for a relatively short period of time during the dry season, with the effect primarily limited to an increased potential for crowding in neighboring reaches.

The effect of macroinvertebrate loss on juvenile steelhead is expected to be negligible because food from upstream sources would be available downstream of the isolated area via drift. Consequently, the temporary loss of aquatic macroinvertebrates as a result of the presence of the diversion is not expected to adversely affect steelhead. The increase in shading at Sonoma Creek could translate to a decrease in primary productivity and in turn a decrease to macroinvertebrates. However, any decrease is expected to be negligible.

Capture and Relocation.—Although dewatering the action area has the potential to harm or kill rearing juvenile steelhead, the proposed action includes precautions to reduce the likelihood of harm and mortality. Prior to dewatering, biologists will capture and relocate steelhead to the nearest suitable habitat downstream of the work space. Caltrans proposes that biologists will be approved by NMFS, and will continuously monitor the placement of the diversion and dewatering in order to capture and relocate any stranded steelhead.

Although Caltrans will document the capture and relocation of juvenile steelhead within the isolated area, the proposed action does not include a provision to notify NMFS of the number of steelhead that may be harmed or injured as a result of the proposed action. In addition, the specific criteria that Caltrans will use to select relocation areas are not described in the proposed action. Based on our experience and familiarity with selection of relocation areas, the sites selected for relocating juvenile steelhead should have ample habitat, but relocated fish may compete with other fish, potentially increasing competition for available food and habitat (Keeley 2003).

Stress from crowding, including increased competition for food among juvenile steelhead in the relocation areas, is expected to be temporary, if experienced, because when the proposed action is finished steelhead will be able to colonize the area that had been dewatered. In addition, the available information indicates abundance of juvenile steelhead in the action areas are quite low and not likely to produce crowding effects.

Based on steelhead survey results of steelhead in the vicinity of the action area in the Sonoma Creek watershed, NMFS expects no more than 35 juvenile steelhead will need to be relocated from the dewatered area in Sonoma Creek each construction season (70 steelhead over two construction seasons) and 38 juvenile steelhead will need to be relocated from the dewatered area in Hooker Creek. NMFS expects that 4 juvenile steelhead may be injured or killed as a result of the proposed action in Sonoma Creek each construction season (8 steelhead over two construction seasons) and 4 juvenile steelhead may be injured or killed in Hooker Creek. This estimated mortality is based on NMFS' experience and knowledge gained on similar projects in Sonoma County during the last several years. Based on NMFS' general familiarity of steelhead abundance in central California in general, and Sonoma County streams in particular, the anticipated number of juvenile steelhead that may be injured or killed as a result of the proposed action is likely to represent a small fraction of the overall watershed-specific populations and the entire CCC DPS of threatened steelhead. Therefore, the effects of the relocation on steelhead are not expected to give rise to population-level effects.

2.5.2.2 Consequences of Physical Habitat Alterations

The temporary loss of riparian vegetation will lead to a reduction in shade and potentially to increased water temperatures. The addition of habitat features along the LPSTP at Hooker Creek will provide shelter for juvenile steelhead when water is present. Since these effects are expected to be minor and the streams regularly dry during the hottest months, the consequences to steelhead are expected to be insignificant.

2.6 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).

NMFS is generally familiar with the activities in the action area and at this is unaware of such actions that would be reasonable certain to occur. Consequently, no cumulative effects are likely, beyond the continuing effects of present land uses that are reasonably certain to occur into the future.

2.7 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.

Juvenile steelhead are expected to be present in the action area during the time the proposed action will be implemented and, therefore, subject to effects of the proposed action. The main risk to individual steelhead involves effects due to dewatering and capture and relocation. The adverse effects include potential displacement, injury, and mortality during dewatering and the process of capture and relocation, but precautions are in place to minimize, if not eliminate, the risk of injury and mortality, and upstream and downstream habitats are expected to suitably

harbor the relocated steelhead. The expected effects associated with the habitat alteration due to dewatering will be short lived and localized.

Based on steelhead surveys and observations described in the environmental baseline section, NMFS concludes non-lethal take of no more than 35 juvenile steelhead that may be captured and relocated each construction season at Sonoma Creek as a result of dewatering the action area (70 over two seasons) and 38 juvenile steelhead that may be captured and relocated during the construction season at Hooker Creek. NMFS estimates a potential lethal take of no more than 4 out of the 35 individuals at Sonoma Creek each construction season (8 over two construction seasons), and 4 steelhead of the 38 individuals at Hooker Creek, thus the risk of mortality is low. Any juvenile steelhead present in the action area likely make up a small proportion of the CCC DPS of steelhead.

Regarding the consequences to designated critical habitat for threatened steelhead, the proposed action will result in a habitat gain of 17 ft^2 at Sonoma Creek due to the pier removal. There will be habitat loss of 172 ft^2 at Hooker Creek due to alteration of the channel alignment and installation of the LPSTP. Habitat features will be added, leading to an expected increase in habitat complexity. The replanted areas are expected to create a functional riparian zone that provides cover for steelhead within the action area of Sonoma and Hooker creeks. The impacts from disturbing the streambed are not expected to reduce the function or value of designated critical habitat in the action areas.

The action area could be subject to higher average summer temperatures and lower precipitation levels in the future as a result of climate change, which would lead to higher creek temperatures and longer dry periods. Reductions in the amount of precipitation would reduce the amount and extent of flow. For this project, the above effects of climate change are unlikely to be detected by the time construction is completed. The short-term effects of the proposed action are expected to have elapsed prior to these climate-change effects. The long-term changes in the channel at the bridge sites are confined to small areas and are unlikely to significantly magnify the likely climate change impacts.

2.8 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 the threatened CCC DPS of steelhead or destroy or adversely modify its designated critical habitat for this species.

2.9 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.

2.9.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows: All the steelhead in the action area, expected to be no more than 35 juveniles each construction season at Sonoma Creek (70 over two construction seasons) and no more than 38 juveniles at Hooker Creek that are captured or harassed during project activities. No more than 4 juvenile steelhead each season at Sonoma Creek (8 over two construction seasons) and 4 juvenile steelhead at Hooker Creek are expected to be injured or killed as a result if relocating the species. No other incidental take is anticipated as a result of the proposed action. The accompanying biological opinion does not anticipate any form of take that is not incidental to the proposed action.

2.9.2 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.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize and monitor incidental take of steelhead. The results of the analysis provide the basis for the following reasonable and prudent measures:

- Avoid and minimize harm and mortality of steelhead during relocation activities.
- Prepare and submit a post-construction report regarding the effects of fish relocation and construction activities.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and Caltrans or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). Caltrans 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:

a. Caltrans' biologist shall select relocation habitat(s) for steelhead prior to undertaking relocation activities. The biologist shall select relocation sites based on attributes such as adequate water quality (a minimum dissolved oxygen level of 5 mg/L and suitable water temperature), size or area, cover (instream and over-hanging vegetation or woody debris), number of fish already present in the site, and adequacy of the living space (e.g., water-column depth, accessible egress, and flowing water through the habitat. Multiple relocation sites may be necessary to prevent overcrowding of a single site depending on the number of steelhead captured, current number of steelhead already occupying the relocation habitat(s), and the size of the receiving habitat(s). One or more of the following methods shall be used to capture steelhead: seine, dip net, minnow trap, or by hand.

b. Steelhead will be relocated as soon as possible to the selected relocation sites, and distributed among multiple relocation sites if Caltrans' biologists determine that overcrowding would otherwise occur.

c. Captured fish shall be handled with extreme care and kept in water to the maximum extent possible during relocation activities. All captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish shall not be removed from this water except when released. To avoid predation, the biologist shall have at least two containers and segregate young-of-year fish from larger age classes and other potential aquatic predators. Captured salmonids will be relocated, as soon as possible, to a suitable instream location in which habitat conditions are present to allow for adequate survival of transported fish and fish already present.

d. Caltrans shall contact NMFS (Jess Adams, 562-533-6813) immediately if one or more steelhead are found dead or injured. The purpose of the contact shall be to review the activities resulting in take and to determine if additional protective measures are required. All steelhead mortalities shall be retained, frozen as soon as practical, and placed in an appropriate-sized sealable bag that is labeled with the date and location of the collection and fork length and weight of the specimen(s). Frozen samples shall be retained by the biologist until additional instructions are provided by NMFS. Subsequent notification must also be made in writing to Jess Adams, NMFS, 501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802 within five days of noting dead or injured steelhead. The written notification shall include 1) the date, time, and location of the carcass or injured specimen; 2) a color photograph of the steelhead; 3) cause of injury or death; and 4) name and affiliation of the person whom found the specimen.

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

a. Caltrans shall provide a written report to NMFS by January 15 of the year following the construction season. The report shall be sent to Jess Adams, jessica.adams@noaa.gov, or NMFS, 501 West Ocean Boulevard, Suite 4200, Long Beach, California 90802. The reports will contain, at a minimum, the following information:

i. Construction related activities – The report will include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on steelhead, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any effect on steelhead; the number of steelhead killed or injured during project construction; and photographs taken before, during, and after the activity from photo reference points.

ii. Fish Relocation – The report will include (1) the number and size of all fish relocated during the proposed action; (2) the date and time of the collection and relocation; (3) a description of any problem encountered during the project or when implementing terms and conditions; and (4) any effect of the proposed action on steelhead that was not previously considered.

iii. Revegetation – The report will include a description of the locations seeded or planted, the area revegetated, proposed methods to monitor and maintain the revegetated area, criteria used to determine the success of the plantings, and pre- and post-planting color photographs of the revegetated area. Caltrans shall provide the results of the vegetation monitoring by January 15 following completion of each annual site inspection following completion of the project. NMFS suggests five years of monitoring to document vegetation establishment. Each report shall include color photographs taken of the project area during each inspection and before implementation of the proposed action.

2.10 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).

- During recovery planning for Central California Coast steelhead, Hooker Creek and upper Sonoma Creek were identified as having a poor aquatic shelter ratio. To aid in recovery of steelhead, Caltrans should work collaboratively with the Sonoma Ecology Center and Sonoma Resource Conservation District to evaluate identify, and improve shelters in pools within the perennially wetted portions of Hooker Creek and upper Sonoma Creek. Implementation of this Conservation Recommendation will address a recovery action for Central California Coast steelhead related to aquatic habitat conditions (SoC-CCCS-6.1.3.1).
- Stormwater discharges to streams carry various pollutants that are toxic to salmonids. To aid

in recovery of steelhead, Caltrans should include bioretention areas or other landscaping features adapted to treat stormwater runoff from Highway 12 (or State Route 12) to Hooker Creek or Sonoma Creek at these two construction sites.

- In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations. This notification shall be submitted to Jess Adams, NMFS, 501 W. Ocean Blvd., Suite 4200, Long Beach, California 90802.

2.11 Reinitiation of Consultation

This concludes formal consultation for the State Route 12 Bridge Scour Mitigation Project: Sonoma and Hooker Creek Bridge Replacement. 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 Caltrans and descriptions of EFH for the Pacific Coast Salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

Pacific coast salmon EFH may be adversely affected by the proposed action. Specific habitats identified in the PFMC (2014) for Pacific coast salmon include habitat areas of particular concern (HAPCs), identified as: 1) complex channels and floodplain habitats; 2) thermal refugia; and 3) spawning habitat. HAPCs include all waters, substrates, and associated biological communities falling within critical habitat as described above in the accompanying biological opinion for the project located within the Sonoma Creek watershed.

3.2 Adverse Effects on Essential Fish Habitat

NMFS determined the proposed actions would adversely affect EFH designated under the Pacific Salmon FMP due to localized increases in turbidity, disturbance of benthic habitat, and expanded area of overwater structure. As discussed above, adverse effects from turbidity and disturbance of the benthic community are expected be temporary and localized. Therefore, NMFS has no practical EFH conservation recommendations to provide to avoid or reduce the magnitude of these effects.

3.3 Supplemental Consultation

Caltrans 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 is Caltrans. Other interested users could include California Department of Fish and Wildlife and U.S. Fish and Wildlife Service. Individual copies of this opinion were provided to Caltrans. 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 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

Abdul-Aziz, O. I., N. J. Mantua, and K. W. Myers. 2011. Potential climate change impacts on thermal habitats of Pacific salmon (Oncorhynchus spp.) in the North Pacific Ocean and adjacent seas. Canadian Journal of Fisheries and Aquatic Sciences 68(9):1660-1680.

Behnke, R. J. 1992. Native Trout of Western North America (American Fisheries Society Monogroph: No 6). American Fisheries Society, Bethesda, Maryland.

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.

Bjorkstedt, E. P., B. C. Spence, J. C. Garza, D. G. Hankin, D. Fuller, W. E. Jones, J. J. Smith, and R. Macedo. 2005. An analysis of historical population structure for evolutionary significant units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain. NOAA Technical Memorandum NOAA-TM-NMFS_SWFSC-382. 210 pages.

Boughton, D. A., P. B. Adams, E. C. Anderson, C. Fusaro, E. A. Keller, E. Kelley, L. D. Lentsch, J. L. Nielsen, K. Perry, H. Regan, J. Smith, C. C. Swift, L. Thompson, and F. G.

R. Watson. 2006. Steelhead of the south-central/southern California coast population characterization for recovery planning. NOAA Tech. Memo. NMFS-SWFSC-394.

Brewer, P. G., and J. Barry. 2008. The other CO2 problem. SciAm 18(4):22-23.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon, and California. NOAA Tech Memo (NMFS-NWFSC-27).

Cayan, D., M. Tyree, and S. Iacobellis. 2012. Climate change scenarios for the San Francisco region.

Cloern, J. E., N. Knowles, L. R. Brown, D. Cayan, M. D. Dettinger, T. L. Morgan, D. H. Schoellhamer, M. T. Stacey, M. Van der Wegen, and R. W. Wagner. 2011. Projected evolution of California's San Francisco Bay-Delta-River system in a century of climate change. PloS one 6(9):e24465.

Cox, P., and D. Stephenson. 2007. Climate change: A changing climate for prediction. Science 317(5835):207-208.

Cushman, R. M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5(3A):330-339.

Doney, S. C., M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, and N. Knowlton. 2011. Climate change impacts on marine ecosystems. Annual Review of Marine Science 4:11-37.

Feely, R. A., C. L. Sabine, K. Lee, W. Berelson, J. Kleypas, V. J. Fabry, and F. J. Millero. 2004. Impact of anthropogenic CO2 on the CaCO3 system in the oceans. Science 305(5682):362-366.

Good, T. P., R. S. Waples, and P. B. Adams. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. NOAA Tech. Memo. NMFS-NWFSC-66:598 pages.

Gregory, R. S., and T. G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50(2):233-240.

Harvey, B. C. 1986. Effects of Suction Gold Dredging on Fish and Invertebrates in Two California Streams. North American Journal of Fisheries Management 6(3):401-409.

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, and E. E. Cleland. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the national academy of sciences 101(34):12422-12427.

Leidy, R. A., G. S. Becker, and B. N. Harvey. 2005. Historical distribution and current status of steelhead/rainbow trout (*Oncorhynchus mykiss*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, California.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, and R. B. MacFarlane. 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).

Lowrance, R., R. Leonard, and J. Sheridan. 1985. Managing riparian ecosystems to control nonpoint pollution. Journal of Soil and Water Conservation 40(1):87-91.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. NOAA Tech. Memo. NMFS-NWFSC-42.

McLeay, D. J., I. K. Birtwell, G. F. Hartman, and G. L. Ennis. 1987. Responses of arctic grayling (*Thymallus arcticus*) to acute and prolonged exposure to yukon placer mining sediment. Canadian Journal of Fisheries and Aquatic Sciences 44(3):658-673.

Milanes, C., T. Kadir, B. Lock, L. Monserrat, N. Pham, and K. Randles. 2018. Indicators of Climate Change in California. Office of Environmental Health Hazard Assessment.

Mitchell, S. 1999. A simple model for estimating mean monthly stream temperatures after riparian canopy removal. Environmental Management 24(1):77-83.

Moser, S., J. Ekstrom, and G. Franco. 2012. Our changing climate 2012: Vulnerability and Adaptation to the Increasing Risks from Climate Change in California. A Summary Report on the Third Assessment from the California Climate Change Center July. CEC-500-20102-007S.

National Marine Fisheries Service (NMFS). 2016. Final Coastal Multispecies Recovery Plan for California Coastal Chinook Salmon, Northern California Steelhead and Central California Coast Steelhead. Santa Rosa, California.

Omernik, J. M., and G. E. Griffith. 2014. Ecoregions of the conterminous United States: evolution of a hierarchical spatial framework. Environmental Management 54(6):1249-1266.

Opperman, J. J., and A. M. Merenlender. 2004. The effectiveness of riparian restoration for improving instream fish habitat in four hardwood-dominated California streams. North American Journal of Fisheries Management 24(3):822-834.

Osgood, K. E. 2008. Climate impacts on US living marine resources: National Marine Fisheries Services concerns, activities and needs. NOAA Tech Memo NMFS-F/SPO-89.

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.

Ruggiero, P., P. D. Komar, and J. C. Allan. 2010. Increasing wave heights and extreme value projections: The wave climate of the US Pacific Northwest. Coastal Engineering 57(5):539-552.

Santer, B. D., C. Mears, C. Doutriaux, P. Caldwell, P. J. Gleckler, T. M. L. Wigley, S. Solomon, N. P. Gillett, D. Ivanova, T. R. Karl, J. R. Lanzante, G. A. Meehl, P. A. Stott, K. E. Taylor, P. W. Thorne, M. F. Wehner, and F. J. Wentz. 2011. Separating signal and noise in atmospheric temperature changes: The importance of timescale. Journal of Geophysical Research: Atmospheres 116(D22):n/a-n/a.

Scavia, D., J. C. Field, D. F. Boesch, R. W. Buddemeier, V. Burkett, D. R. Cayan, M. Fogarty, M. A. Harwell, R. W. Howarth, C. Mason, D. J. Reed, T. C. Royer, A. H. Sallenger, and J. G. Titus. 2002. Climate change impacts on US coastal and marine ecosystems. Estuaries 25(2):149-164.

Schaaf, C. J., S. J. Kelson, S. C. Nusslé, and S. M. Carlson. 2017. Black spot infection in juvenile steelhead trout increases with stream temperature in northern California. Environmental Biology of Fishes 100(6):733-744.

Spence, B. C., E. P. Bjorkstedt, J. C. Garza, J. J. Smith, D. G. Hankin, D. W. Fuller, W. E. Jones, R. Macedo, T. H. Williams, and E. Mora. 2008. A framework for assessing the viability of threatened and endangered salmon and steelhead in the North-Central California Coast Recovery Domain. NOAA Tech Memo NMFS-SWFSC-423.

Spence, B. C., E. P. Bjorkstedt, S. Paddock, and L. Nanus. 2012. Updates to biological viability criteria for threatened steelhead populations in the North-Central California Coast Recovery Domain. NOAA Tech Memo (NMFS-SWFSC-423).

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, OR. (Available from the National Marine Fisheries Service, Portland, Oregon).

Thomas, V. G. 1985. Experimentally determined impacts of a small, suction gold dredge on a Montana stream. North American Journal of Fisheries Management 5(3B):480-488.

Turley, C. 2008. Impacts of changing ocean chemistry in a high-CO 2 world. Mineralogical Magazine 72(1):359-362.

Velagic, E. 1995. Turbidity study: a literature review. Prepared for Delta planning branch, California Department of Water Resources by Centers for Water and Wildland Resources, University of California, Davis.

Welsch, D. J. 1991. Riparian forest buffers: function and design for protection and enhancement of water resources. USDA Forest Service, NA-PR-07-91, Radnor, Pennsylvania.

Westerling, A., B. Bryant, H. Preisler, T. Holmes, H. Hidalgo, T. Das, and S. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climatic Change 109(1):445-463.

Williams, T. H., S. T. Lindley, B. C. Spence, and D. A. Boughton. 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. NOAA's National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA.

Williams, T. H., B. C. Spence, D. A. Boughton, R. C. Johnson, E. G. R. Crozier, N. J. Mantua, M. R. O'Farrell, and S. T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

Zimmerman, C. E., and G. H. Reeves. 2000. Population structure of sympatric anadromous and nonanadromous *Oncorhynchus mykiss*: evidence from spawning surveys and otolith microchemistry. Canadian Journal of Fisheries and Aquatic Sciences 57(10):2152-2162.