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

January 31, 2025 **Refer to NMFS No:** WCRO-2024-01380

Tom Holstein
Environmental Branch Chief
Local Assistance Environmental
California Department of Transportation, District 4
P.O. Box 23600, 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 King Ridge Bridge over Austin Creek Replacement (BRLO-5920(146))

Dear Mr. Holstein:

Thank you for your letter on May 16, 2024, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the King Ridge Bridge over Austin Creek Replacement (BRLO5920(146)).[1]

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. We have concluded that the action would adversely affect EFH designated under the Pacific Coast Salmon Fisheries Management Plan (FMP). While the proposed action will result in adverse effects to EFH, the proposed project contains measures to minimize, mitigate, or otherwise offset the adverse effects; thus, no EFH Conservation Recommendations are included in this opinion.

The enclosed biological opinion is based on our review of the California Department of Transportation's (Caltrans)[1] proposed project and describes NMFS' analysis of potential effects on threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) and California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha)*, and endangered CCC coho salmon (*Oncorhynchus kisutch*), and the designated critical habitat for the species in accordance with section 7 of the ESA. In the enclosed biological opinion, NMFS concludes the project is not

[1] Caltrans is acting as the lead agency for ESA Section 7(a)(2) and MSA Section 305(b) formal consultation under National Environmental Policy Act Assignment from Federal Highway Administration (327 Memorandum of Understanding (MOU) 2022 and 326 MOU 2022). As assigned by the MOUs, Caltrans is responsible for the environmental review, consultation, and coordination on this project.

likely to jeopardize the continued existence of threatened CCC steelhead and CC Chinook salmon, or endangered CCC coho salmon, nor is the project likely to result in the destruction or adverse modification of critical habitat for the aforementioned species. However, NMFS anticipates take of CCC steelhead and CCC coho salmon will occur during dewatering and fish relocation activities as a result of project construction, and may occur post-construction due to permanent bank stabilization. An incidental take statement with terms and conditions is included with the enclosed biological opinion.

Please contact Elena Meza at (707) 531-0706, or elena.meza@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: Keevan Harding, Caltrans keevan.harding@dot.ca.gov
Copy to Efile: FRN 151422WCR2024SR00119

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

King Ridge Bridge over Austin Creek Replacement

NMFS Consultation Number: WCRO-2024-01380

Action Agency: California Department of Transportation (Caltrans)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	If likely to adversely affect, Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	If likely to adversely affect, is Action Likely to Destroy or Adversely Modify Critical Habitat?
Central California Coast Coho Salmon (*Oncorhynchus kisutch*)	Endangered	Yes	No	Yes	No
California Coastal Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	No	No	N/A	N/A
Central California Coast Steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: January 31, 2025

Table of Contents

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 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 402.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the California Coastal NMFS office in Santa Rosa.

1.2. Consultation History

On December 17, 2020, a virtual site visit was held with resource agencies and the California Department of Transportation (Caltrans) to introduce the project and the site to agency representatives and to solicit technical assistance on the project. Topics discussed were general project elements, species present, bridge removal impacts, potential impacts to critical habitat, work pads/creek diversion, falsework and access road impacts, timing for completion of NMFS consultation and other agency permits, and recommendations for softening up proposed hard scape (RSP) with incorporation of large woody debris onsite, and inclusion of vegetated elements within hardscape.

On May 16, 2024, NMFS received an email from Caltrans requesting to initiate formal consultation on behalf of Sonoma County. The email included a letter requesting initiation of section 7 consultation, a request to consult on Essential Fish Habitat, and a biological assessment that included site photos, and several design plan sheets. After reviewing these materials, NMFS determined that there was insufficient information to initiate the consultation. NMFS requested the following, via email, on June 21, 2024 and July 22, 2024: 1) full set of project plans, 2) square area of fill proposed for installation (i.e., RSP and removal, piers from existing bridge, and miscellaneous remnant concrete), 3) description of stormwater quantity and quality for pre- and post-project implementation, 4) proposal for post-construction stormwater treatment, and 5) survey data on fish expected to be in the area. NMFS also asked for clarifying information regarding access to the creek, guardrail design type on bridge over water, falsework placement and timing, and the effect determinations for California Coastal Chinook and designated critical habitat. In addition to the aforementioned, NMFS recommended that Caltrans reconsider their effect determination from *may affect, not likely to adversely affect* designated critical habitat for steelhead and coho to *may affect, likely to adversely affect* due to inclusion of construction activities that are expected to adversely affect critical habitat (i.e., dewatering, vegetation removal, installation of RSP, etc.).

On June 27, 2024 and August 8, 2024, Caltrans responded to NMFS' requests and provided 35% design plans, detailed information on stormwater treatment pre- and post-construction, proposed plan for post-construction stormwater treatment, dimensions of fill and proposed work pad, and provided responses to clarification requests. NMFS reviewed the information provided and while most of the information requested was provided, there were remaining outstanding items. On September 10, 2024, NMFS sent out a final email recommending an increase in treatment of stormwater runoff to cover 100% of a 24-hour storm event of the entire project area given that an endangered species (Central California Coast coho salmon) highly susceptible to stormwater runoff pollutants (i.e., 6PPD-quinone (6PPD-q)) is expected within the action area, and information on the location of the proposed bioswales, and the required materials that will be submitted to the state for issuance of a 401 permit.

On September 17, 2024, Caltrans responded to NMFS' request and provided a Draft Drainage Report, 65% plan sheets specific to the proposed bioswales, and a list of the items that will be submitted with their state 401 permit. In addition to the above materials, Caltrans also confirmed that the project is proposing to treat 100% of the impervious surface area associated with the project, and that all new impervious surfaces will drain to bioswales prior to discharging to the creek. Caltrans also updated their effect determination for steelhead and coho designated critical habitat from a *may affect, not likely to adversely affect* to *may affect, likely to adversely affect*. NMFS reviewed the information provided and decided that there was sufficient information to initiate the consultation. NMFS notified Caltrans on September 24, 2024 via email that sufficient information was provided and that the consultation was initiated on September 17, 2024.

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

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 (see 50 CFR 402.02). Under the MSA, "federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a federal agency (see 50 CFR 600.910).

The County of Sonoma (County), in cooperation with Caltrans, proposes to replace the King Ridge Road Bridge (Bridge No. 20C0433) on a new alignment, spanning Austin Creek, to provide the public with a new bridge, just upstream of the existing bridge, that will meet current design standards, improve driver safety, and be consistent with the American Association of State Transportation Official safety standards (AASHTO). King Ridge Road is a narrow, low-volume road, and the existing bridge is located near the unincorporated community of Cazadero, Sonoma County, California (Figure 1). King Ridge Road Bridge is comprised of a reinforced concrete (RC) deck on rolled steel beams, with RC pedestal seat abutments and RC wall piers. The bridge was constructed in 1965 with an unstriped single-through lane, and is approximately 120.5 feet long and 16 feet wide (0.05 acres). The bridge does not meet current AASHTO design requirements, is rated as scour critical, and was recommended for bridge replacement in 2014 due to its instability. Furthermore, untreated stormwater within the project footprint discharges directly into Austin Creek from the existing bridge and drainage ditches.

Source: Google 2023; EPA 2020; USGS 2021b

Figure 1. Project Location within unincorporated Sonoma County, California

The new bridge would be a clear-span steel girder type bridge approximately 142 feet long and 26 feet wide (0.08 acres), and will support two 11-foot wide lanes of traffic and two 2-foot shoulders. The new bridge will be supported by concrete seat abutments founded on 48-inch diameter cast-in-drilled-hole (CIDH) piles. Each abutment will require three CIDH piles, totaling six CIDH piles to support the bridge. To protect the new bridge and banks from future scour, a combination of new and existing RSP will be installed on the southern and northeastern banks.

Approximately 0.06 acres of existing RSP will be repaired and reinstalled along the northeastern bank, and approximately 0.02 acres of new RSP will be installed on the southern bank. The project will result in a total of 0.11 acres of permanent impacts to the creek bed and banks resulting from the increased width of the new bridge structure (0.03 acres), and installation of RSP for scour protection (0.08 acres).

To improve channel restriction and restore more natural channel form and function, the new abutments will be placed outside of the active channel and above the ordinary high-water mark (OHWM) of the creek (Appendix A), and remnant concrete from previous bridge repairs will be removed from the creek bed. Following construction of the new bridge, all post-project impervious surface area will drain to bioswales located west of the proposed new bridge (Appendix B) prior to discharging to Austin Creek (HDR 2024).

Table 1. Impervious Areas Associated with Proposed Project

Impervious Surface Area	Acres
Pre-project	0.225
Replaced	0.225
Net New	0.011
Total New	0.236
Post-Project	0.236
Post-Project Treatment	**0.250**

Two vegetated bioswales are proposed to treat runoff post-construction. The bioswales were designed using a 10-year peak flow, and rainfall intensity of 4.87 inches per hour, and according to the Sonoma County's Low Impact Development Technical Design Manual (2020). The bioswales will include 18-inches of imported biofiltration soil, and will be an engineered mix that will have a saturated hydraulic conductivity of at least 5 inches per hour. Permanent stormwater treatment methods that utilize infiltration, sorption, and effectively capture tire wear particles, such as the proposed bioswale design, have a potential treatment rating of "high" (Washington State Department of Ecology 2022), which is NMFS' recommend treatment level for waterways that support endangered coho salmon. Overall, the project will treat 0.250 acres of impervious surface, providing an additional 0.014 acres of treatment above the post-project impervious area (Table 1).

The entire project is expected to take two construction seasons to complete and can be broken down into two phases (each expected to take one year to complete): 1) construction of the new bridge, and 2) demolition of the existing bridge and placement of permanent RSP. Because construction of the new bridge will take place either above OHWM, and/or from top of bank, construction is proposed to start April 1 (considered the end of the rain season) with vegetation removal activities, and clearing and grubbing. Clearing involves removing and disposing of all unwanted surface material such as trees, brush, grass, weeds, downed trees, and other materials. Grubbing entails removing unwanted vegetative matter from beneath the ground surface, such as stumps, roots, buried logs, and other debris. Trees, shrubs, and landscaping in the proposed action area in conflict with new construction and staging/access areas will be removed and/or trimmed when feasible. To facilitate a clear path down to the creek bed, shrub and herbaceous vegetation located on the left bank downstream of the existing bridge will be cleared and grubbed. In addition, clearing activities include removal and/or pruning of 47 trees or stumps. Eighteen trees along the hillside at the southern approach will be removed to accommodate the new roadway alignment, 22 trees will be removed inside the channel under the footprint of the new bridge, and 7 trees will be removed along the hillside at the southern approach to accommodate the new bioswale/drainage system. In addition to the aforementioned trees, other herbaceous vegetation along the banks approximately 50 feet both up- and downstream of the bridge will be cleared/grubbed to allow for permanent placement of RSP.

Following vegetation activities needed to prepare the site, the new 48-inch CIDH support piles will be constructed to an anticipated maximum depth of approximately 80 feet below the top of bank. Once complete, falsework will be installed, abutment forms will be set, and concrete will be poured to construct the abutments. Following curing, the streel truss bridge elements will be hauled to the site in segments, assembled, and then lifted into place. Following construction of the new bridge, traffic will be shifted to the new structure and demolition of the existing bridge will begin. Cranes will be used to remove the existing bridge span, concrete column piers, and abutments. Abutment walls would be removed to the top of the bearing seat, or to a depth of five feet below grade, whichever is less. RSP will be installed to protect the new bridge and banks from scour. To complete demolition of the existing bridge, creek access will be needed, and while instream construction will be conducted during the dry season when flows are at annual lows (June 15 to October 15), a creek diversion will be necessary for a dry work area. Access will be from the large road shoulder just above the existing bridge down to the top of the bank.

The creek diversion will consist of clean river-run gravel berms and pipe culverts, and may extend from 50 feet upstream of the new bridge to 30 feet downstream of the new bridge. To install the stream diversion a combination of culverts, coffer dams, and/or k-rail will be placed in the creek bed to bypass stream flow through the work site. Following demolition, the river-run gravel berms will be left within the creek to replenish habitat; winter storms are expected to redistribute the gravel downstream. The temporary diversion will utilize NMFS' Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001). A maximum of 105 linear feet of Austin Creek will be diverted/dewatered to complete demolition of the existing bridge. Demolition of the existing bridge is expected to be completed in one season with one dewatering event. Juvenile CCC steelhead and CCC coho salmon, if present in the work area, will be collected, relocated, and/or excluded from the area prior to dewatering the work site.

Heavy equipment will be used during construction activities and may include any combination of the following: excavator, hydraulic equipment, drill rigs, cranes, front-end loader, bulldozer, dump trucks, concrete trucks, grader, off road forklift, service trucks and vehicles, asphalt pavers, and rollers.

Caltrans proposes to include several avoidance and minimization measures (AMMs) that will be implemented before, during, and after construction to prevent and minimize project-related affects to CCC steelhead and CCC coho salmon, and the surrounding habitat. These measures include working within the in-water work window of June 15 to October 15; ensuring proper handling and relocation of listed salmonids during dewatering/diverting and fish exclusion activities; ensuring establishment of revegetation areas; preventing introduction of contaminants into waterways using a debris containment system; ensuring complete removal and proper disposal of all construction waste; implementing erosion control measures; and development of a fish handling and relocation plan, a stormwater pollution prevention plan, and a stormwater management plan. A detailed list of the AMMs and additional best management plans (BMPs) are described in Caltrans' Biological Assessment (2024).

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 to 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 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 also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for CCC steelhead and CCC coho use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the 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 ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision 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 critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to 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" for the jeopardy analysis. The opinion also examines the condition of designated critical habitat, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated critical habitat, and discusses the function of the PBFs that are essential for the species' conservation.

2.2.1. Species Description and Life History

This biological opinion analyses the effects of the federal action on the following Federally-listed species (Distinct Population Segment (DPS) or Evolutionary Significant Unit (ESU)) and designated critical habitat:

Central California Coast (CCC) steelhead DPS (*Oncorhynchus mykiss*)
Threatened (71 FR 834, January 5, 2006)
Critical habitat (70 FR 52488, September 2, 2005);

Central California Coast (CCC) coho salmon ESU (*O. kisutch*)
Endangered (70 FR 37160; June 28, 2005)
Critical habitat designation (64 FR 24049; May 5, 1999);

California Coastal (CC) Chinook salmon ESU (*O. tshawytscha*)
Threatened (70 FR 37160; June 28, 2005).

Critical habitat is not designated for CC Chinook salmon within Austin Creek and thus, this biological opinion does not analyze designated critical habitat for CC Chinook salmon in this consultation. While Chinook salmon are often observed in lower Austin Creek downstream of the action area (J. Smith, Pers. Comm. December 19, 2024), juveniles are not expected within the action area during the proposed construction window. Thus, Caltrans determined the proposed action is not likely to adversely affect threatened CC Chinook salmon. Therefore, this biological opinion does not analyze effects to individual CC Chinook salmon, and NMFS' concurrence for the species is documented below in the "Not Likely to Adversely Affect" Determinations (section 2.12).

The CCC steelhead DPS includes steelhead in coastal California streams from the Russian River to Aptos Creek, and the drainages of Suisun, San Pablo, and San Francisco Bays (72 FR 5248). The CCC coho salmon ESU includes coho from Punta Gorda in northern California south to, and including, Aptos Creek in central California, as well as populations in tributaries to San Francisco Bay, excluding the Sacramento-San Joaquin River System (61 FR 56138).

The action area is within designated critical habitat for CCC steelhead and CCC coho salmon. CCC steelhead critical habitat is designated from the Russian River to the San Lorenzo River to a lateral extent of ordinary high water in freshwater stream reaches, and to extreme high water in estuarine areas. CCC coho salmon critical habitat is designated to include all river reaches assessable to listed coho salmon from Punta Gorda in northern California south to the San Lorenzo River in central California, including Arroyo Corte Madera Del Presidio and Corte Madera Creek, tributaries to San Francisco Bay. Critical habitat consists of the water, substrate, and adjacent riparian zone of estuarine and riverine reaches (including off-channel habitats).

2.2.1.1. General Life History of Listed Species

2.2.1.1.1. CCC Steelhead

Steelhead are the anadromous form of *O. mykiss*, spawning in freshwater and migrating to marine environments to grow and mature. Steelhead have a complex life history that requires successful transition between life stages across a range of freshwater and marine habitats (i.e., egg-to-fry emergence, juvenile rearing, smolt outmigration, ocean survival, and upstream migration and spawning). Steelhead exhibit a high degree of life history plasticity (Shapovalov and Taft 1954; Thrower et al. 2004; Satterthwaite et al. 2009; Hayes et al. 2012). The occurrence and timing of these transitions are highly variable and generally driven by environmental conditions and resource availability (Satterthwaite et al. 2009; Sogard et al. 2012).

Steelhead are generally divided into two ecotypes based on timing and state of maturity when returning to freshwater: summer-run and winter-run. Summer-run steelhead return to natal streams in spring and early summer while they are still sexually immature and spend several months maturing before spawning in January and February (Nielson and Fountain 2006). Winter-run steelhead enter natal streams as mature adults with well-developed gonads. They typically immigrate between December and April and spawn shortly after reaching spawning grounds (Shapovalov and Taft 1954; Moyle et al. 2008).

Adult steelhead spawn in gravel substrates with low sedimentation and suitable flow velocities. Females lay eggs in redds, where they are quickly fertilized by males and covered. Egg survival depends on oxygenated water circulating through the gravel, facilitating gas exchange and waste removal. Adults usually select spawning sites in pool-riffle transition areas of streams with gravel cobble substrates between 0.6 to 10.2 centimeters (cm) in diameter and flow velocities between 40 - 91cm per second (Smith 1973; Bjornn and Reiser 1991). Eggs incubate in redds for approximately 25 to 35 days depending on water temperature (Shapovalov and Taft 1954). Incubation time depends on water temperature, with warmer temperatures leading to lower incubation periods due to increased metabolic rates. Eggs hatch as alevin and remain buried in redds for an additional two to three weeks until yolk-sac absorption is complete (Shapovalov and Taft 1954). Optimal conditions for embryonic development include water temperatures between 6 and 10°C, dissolved oxygen near saturation, and fine sediments less than 5% of substrate by volume (Bjornn and Reiser 1991; USEPA 2001).

Upon emerging from redds, juvenile steelhead occupy edge water habitats where flow velocity is lower and cover aids in predator avoidance. Rearing juveniles feed on a variety of aquatic and terrestrial invertebrates. As they grow, juveniles move into deeper pool and riffle habitats where they continue to feed on invertebrates and have been observed feeding on younger juveniles (Chapman and Bjornn 1969; Everest and Chapman 1972). Juveniles can spend up to four years rearing in freshwater before migrating to the ocean as smolts, although they typically only spend one to two years in natal streams (Shapovalov and Taft 1954; Busby et al. 1996; Moyle 2002). Successful rearing depends on stream temperatures, flow velocities, and habitat availability. Preferred water temperature ranges from 12 to 19°C and sustained temperatures above 25°C are generally considered lethal (Smith and Li 1983; Busby et al. 1996; Moyle 2002; McCarthy et al. 2009). In Central California streams, juvenile steelhead are able to survive peak daily stream temperatures above 25°C for short periods when food is abundant (Smith and Li 1983). Response to stream temperatures can vary depending on the conditions to which individuals are acclimated, however, consistent exposure to high stream temperatures results in slower growth due to elevated metabolic rates and lower survival rates overall (Hokanson et al. 1977; Busby et al. 1996; Moyle 2002; McCarthy et al. 2009).

Juveniles undergo behavioral, morphological, and physiological changes in preparation for ocean entry, collectively called smoltification. Juveniles begin smoltification in freshwater and the process continues throughout downstream migration with some smolts using estuaries for further acclimation to saltwater prior to ocean entry (Smith 1990; Hayes et al. 2008). Juveniles typically will not smolt until reaching a minimum size of 160 mm (Burgner et al. 1992). Smoltification is cued by increasing photoperiod. Stream temperatures influence the rate of smoltification, with warmer temperatures leading to more rapid transition. Downstream migration of smolts typically occurs from April to June when temperature and stream flows increase. Preferred temperature for smoltification and outmigration is between 10 and 17°C with temperatures below 15°C considered optimal (Hokanson et al. 1977; Wurtsbaugh and Davis 1977; Zedonis and Newcomb 1997; Moyle 2002; Myrick and Cech 2005). In coastal systems with seasonal lagoons, smolts may take advantage of higher growth potential in productive lagoon habitats before ocean entry (Osterback et al. 2018).

Adult steelhead are known to be highly migratory during ocean residency but little is known of their habitat use and movements. They have been observed moving north and south along the continental shelf, presumably to areas of high productivity to feed (Barnhart 1986). Adults will typically spend one to two years in the ocean, feeding and growing in preparation for spawning (Shapovalov and Taft 1954; Busby et al. 1996). Upstream migration typically begins once winter rains commence and stream flows increase. For coastal systems with seasonal freshwater lagoons, winter storms are required to breech the sandbars and allow access to upstream spawning sites. Unlike most congenerics, steelhead are iteroparous, meaning they can return to spawn multiple times. Adult steelhead may spawn up to four times in their lifetime, although spawning runs predominantly consist of first-time spawners (~59%) (Shapovalov and Taft 1954). The maximum life span of steelhead is estimated to be nine years (Moyle 2002).

2.2.1.1.2. CCC Coho Salmon

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954). In contrast to the life history patterns of other anadromous salmonids, coho salmon in California generally exhibit a relatively simple three-year life cycle. Adult coho salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late fall or winter rains breach the sandbars at the mouths of coastal streams (Sandercock 1991). Migration continues into March, generally peaking in December and January, with spawning occurring shortly after arrival to the spawning ground (Shapovalov and Taft 1954).

Coho salmon are typically associated with medium to small coastal streams characterized by heavily forested watersheds; perennially-flowing reaches of cool, high-quality water; dense riparian canopy; deep pools with abundant overhead cover; instream cover consisting of large, stable woody debris and undercut banks; and gravel or cobble substrates.

Female coho salmon choose spawning areas usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and small to medium gravel substrate are present. The flow characteristics surrounding the redd usually ensure good aeration of eggs and embryos, and flushing of waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have: nearby overhead and submerged cover for holding adults; water depth of 4 to 21 inches; water velocities of 8 to 30 inches per second; clean, loosely compacted gravel (0.5 to 5 inch diameter) with less than 20 percent fine silt or sand content; cool water ranging from 39 to 50 degrees Fahrenheit (°F) with high dissolved oxygen of 8 mg/L; and inter-gravel flow sufficient to aerate the eggs. Lack of suitable gravel often limits successful spawning.

Each female builds a series of redds, moving upstream as she does so, and deposits a few hundred eggs in each. Fecundity of female coho salmon is directly proportional to size; each adult female coho salmon may deposit from 1,000 to 7,600 eggs (Sandercock 1991). Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males may also engage in spawning. Coho salmon may spawn in more than one redd and with more than one mate (Sandercock 1991). Coho salmon are semelparous meaning they die after spawning.

The eggs generally hatch after four to eight weeks, depending on water temperature. Survival and development rates depend on temperature and dissolved oxygen levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, mortality during this period can be as low as 10 percent; under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and fry survival drops sharply when fine sediment makes up 15 percent or more of the substrate. The newly hatched fry remain in the redd from two to seven weeks before emerging from the gravel (Shapovalov and Taft 1954). Upon emergence, fry seek out shallow water, usually along stream margins. As they grow, juvenile coho salmon often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools, with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August; they reside exclusively in deep pool habitat. Juvenile coho salmon prefer: well shaded pools at least 3.3 feet deep with dense overhead cover, abundant submerged cover (undercut banks, logs, roots, and other woody debris); water temperatures of 54° to 59° F (Brett 1952, Reiser and Bjornn 1979), but not exceeding 73° to 77° F (Brungs and Jones 1977) for extended time periods; dissolved oxygen levels of 4 to 9 mg/L; and water velocities of 3.5 to 9.5 inches per second in pools and 12 to 18 inches per second in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 50° to 59° F (Bell 1973, McMahon 1983). Growth is slowed considerably at 64° F and ceases at 68° F (Bell 1973).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing within the interstices of the substrate and in leaf litter in pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow. During December through February, winter rains result in increased stream flows. By March, following peak flows, fish resume feeding on insects and crustaceans, and grow rapidly.

In the spring, as yearlings, juvenile coho salmon undergo a physiological process, or smoltification, which prepares them for living in the marine environment. They begin to migrate downstream to the ocean during late March and early April, and out-migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Entry into the ocean at this time facilitates more growth and, therefore, greater marine survival (Holtby et al. 1990). At this point, the smolts are about four to five inches in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown et al. 1994). Although they can range widely in the north Pacific, movements of coho salmon from California are poorly understood.

2.2.2. Status of the Listed Species

NMFS assesses four population viability[2] parameters to discern the status of the listed ESUs and DPSs and to assess each species ability to survive and recover. These population viability parameters are: abundance, population growth rate, spatial structure, and diversity (McElhany et al. 2000). While there is insufficient data to evaluate these population viability parameters quantitatively, NMFS has used existing information to determine the general condition of the populations in the CCC steelhead DPS and the CCC coho salmon ESU, and factors responsible for the current status of these listed species.

The population viability parameters are used as surrogates for numbers, reproduction, and distribution, which are included in the regulatory definition of "jeopardize the continued existence of" (50 CFR 402.02). For example, abundance, population growth rate, and distribution are surrogates for numbers, reproduction, and distribution, respectively. The fourth parameter, diversity, is related to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained, resulting in reduced population resilience to environmental variation at local or landscape-level scales.

2.2.2.1. CCC Steelhead

Historically, approximately 70 populations 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 (McElhaney et al. 2000, 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 the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River –the largest population within the DPS (Busby et al. 1996). More recent estimates for the Russian River are on the order of 4,000 fish (NMFS 1997a). Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Pudding, and Caspar creeks) of individual run sizes of 500 fish or less (62 FR 43937; August 18, 1997). 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). In San Francisco Bay streams, reduced population sizes and fragmented habitat conditions has likely also depressed genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see Busby et al. 1996; NMFS 1997a; Good et al. 2005; Spence et al. 2008; Williams et al. 2011; and Williams et al. 2016.

---

[2] NMFS defines a viable salmonid population as "an independent population of any Pacific salmonid (genus *Oncorhynchus*) that has a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100- year time frame" (McElhany et al. 2000).

CCC steelhead long-term population trends suggest a negative growth rate, indicating the DPS may not be viable in the long-term. Populations that historically provided enough steelhead immigrants to support dependent 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 has slowed their rate of decline relative to other salmonid species. The 2005 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).

While data availability for this DPS remains generally poor, the new information for CCC steelhead available since the previous viability assessment (Spence 2016) indicates that overall extinction risk is moderate and has not changed appreciably since the prior assessment (NMFS SWFSC). Although conservation efforts for CCC steelhead have reduced some threats for this DPS, most threats remain unchanged since the previous 5-year review. In addition, increased risks of wildfires, drought, and poor ocean conditions are likely to continue and worsen. Based on the 2024 status review, NMFS concluded that the CCC steelhead DPS remains threatened (NMSF 2024).

2.2.2.2. CCC Coho Salmon

Historically, the CCC coho salmon ESU was comprised of approximately 76 coho salmon populations. Most of these were dependent populations that needed immigration from other nearby populations to ensure their long-term survival. Historically, there were 11 functionally independent populations and 1 potentially independent population of CCC coho salmon (Spence et al. 2008, Spence et al. 2012). Most of the populations in the CCC coho salmon ESU are currently doing poorly as a result of low abundance, range constriction, fragmentation, and loss of genetic diversity, as described below.

Brown et al. (1994) estimated that annual spawning numbers of coho salmon in California ranged between 200,000 and 500,000 fish in the 1940s, which declined to 100,000 fish by the 1960s, followed by a further decline to 31,000 fish by 1991. More recent abundance estimates vary from approximately 600 to 5,500 adults (Good et al. 2005). Williams et al. (2011) indicated that CCC coho salmon are likely to continue to decline in number. CCC coho salmon have also experienced acute range restriction and fragmentation. Adams et al. (1999) found that in the mid 1990’s coho salmon were present in 51 percent (98 of 191) of the streams where they were historically present, and documented an additional 23 streams within the CCC coho salmon ESU in which coho salmon were found for which there were no historical records. More recent genetic research has documented reduced genetic diversity within subpopulations of the CCC coho salmon ESU (Bjorkstedt et al. 2005). The influence of hatchery fish on wild stocks has likely also contributed to the lack of diversity through outbreeding depression and disease. Available data from the few remaining independent populations suggests population abundance continues to decline, and many independent populations that in the past supported the species overall numbers and geographic distributions have been extirpated. This suggests that populations that historically provided support to dependent populations via immigration have not been able to provide enough immigrants for many dependent populations for several decades.

The near-term (10-20 years) viability of many of the extant independent CCC coho salmon populations is of serious concern. These populations may not have enough fish to survive additional natural and human caused environmental change.

The CCC coho salmon ESU also includes coho salmon from the following conservation hatchery programs: the Russian River Coho Salmon Captive Broodstock Program at Don Clausen Fish Hatchery in Sonoma County, California, and the smaller Southern Coho Salmon Captive Broodstock Program at Kingfisher Flat Hatchery in the Scott Creek watershed, Santa Cruz County, California. While differing in size and funding, both programs were initiated in 2001 in response to severely depressed coho salmon abundances. Fish are collected from the wild, brought into the hatcheries, genetically tested, and spawned to maximize diversity and prevent inbreeding. In the hatchery, fish are raised to various ages, fed krill, tagged, and released into streams throughout the watersheds. This release strategy allows the fish to imprint on the creek with the aim that they will return to these streams as adults so they can spawn naturally. Juvenile coho salmon and coho salmon smolts have been released into several Russian River tributaries and coastal watersheds in San Mateo and Santa Cruz counties.

None of the five diversity strata defined by Bjorkstedt et al. (2005) currently support viable coho salmon populations. According to Williams et al. (2016), recent surveys suggest CCC coho salmon abundance has improved slightly since 2011 within several independent populations (mainly north of San Francisco bay), although all populations remain well below their high-risk dispensation thresholds identified by Spence et al. (2008). The Russian River and Lagunitas Creek populations are relative strongholds for the species compared to other CCC ESU populations, the former predominantly due to out-planting of hatchery-reared juvenile fish from the Russian River Coho Salmon Captive Broodstock Program.

Overall, the available new information since the 2016 viability assessment indicates the extinction risk has not changed appreciably, with slight improvements in the two northern-most diversity strata, but little change in the Coastal Diversity Stratum and perhaps worsening conditions in the Santa Cruz Mountain Stratum. The extinction risk for CCC coho salmon as a whole thus remains high (NMFS SWFSC 2023). Based on the 2023 status review, NMFS concluded that the CCC coho salmon ESU remains endangered (NMFS 2023b).

2.2.3. Status of CCC Steelhead and CCC Coho Salmon Critical Habitat

In designating critical habitat, NMFS considers the following requirements of the species: 1) space for individual and population growth and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for spawning, reproduction, and rearing offspring; and 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of the species (50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on PBFs (formerly termed PCEs and/or essential habitat types) within the designated area that are essential to the conservation or protection (81 FR 7414).

PBFs for CCC steelhead and CCC coho salmon critical habitat, and their associated essential features within freshwater include:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
2. Freshwater rearing sites with:
    a. water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility;
    b. water quality and forage supporting juvenile development; and
    c. natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
3. Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

For CCC coho salmon critical habitat, the following essential habitat types were identified: 1) juvenile summer and winter rearing areas; 2) juvenile migration corridors; 3) areas for growth and development to adulthood; 4) adult migration corridors; and 5) spawning areas. Within these areas, essential features of coho salmon critical habitat includes adequate: 1) substrate, 2) water quality, 3) water quantity, 4) water temperature, 5) water velocity, 6) cover/shelter, 7) food, 8) riparian vegetation, 9) space, and 10) safe passage conditions (64 FR 24029).

The condition of CCC steelhead and CCC coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations, and does not provide the full extent of conservation value necessary for the recovery of the species. NMFS has determined that currently depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[3]: logging, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Impacts of concern include altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas (Weitkamp *et al*. 1995; Busby *et al.* 1996; 64 FR 24049; 70 FR 37160; 70 FR 52488). Diversion and storage of river and stream flow has dramatically altered the natural hydrologic cycle in many of the streams within coho salmon ESUs and steelhead DPSs. Altered flow regimes can delay or preclude migration, dewater aquatic habitat, and strand fish in disconnected pools, while unscreened diversions can entrain juvenile fish. Similarly, land development has led to channelization of streams and placement of developed areas close to waterways.

[3] Other factors, such as over fishing and artificial propagation have also contributed to the current population status of these species. All of these human induced factors have exacerbated the adverse effects of natural environmental variability from such factors as drought and poor ocean conditions.

2.2.4. Additional Threats to CCC Steelhead and CCC Coho Salmon Critical Habitat

2.2.4.1. Global Climate Change

Another factor affecting the range-wide status of CCC steelhead and CCC coho salmon, and aquatic habitat at large, is global climate change, which presents an additional threat to salmonids and their critical habitat. Recent work by the NMFS Science Centers ranked the relative vulnerability of west-coast salmon and steelhead to climate change. In California, listed coho salmon are generally at greater risk (high to very high risk) than listed steelhead (moderate to high risk) (Crozier et al. 2019).

Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir et al. 2013). Snowmelt from the Sierra Nevada has declined; however, total annual precipitation amounts have shown no discernable change (Kadir et al. 2013). Although CCC steelhead and CCCO coho salmon are not dependent on snowmelt driven streams, they have likely already experienced some detrimental impacts from climate change through lower and more variable stream flows, warmer stream temperatures, and changes in ocean conditions. California experienced well below average precipitation during the 2012-2016 drought, as well as record high surface air temperatures in 2014 and 2015, and record low snowpack in 2015 (Williams et al. 2016). Paleoclimate reconstructions suggest the 2012-2016 drought was the most extreme in the past 500 to 1,000 years (Williams et al. 2016, Williams et al. 2020, Williams et al. 2022). Anomalously high surface temperatures substantially amplified annual water deficits during 2012-2016. California entered another period of drought in 2020. These drought periods are now likely part of a larger drought event (Williams et al. 2022). This recent long-term drought, as well as the increased incidence and magnitude of wildfires in California, have likely been exacerbated by climate change (Williams et al. 2020, Williams et al. 2022, Diffenbaugh et al. 2015, Williams et al. 2019).

The threat to these listed salmonids from global climate change is expected to increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (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, Kadir et al. 2013). Total precipitation in California may decline; critically dry years may increase (Lindley et al. 2007, Schneider 2007, Moser et al. 2012). Wildfires are expected to increase in frequency and magnitude (Westerling et al. 2011, Moser et al. 2012). Increases in wide year-to-year variation in precipitation amounts (droughts and floods) are projected to occur (Swain et al. 2018). 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). 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 (DWR 2013). 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 salmonid habitat by, for example, reducing streamflow volume and raising water temperatures during the summer.

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 (Brewer and Barry 2008; Feely 2004; Osgood 2008; Turley 2008; Abdul-Aziz *et al.* 2011; Doney *et al*. 2012). Some of these changes, including increased incidence of marine heat waves, are likely already occurring, and are expected to increase (Frolicher *et al.* 2018). In fall 2014, and again in 2019, a marine heatwave, known as “The Blob” formed throughout the northeast Pacific Ocean, which greatly affected water temperature and upwelling from the Bering Sea off Alaska, south to the coastline of Mexico. The marine waters in this region of the ocean are utilized by salmonids for foraging as they mature (Beamish 2018). Although the implications of these events on salmonid populations are not fully understood, they are having considerable adverse consequences to the productivity of these ecosystems and presumably contributing to poor marine survival salmonids. 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).

The threat of climate change to listed steelhead and coho salmon will likely be lower in the northern coastal areas due to the fog zone and benefits of old growth redwood forests, including shady, complex stream and riparian areas, and cool stream temperatures (NMFS 2014, NMFS 2016a). Climate change will impact forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreak (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will occur at low- and high-elevation forests, with expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

2.2.4.2. Water Quality

Stormwater runoff from urban areas and roadways is a primary source of water quality degradation in aquatic habitats, including streams designated as CCC steelhead and CCC coho critical habitat. Various pesticides, petroleum hydrocarbons, metals, and other toxic chemical contaminants common to commercial, industrial and residential land-use activities have been documented in stormwater runoff (Caltrans 2000, 2003a, 2003b). These chemicals are mobilized from roads, lawns, and other surfaces by rainfall or irrigation, and are transported to aquatic habitats via terrestrial runoff and discharges from stormwater conveyances (Good 1993). Recent studies have identified the degradation of some tire products as a causal factor in salmonid mortalities, even in concentrations of less than one part per billion (Tian et al. 2020). The identified contaminant, 6PPD-quinone, has been found where both rural and urban roadways drain into waterways (Sutton et al. 2019). Studies have identified this issue and determined the cause of observed mortalities of adult and juvenile coho salmon in both field (Scholz et al. 2011) and laboratory settings respectively (Chow et al. 2019).

2.3. Action Area

“Action area” means all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area encompasses the streambed and banks of Austin Creek where the existing bridge crosses the creek[4], the streambed and banks of Austin Creek along the proposed alignment for the new bridge, the roadway associated with road improvements, bridge approaches, areas needed for staging and access, areas up- and downstream of the bridge proposed to be dewatered, and approximately 100 linear feet of the creek downstream of the dewatered area where temporary construction effects may occur.

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 impacts to listed species or designated critical habitat from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The Austin Creek watershed has had an active land use history with timber harvest occurring from the late 1800s through the turn of the century and again after World War II. The timber industry boom was short-lived, as the vast majority of harvestable redwoods had been removed by the 1900s (Clar 1954). During World War II, tractor logging of Douglas fir forests followed to provide lumber for the ever-expanding urban population in California, but as Northwestern Railroad's freight business plummeted, the same railways carried vacationers and weekend travelers who constructed vacation homes in popular destinations throughout the Lower Russian River from Rio Nido to Duncan's Mills. By the 1930s, logging roads and residences were being converted to residential roads and vacation homes to capitalize on Russian River recreation and fishing opportunities. The remains of the narrow-gauge railroad, which ran from Cazadero to the headwaters of East Austin and Austin Creeks to mine magnetite, is still evident on high terraces in East Austin Creek. Effects from these mines still linger in the form of large instream gravel deposits below their source. A wild fire in the 1960s further contributed to unstable slopes and sediment erosion.

Until the early 1990s, summer dams were annually constructed out of gravel, rubble, and flashboards on the mainstem and tributaries to provide swimming opportunity for residents and the burgeoning Bay Area vacationer population. The lower 1.5 miles of Austin Creek have been mined continuously for over 60 years by Bohan and Canelis/Austin Creek Ready Mix, and periodically by early predecessors such as the railroad to Cazadero and the Sonoma County Road Department. Since 1949, approximately 1.5 million tons of aggregate material have been mined from lower Austin Creek (Cluer *et al.* 2010). Together with historic watershed uses that supplied the sediment source, these two practices reduced the channel's capacity for sediment transport, flattening the channel and filling in historic pools which provided year-round summer habitat for fish.

[4] Latitude/longitude: 38.562, -123.101

Austin Creek enters the Russian River downstream of the town of Cazadero. The watershed is primarily privately owned, except for portions under California State Park System ownership [e.g., Armstrong Woods State Park and Austin Creek State Recreation Areas (5,683 acres)]. Year-round residential and summer homes are scattered along the mainstem corridor and the lower 1.5 miles of East Austin Creek, though the watershed is generally lightly populated. Large acre parcels (120-320 acre minimums) are designated by Sonoma County throughout the majority of the watershed, though 0.3 to 10 acre minimums exist in Cazadero and along the lower mainstem. These riparian parcels are all on septic systems and wells, and are crisscrossed with dirt service roads (Laurel Marcus and Associates 2005).

Major land uses in the Austin Creek watershed include timber production, gravel mining and rural development. In 1991, after 116 years of ongoing practice, the construction of summer recreational dams in Austin Creek was stopped by the California Department of Fish & Game due to lack of permits and impacts on salmonid habitat. Addressing the impacts of historic gravel mining practices, NMFS recommended in 2003 that mining practices be changed so that instream gravel bars would be retained in order to confine the low flow channel, and maintain natural physical processes that scour and sort sediments and maintain fish habitat (Cluer *et al.* 2010). Logging continues on a smaller scale in the watershed and has been controversial in recent years due to concerns regarding listed salmonids and their habitat. Compared to other watersheds within the Russian River basin, Austin Creek has a fairly undisturbed hydrologic regime.

2.4.1. Status of Critical Habitat and Listed Species in the Action Area

Austin Creek is a fourth order stream and is approximately sixteen miles long, with thirteen miles mapped as blue line stream (CDFG 2006). The creek's headwaters originate in "the cedars", a noted serpentine bedrock ecological system with runoff and precipitation as the principal water sources (Caltrans 2024). Austin Creek and its tributaries drain a basin of approximately 68 square miles. Redwood and Douglas fir forest dominate the watershed, with oak woodlands and grasslands as a sub-dominant community type especially on ridge tops and south facing exposures.

Austin Creek is designated critical habitat for CCC steelhead and CCC coho salmon and provides migration, spawning, and rearing habitat. This portion of the action area contains suitable water quality and adequate natural cover such as shade, aquatic vegetation, large boulders, and large woody debris providing adequate habitat complexity. In addition, the action area contains physical and biological features of critical habitat for freshwater migration for both species, including adequate water quantity free from obstructions, freshwater migration corridors, natural cover, such as overhanging vegetation, and undercut banks that support juvenile and adult salmonid mobility and survival. Austin Creek flows in a southwesterly direction through this reach and the channel morphology is an aggraded stream and flows are mostly confined within the creek bed due to steep banks, and the existing bridge abutments. Riparian forest lines both banks of the channel and is the dominant vegetation type within the action area, although barren and sparsely vegetated areas are also found within the action area. Summer flows within the action area have been recently measured at approximately 0.5 cubic feet per second, sourced mainly by subsurface flows, and the creek channel substrate consists of gravel and cobble (Caltrans 2024). The lack of stormwater treatment results in conveyance of roadway runoff from the bridge directly into Austin Creek. Habitat surveys conducted by CDFW (2006) indicate that mainstem Austin Creek has impaired salmonid rearing, spawning, and migratory habitat due to low stream canopy, aggraded conditions, and high levels of fine sediment. Yet, Austin Creek is still able to provide adequate features to support rearing, spawning, and migration activities (CDFG 2006).

NMFS' recovery plans (NMFS 2016; 2012) call for a range of general actions including the restoration of floodplains and channel structure, restoration riparian conditions, improving streamflow, restoring fish passage, protecting and restoring estuarine habitat to promote recovery of both listed species. Several recovery actions are related specifically to Austin Creek and include: 1) improve the structure and composition of riparian areas to provide shade and bank stabilization; 2) ensure all future bank stabilization projects minimize RSP, and evaluate alternatives; 3) where RSP and other bank hardening is necessary, integrate other habitat-forming features – including appropriate native riparian plantings and other methodologies to minimize habitat alteration effects; 4) improve habitat complexity; 5) decrease sediment sources and improve substrate quality; and 6) improve smolt and adult passage. Recovery plan actions are primarily designed to restore ecological processes that support healthy salmonid populations, and address various activities that harm these processes and threaten the species' survival.

The mainstem of Austin Creek is a major area of steelhead production due to the deep forested canyons that provide cool water and year-round pools for over-summering fish (NMFS 2016). Historical fish surveys dating back to the 1950s exist for Austin Creek and its many tributary streams, and recently the lower mainstem has been monitored to quantify the numbers and sources of out-migrating juveniles. Sporadic historical surveys indicate that steelhead were once abundant, and coho salmon were documented occasionally. Steelhead were commonly rescued and relocated to tributary streams both within, and from out of, the basin through the 1960s. In fall 2002, NMFS conducted systematic summer juvenile sampling in mainstem Austin Creek (at the music camp) and although the data report was never finalized, the draft report indicates that steelhead in all age classes were documented within Austin Creek in fair numbers (NMFS 2003). From 2003 to 2007, the Sonoma County Water Agency (SCWA), Trout Unlimited, and NMFS collaborated in an out-migrant trapping effort to quantify steelhead and salmonid smolt migrations, and to aid the evaluation of efforts to mitigate impacts of gravel mining in the most downstream segment of Austin Creek (Katz and Hines 2007). SCWA resumed annual out-migrant trapping in 2010 for purposes of monitoring movement of juvenile steelhead from Austin Creek into the Russian River estuary. Juvenile salmon are trapped at a site located about 0.3 miles from the mouth of Austin Creek where they are tagged with Passive Integrated Transponder tags that are used to document their subsequent movements. All age classes of juvenile steelhead have been documented moving in fair numbers to the estuary. During the springs of 2010 and 2011, the fish trap in lower Austin Creek collected a total of 4,682 and 1,974 juvenile steelhead respectively, and 1,906 and 45 juvenile coho salmon respectively. More recently in March 2022, 1,603 steelhead (of which 849 were YOY), and 227 coho salmon (of which 114 were YOY) were captured (Martini-Lamb 2024).

Juvenile steelhead have been observed consistently within the action area, and are expected to occur here year-round when suitable streamflow exists. Likewise, given the suitable habitat conditions within the action area to support steelhead migration and rearing, adults are expected to occur in the action area mid-December to April. As indicated above, adult and juvenile coho salmon have historically been documented in Austin Creek, and while neither adult nor juvenile coho have been observed within the action area, they do occur in lower Austin Creek (i.e., below Ward Creek approximately 4 miles downstream of the action area), and within the Russian River. Because there are no substantial barriers to upstream migration between the Russian River and Austin Creek, it is possible that coho salmon may be found in low numbers within the action area. The number of coho and steelhead that may be present in the action area is difficult to predict with much confidence, but based on the above, NMFS expects that the action area has habitat conditions that are adequate to support juvenile steelhead and coho salmon during the proposed in-water work window (June 15 to October 15).

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 but that are not part of the 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 402.02).

2.5.1. Fish Collection and Relocation

To facilitate completion of the project, a portion of Austin Creek will need to be dewatered. As discussed above, a maximum amount of 105 linear feet will be dewatered during one construction season. The County proposes to collect and relocate fish in the dewatered area prior to, and during dewatering, to avoid fish stranding and exposure to construction activities. Before, and during dewatering of the construction site, juvenile salmonids will be captured by a qualified biologist using one or more of the following methods: dip net, seine, thrown net, block net, minnow trap, and electrofishing. Collected salmonids will be relocated to an appropriate stream reach that will minimize impacts to captured fish, and to fish that are already residing at the release site(s). Since construction is scheduled to occur between June 15 and October 15, relocation activities will occur during the summer low-flow period after emigrating smolts have left and before adults have immigrated for spawning. Only juvenile salmonids are expected to be in the action area during the construction period. Therefore, NMFS expects capture and relocation of listed salmonids will be limited to pre-smolting and YOY juveniles.

Fish collection and relocation activities pose a risk of injury or mortality to rearing juvenile salmonids. Any fish collecting gear, whether passive (Hubert 1996) or active (Hayes et al. 1996) has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish capture varies widely, depending on the method used, the ambient conditions, and the expertise and experience of the field crew. Since fish relocation activities will be conducted by qualified fisheries biologists following NMFS electrofishing guidelines (NMFS 2001), injury and mortality of juvenile salmonids during capture and relocation will be minimized. Based on prior experience with current relocation techniques and protocols likely to be used to conduct the fish relocation, unintentional mortality of listed juvenile salmonids expected from capture and handling procedures is not likely to exceed two percent.

Relocated fish may also have to compete with other fish, causing increased competition for available resources such as food and habitat. To reduce the potential for competition, fish relocation sites will be pre-approved by NMFS to ensure the sites have adequate habitat to allow for survival of transported fish and fish already present. Nonetheless, crowding could occur which would likely result in increased inter- and intraspecific competition at those sites. Responses to crowding by salmonids include self-thinning, resulting in emigration and reduced salmonid abundance with increased individual body size within the group, and/or increased competition (Keeley 2003). Relocation sites will be selected to ensure they have similar water temperatures as the capture sites, and adequate habitat to allow for survival of transported fish and fish already present. However, some of the fish released at the relocation sites may choose not to remain in these areas and move either upstream or downstream to areas that have more vacant habitat and a lower density of fish. As each fish moves, competition remains either localized to a small area or quickly diminishes as fish disperse. In some instances, relocated fish may endure some short-term stress from crowding at the relocation sites. Such stress is not likely to be sufficient to reduce their individual fitness or performance. NMFS cannot accurately estimate the number of fish likely to be exposed to competition, but does not expect this short-term stress to reduce the individual performance of juvenile salmonids, or cascade through the watershed population of these species. Fish that avoid capture during relocation may be exposed to risks described in the following section on dewatering (see Section 2.5.2 below).

As indicated above in Section 2.4.1, juvenile steelhead and coho salmon are found within Austin Creek in reaches downstream of the action area, and when considering steelhead, within the action area itself. The number of juvenile steelhead and coho salmon that may be present in the 105 linear foot dewatered area is difficult to predict with much confidence. Yet, NMFS expects juvenile steelhead, and a small number of juvenile coho, will be encountered and relocated during dewatering activities.

Applying applicable AMMs to fish collection, relocation, and dewatering activities is expected to appreciably reduce the effects of project actions on juvenile salmonids. Specifically, salmonid collection and relocation activities conducted by NMFS-approved fisheries biologists will ensure proper equipment operation and application of NMFS guidelines thereby minimizing injury and mortality to juvenile salmonids. Restricting the work window to June 15 to October 15 will limit the effects to stream rearing juvenile salmonids. NMFS expects applying AMMs will effectively minimize injury and mortality to juvenile salmonids in the action area.

2.5.2. Dewatering

As described above, completion of the project will require dewatering of Austin Creek. Gravel berms and a series of pipes will be used to temporarily divert flows around the work site during construction. Dewatering of the channel is estimated to affect up to 105 linear feet of Austin Creek. NMFS anticipates temporary changes to instream flow within, and downstream of, the project site during installation of the diversion system, and during dewatering operations. Once installation of the diversion system is complete, stream flow above and below the work site should be the same as free-flowing pre-project conditions, except within the dewatered reaches where stream flow is bypassed and/or pools are dewatered. These fluctuations in flow are anticipated to be small, gradual, and short-term, but are expected to cause a temporary loss, alteration, and reduction of aquatic habitat, and in the case of areas that will be dewatered, will likely result in mortality of any salmonids that avoid capture during fish relocation activities.

Stream flow diversion and dewatering could harm any rearing salmonid individuals by concentrating or stranding them in residual wetted areas before they are relocated. Juvenile salmonids that avoid capture in the project work area will likely die during dewatering activities due to desiccation, thermal stress, or may be crushed by equipment or foot traffic if not found by biologists while water levels within the reach recede. Because the pre-dewatering fish relocation efforts at the project site will be performed by qualified biologists, NMFS expects that the number of juvenile salmonids that will be killed as a result of stranding during dewatering activities will be very small, likely no more than one percent of the steelhead within the work site prior to dewatering.

Dewatering operations at the work site may affect benthic (bottom dwelling) aquatic macroinvertebrates, an important food source for salmonids. Benthic aquatic macroinvertebrates at the project site may be killed or their abundance reduced when river habitat is dewatered (Cushman 1985). However, effects to aquatic macroinvertebrates resulting from stream flow diversion and dewatering activities will be temporary because construction activities will be short lived, and the dewatered reach will not exceed 105 linear feet within Austin Creek. Rapid recolonization (typically one to two months) of disturbed areas by macroinvertebrates is expected following rewatering (Cushman 1985, Thomas 1986, Harvey 1986). Within the action area, the effect of macroinvertebrate loss on juvenile salmonids is likely to be negligible because food from upstream sources (via drift) would be available downstream of the dewatered area since stream flow will be bypassed around the work site. Based on the foregoing, juvenile salmonids are not anticipated to be exposed to a reduction in food sources at the work site from the minor and temporary reduction in aquatic macroinvertebrates as a result of dewatering activities.

Beyond the dewatered area, the temporary stream diversion is expected to resemble typical summer low flow conditions. The diversion system at the work site could restrict movement of listed salmonids in a manner similar to the normal seasonal isolation of pools by intermittent flow conditions that typically occur during summer within a portion of some streams throughout the range of the listed species considered in this biological opinion. Because habitat in and around the action area is adequate to support salmonids, NMFS expects salmonids will be able to find food both up- and downstream of the action area as needed during dewatering activities.

2.5.3. Increased Sedimentation and Turbidity

The proposed project will result in disturbance of the streambed and banks for construction. Construction activities within the action area may result in disturbance of the dewatered streambed and banks for equipment access, construction activities, and placement/removal of stream diversion structures. While the cofferdam and stream diversion is in place, construction activities are not expected to degrade water quality in the action area because the work areas will be dewatered and isolated from flowing waters. This disturbed soil on the creek bank is more easily mobilized when later fall and winter storms increase streamflow levels. Thus, NMFS anticipates disturbed soils could affect water quality in the action area in the form of small, short-term increases in turbidity during rewatering (i.e., cofferdam removal), and subsequent higher flow events during the first winter storms post-construction.

Instream and near-stream construction activities have been shown to result in temporary increases in turbidity (reviewed in Furniss et al. 1991, Reeves et al. 1991, Spence et al. 1996). Sediment may affect fish by a variety of mechanisms. High concentrations of suspended sediment can disrupt normal feeding behavior and efficiency (Cordone and Kelley 1961, Bjornn et al. 1977, Berg and Northcote 1985), reduce growth rates (Crouse et al. 1981), and increase plasma cortisol levels (Servizi and Martens 1992). High turbidity concentrations can reduce dissolved oxygen in the water column, result in reduced respiratory functions, reduce tolerance to disease, and can also cause fish mortality (Sigler et al. 1984, Berg and Northcote 1985, Gregory and Northcote 1993, Velagic 1995, Waters 1995). Even small pulses of turbid water will cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat and/or increase competition and predation, decreasing chances of survival. Increased sediment disposition can fill pools and reduce the amount of cover available to fish, decreasing the survival of juveniles (Alexander and Hansen 1986).

Chronic elevated sediment and turbidity levels may affect salmonids as described above. However, sedimentation and turbidity levels associated with rewetting of the construction site within the action area, and subsequent rainfall events are not expected to rise to the levels described in the previous paragraph because the project's proposed soil and channel stabilization measures will be implemented to avoid and/or minimize sediment mobilization. Additionally, Caltrans' proposed additional AMMs and BMPs specifically aimed at reducing erosion, scour, and sedimentation in storage and staging areas, and from dewatering (Caltrans 2023). Therefore, any resulting elevated turbidity levels would be minor, occur for a short period, and be well below levels and duration shown in the scientific literature as cause injury or harm to salmonids (Sigler et al. 1984, Newcombe and Jensen 1996). NMFS expects any sediment or turbidity generated by the project would not extend more than 100 feet downstream of the worksite, based on site conditions and methods used to control sedimentation and turbidity. Thus, NMFS does not anticipate harm, injury, or behavioral impacts to juvenile salmonids associated with exposure to minor elevated suspended sediment levels that could reduce their survival chances.

2.5.4. Pollution from Hazardous Materials and Contaminants During Construction

Operating equipment in and near streams has the potential to introduce hazardous materials and contaminants into streams. Potentially hazardous materials include wet and dry concrete debris, fuels, and lubricants. Spills, discharges, and leaks of these materials can enter streams directly or via runoff. If introduced into streams, these materials could impair water quality by altering the pH, reducing oxygen concentrations as the debris decomposes, or by introducing toxic chemicals such as hydrocarbons or metals into aquatic habitat. Oil and similar substances from construction equipment can contain a wide variety of polynuclear hydrocarbons (PAHs) and metals. PAHs can alter salmonid egg hatching rates and reduce egg survival as well as harm the benthic organisms that are a salmonid food source (Eisler 2000). Disturbance of streambeds by heavy equipment or construction activities can also cause the resuspension and mobilization of contaminated stream sediment with absorbed metals.

The equipment needed to complete the project has the potential to release debris, hydrocarbons, concrete, and similar contaminants into surface waters. These effects have the potential to harm or injure exposed fish and temporarily degrade habitat. However, AMMs proposed will substantially reduce or eliminate the potential for construction materials and debris to enter waterways. Limiting the work window to the dry season from June 15 to October 15 will limit hazardous material exposure to juvenile salmonids, and eliminate potential for containments to adversely affect the most sensitive life stages (i.e., eggs, alevin, and fry). Equipment will be checked daily to ensure proper operation and avoid any leaks or spills. Proper storage, treatment, and disposal of construction materials and discharge management is expected to substantially reduce or eliminate contaminants entering both waterways via runoff. A SWPPP and a SWCP will be implemented to maintain water quality during and after construction within Austin Creek, and render the potential for the project to degrade water quality and adversely affect salmonids improbable.

2.5.5. Post-Construction Water Quality

The proposed project would result in a larger bridge adding approximately 0.011 acres of net new impervious surface area in the project footprint. Despite the increased size of the new bridge, traffic is not anticipated to increase along the rural low-trafficked roadway. Currently, there is no stormwater treatment onsite, and runoff sheet flows from the bridge into Austin Creek below. Runoff from roadways has been shown to convey contaminants that are toxic to salmonids, including steelhead and coho salmon (McIntyre et al. 2018, Chow et al. 2019, Peter et al. 2018, Tian et al. 2020, Feist et al. 2018, French et al. 2022, Sutton et al. 2019). Pollutants associated with vehicular traffic are expected to originate from the impervious surface of the new bridge deck. Published work has identified stormwater from roadways and streets as causing a high percentage of rapid mortality of adult and juvenile coho salmon (Scholz et al. 2011; McIntyre et al. 2018; Chow et al. 2019) with mortality or symptoms of exposure noticeable within hours. Mortalities have now been directly linked to motor vehicle tires, which deposit the compound 6PPD and its abiotic transformation product 6PPD-q onto roads. 6PPD or [(N-(1, 3-dimethylbutyl)-N'-phenyl-p-phenylenediamine] is used to preserve the elasticity of tires. 6PPD can transform in the presence of ozone ($O3$) to 6PPD-q. 6PPD-q is ubiquitous to roadways (Sutton et al. 2019) and was identified by Tian et al. (2021) as the primary cause of urban runoff coho mortality syndrome described by Scholz et al. (2011). Subsequent examinations documented impacts to steelhead also within a few hours and neither species recovered when transferred to clean water (Chow et al. 2019; French et al. 2022). The LC50 (the concentration at which 50% of the test organisms die) for juvenile coho (1+ years old) was established at an exceedingly low level (95 parts per trillion (ng/L)(Tian et al. 2022)) that is realistic and documented in the environment (Challis et al. 2021; Johannessen et al. 2022a). Subsequent examinations of younger coho salmon juveniles have found mortality at lower levels. Greer et al. (2023) tested approximately 6-month-old coho juveniles and documented mortalities starting as low as 51.2 ng/L. They estimated an LC50 of 80.4 ng/L and a LC5 of 20.7 ng/L. Lo et al. (2023) tested juvenile coho approximately 3 weeks post swim-up and estimated a LC50 at this lifestage of 41 ng/L and a LC5 of 16.6 ng/L. There are fewer studies on steelhead thus far and no studies published examining sublethal effects on salmonids. Brinkmann et al. (2022) found a LC50 for 2-year old *O. mykiss* of 1 part per billion (µg/L) and remains the only study found reporting fish details at this time. It is anticipated that younger *O. mykiss* are likely more vulnerable to toxic effects from 6PPD-q in a manner similar to coho salmon. EPA (2024) examined these studies and many others to establish a screening value concentration expected to be generally protective of 95% of freshwater species exposed to 6PPD-q for short durations (e.g., one hour or less) of 11 ng/L.

Recent literature has also shown that mortality can be prevented by infiltrating road runoff through soil media containing organic matter, which removes 6PPD-q and other contaminants (McIntyre et al. 2015; Spromberg et al. 2016; Fardel et al. 2020; WA State DOE 2022; Navicikis-Brasch et al. 2022; McIntyre et al. 2023; Rodgers et al. 2023). Research and corresponding adaptive management surrounding 6PPD is rapidly evolving.

Heavy metals such as copper and zinc, well documented contaminants in stormwater from roadways (Caltrans 2000; 2003a, 2003b; DTSC 2021), detrimentally affect salmonids at low and environmentally realistic levels. Effects includes decreased resistance of fishes to disease, hyperactivity, impair respiration, disrupt osmoregulation and calcium levels and/or impact olfactory performance leading to disruption in critical fish behaviors at concentrations that are at, or just slightly above, ambient concentrations (Hansen et al. 1999a; 1999b; Baldwin et al. 2003; Sandahl et al. 2007; McIntyre et al. 2012).

Unlike traditional stormwater collection and conveyance practices, such as storm drain systems with direct outfalls to waterways, vegetated filter strips at the edges of paved surfaces, vegetated swales, and bioswales can collect and convey stormwater in ways that infiltrate into soils with large amounts of organic matter that bind or otherwise remove contaminants from the stormwater before it reaches a stream (Caltrans 2003b, McIntrye et al. 2015). As described above in Section 1.3, the project will treat roadway runoff associated with all impervious surfaces within the project footprint (0.250 acres) through two bioswales (Appendix B) that have a proposed treatment rating of “high”. As a result of the proposed stormwater treatment, 100% of roadway runoff within the project footprint will drain into bioswales and be treated prior to entering into Austin Creek. Thus, exposure to untreated roadway runoff (including 6PPD-q) will be avoided. Therefore, we expect mortality and other sublethal effects associated with construction of the new bridge and post-construction water quality, when implemented with the proposed preventative water quality control measures, will be avoided.

2.5.6. Removal of Riparian Vegetation, Habitat Loss, and Increased Shade

The project will result in temporary and permanent reductions in riparian vegetation during tree removal for bridge construction, access and staging, RSP installation, and bioswale construction. In total, 47 trees or stumps will be removed and/or trimmed and pruned to complete various elements of construction: 25 trees along the southern approach within the new roadway alignment and/or the new bioswale, and 22 trees within the creek bed under the footprint of the new bridge. Other herbaceous vegetation will be removed along the banks where permanent RSP will be installed for scour protection.

Riparian vegetation helps maintain stream habitat conditions necessary for salmonid growth, survival, and reproduction. Riparian zones and wetland/aquatic vegetation serve important functions in stream ecosystems such as providing shade (Pool and Berman 2001), sediment storage and filtering (Cooper et al. 1987, Mitsch and Gosselink 2000), nutrient inputs (Murphy and Meehan 1991), water quality improvements (Mitsch and Gosselink 2000), channel and streambank stability, source of woody debris that creates fish habitat diversity (Bryant 1983, Lisele 1986, Shirvell 1990), and both cover and shelter for fish (Wesche et al. 1987, Murphy and Meehan 1991. Riparian vegetation disturbance and removal can degrade these ecosystem functions and removal can degrade these ecosystem functions and impair stream habitat. Removal of riparian vegetation increases stream exposure of solar radiation, leading to increases in stream temperatures (Poole and Berman 2001).

Tree and vegetation removal will be minimized to the maximum extent feasible to prevent erosion and to reduce potential impacts of riparian vegetation removal on salmonids. The removal of riparian vegetation will result in both permanent and temporary reductions in shade and cover for fish, and will remove sources of woody debris that may contribute to habitat diversity and complexity. Trimmed vegetation is expected to grow back and the native trees and vegetation disturbed during construction will be replanted on-site, following project completion. The project site will be monitored to ensure the success of revegetation efforts to restore areas impacted by removal of native trees and riparian vegetation. Therefore, the services provided by vegetation such as shade and cover, sediment storage and filtering, nutrient inputs, sources of woody debris, and habitat complexity (i.e., cover) will remain degraded until new vegetation is replanted and becomes established. When considering complete removal of trees, we expect riparian vegetation attributes on-site will return to pre-project levels after native trees are replanted and established; possibly within 5-10 years due to Caltrans' proposed AMMs, revegetation measures, and vegetation growth rates. Because of the timing and establishment of the on-site revegetation and recruitment of new woody debris, loss of riparian vegetation may cause individual salmonids to seek alternative areas for cover and forage. Such temporary displacement of salmonids is not expected to reduce their individual performance because there are sites nearby that provide these features and can accommodate additional individuals without becoming overcrowded. However, a number of individuals could remain in the area directly adjacent to areas where vegetation is either temporarily or permanently impacted. For individuals that choose to stay in the area, the impacts of reduced shade, cover, and other vegetative services (i.e., sediment storage and filtering, nutrient input, etc.) from removal of riparian vegetation is not expected to significantly reduce their performance. Furthermore, as a result of project construction, the action area will see an increase in shaded environments on Austin Creek because of the increase in size of the new bridge. This new shaded area (0.03 acres) may provide nominal benefits (i.e., cooler water temperatures) to salmonids within the action area; however, it could also reduce the amount of riparian vegetation growing on the creek banks and bed adjacent to the bridge. Due to the small area affected by new shading, NMFS expects that the effects that bridge widening will have on riparian vegetation will not negatively impact the behavior or fitness of individual salmonids.

2.5.7. Channel Form and Function

2.5.7.1. RSP Installation

To protect the new bridge and banks from future scour, a combination of new and existing RSP will be installed on the southern and northeastern banks. Approximately 0.06 acres of existing

RSP will be repaired and reinstalled along the northeastern bank, and approximately 0.02 acres of new RSP will be installed on the southern bank.

Streams transport water and sediment from upland sources to the ocean and, the faster the streamflow, the greater the erosive force. Natural processes, including complex structures within and near the stream channel, slow water velocity and reduce erosive forces (Knighton 1998). Where existing geology and geomorphology allow, a stream channel will also naturally meander, eroding laterally and dissipating its hydraulic energy while creating a sinuous longitudinal course that dissipates its hydraulic and physical components of instream habitat used by migrating, spawning, and rearing fish and other aquatic species. For instance, specific to steelhead and salmon, a meandering, unconstrainted stream channel sorts and deposits gravel and other substrate necessary for optimal food production and spawning success. These processes contribute to the maintenance of a healthy and diverse riparian corridor for fish that supplies large woody debris (LWD) and allows floodplain engagement during appropriate winter flows (Spence et al. 1996).

By design, streambank stabilization projects prevent lateral channel migration and force streams into a simplified liner configuration without the ability to move laterally, which consequently results in stream eroding and deepening vertically (Leopold 1968; Dunne and Leopold 1978). The resulting “incised” channel fails to create and maintain aquatic and riparian habitat through lateral migration, and can instead impair groundwater/stream flow connectivity and repress floodplain and riparian habitat function. The resulting simplified stream reach typically produces limited macroinvertebrate prey and poor functional habitat for rearing juvenile salmonids (Pollock et al. 2007, Florsheim et al. 2008). Because bank stabilization utilizing RSP typically is designed to withstand high streamflow caused by large storm events, the RSP structure, and by extension the impacts to instream habitat, are long-term, harming future fish generations in perpetuity. Moreover, streambank stabilization impacts not only extend temporally but also spatially. Altered geomorphic and hydraulic processes can propagate both up- and downstream of hardened bank structures, often resulting in future bank stabilization projects within the same system (Florsheim et al. 2008). Natural earther streambanks provide complex fish habitat (e.g., undercut banks, submerged rootwads, etc.) (Fischenich and Copeland 2001), and RSP as a stabilization material is an immediate and long-term conversion of natural streambank to a relatively simple homogenous streambank structure less suitable for juvenile steelhead and salmonids (Schmetterling et al. 2001; Fischenich 2003).

Stream bank habitat degradation and long-term preclusion of natural fluvial and geomorphic processes resulting from RSP installation will result in adverse effects to CCC steelhead and CCC coho salmon critical habitat. Habitat conditions in the action area are degraded from historical conditions, and although impaired, habitat conditions are adequate to support salmonids. The RSP is likely to further degrade habitat when compared to the existing condition. By stabilizing a length of the banks of Austin Creek with RSP, the project will likely reduce the availability of migrating and rearing critical habitat PBFs by precluding natural fluvial and geomorphic processes within the action area for the foreseeable future. Fish migrating through and rearing within the action area along the proposed stabilization sites will experience degraded aquatic habitat caused by the RSP installation. The RSP and its resulting effect on natural channel-evolution process and instream habitat are expected to last well into the future. Thus, for species with typically short life-spans (3-4 years for steelhead, and 3 years for coho salmon) the RSP will not only impact individual fish but will likely manifest population-level impacts also. The long-term impacts from RSP installation likely indicates reduced productivity and abundance of steelhead and coho salmon in the action area over successive generations.

The amount of harm, injury, or mortality to steelhead and coho salmon that may result from the project's RSP is expected to be low due to the limited scope of the project compared to the extent of habitat available elsewhere in Austin Creek, and the Russian River watershed, but cannot be accurately quantified as a specific number of CCC steelhead or CCC coho salmon individuals due to the difficulties of counting the precise number of salmonids, including: 1) some life-stages are relatively small (especially as eggs, alevins, and juveniles); 2) these species live in aquatic environments where visibility is often low, hiding cover is often available, and predators feed; and 3) we cannot precisely predict where and when habitat impacts may affect these species later in their life cycles. In addition, some rearing individual steelhead or coho salmon in the action area could move away seeking more suitable habitat. Such temporary displacement of salmonids is not expected to reduce their individual performance because there are sites nearby that provide these features and can accommodate additional individuals without becoming overcrowded. However, a number of individuals could remain in the area directly adjacent to the RSP. Some proportion (likely small) of these rearing individuals would be injured or killed as a result of degraded cover and forage habitat brought about by the RSP. For example, some individuals would not be able to obtain sufficient size and would have significantly less survival probability during their first few months in the ocean.

2.5.7.2. Removal of Fill from Active Channel

In contrast to the above, the proposed action will beneficially impact and improve freshwater rearing and migration PBFs by removing existing bridge piers/piles, concrete abutments, and other miscellaneous remnant concrete from the active channel within Austin Creek. The existing abutments and bridge piers/piles are within the active channel and inhibit natural channel form and function. The proposed new abutments will be outside of the active channel and will be parallel to the flow of the creek. Removal of this fill will restore more natural form and function to this portion of the creek, and will provide a small amount of migratory and/or rearing habitat to all juvenile and adult CCC steelhead and CCC coho salmon that travel through the action area that has not been accessible since construction of the bridge. In addition, a nominal amount of critical habitat will be restored with the removal of the remnant concrete, bridge piers/piles, and abutments.

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]. 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 earlier in the discussion of environmental baseline (Section 2.4).

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. 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.

CCC steelhead and CCC coho salmon occur within Austin Creek, and are currently at low abundance levels throughout their ranges as compared to historical population estimates. Designated critical habitat for threatened CCC steelhead and endangered CCC coho salmon also occurs within Austin Creek. Human induced factors affecting steelhead and coho salmon and their critical habitat such as logging, agricultural and mining activities, urbanization, stream channelization, dams, and wetland loss, have impaired migration, spawning, and rearing habitat throughout their historic ranges.

As described in Section 2.5 Effects of the Action, NMFS identified the following components of the project that may result in effects to CCC steelhead and CCC coho salmon and/or habitat: fish collection and relocation, dewatering, increases in sedimentation and turbidity, pollution from hazardous materials and contaminants, removal of riparian vegetation, habitat loss, streambank hardening and increased shade. Of these, fish collections and relocation, dewatering, and streambank hardening/RSP placement have the potential to result in reduced fitness, injury, and/or mortality of CCC steelhead and CCC coho salmon.

2.7.1. Listed Species

The project proposes to dewater Austin Creek June 15 to October 15, during low flow conditions in the summer. Therefore, it is anticipated that only rearing juvenile salmonids would be affected by project activities and no adult salmonids or migrating smolts would be affected by the project activities. Furthermore, due to the small area of stream affected, and the low summer streamflow, NMFS estimates that a very small number of juvenile salmonids will be present in the dewatered reach prior to the construction. Individuals present will likely make up a small portion of the salmonid population within Austin Creek. Anticipated mortality from relocation is expected to be two percent (or less) of the fish relocation and mortality expected from dewatering is expected to be one percent (or less) of the fish in the area prior to dewatering (combined mortality not to exceed three percent). Due to the relatively large number of juveniles produced by each spawning pair, salmonid spawning in the area in future years are likely to produce enough juveniles to replace the few juveniles that be lost as the project site due to relocation and dewatering. Thus, it is unlikely that the small potential loss of juvenile salmonids during the life of the project will impact future adult returns.

As described in section 2.5.7.1 above, long-term habitat degradation from installation of the RSP is expected to perpetuate degraded habitat complexity, and reduce cover and forage habitat. Some proportion (likely small) of rearing individuals would be injured or killed as a result of degraded cover and forage habitat brought about by the RSP.

For short-term effects, climate change is not expected to significantly worsen existing conditions over the time frame considered in this biological opinion. Considering the above, we do not expect climate change to affect salmonids in the action area beyond the scope considered in this biological opinion. For the long-term effects, climate change would likely worsen conditions if total precipitation in California declines and critically dry years increase. These conditions would likely modify water quality, streamflow levels, rearing habitat and salmonid migration. The overall reduction in habitat quality caused by the project is limited to a small area of the watershed and therefore, even if climate change reduced the overall habitat quality in the future when combined with this proposed action any amplification in habitat degradation would be very small.

In addition to the adverse effects described above, we also consider the potential impacts of increased sedimentation and turbidity, pollution from hazardous materials and contaminants, removal of riparian vegetation, habitat loss, stormwater runoff, and increased shading. The implementation of bioswales to treat roadway runoff from impervious surfaces before entering into the water way, coupled with additional proposed AMMs pertaining to water quality treatment are expected to render the potential for fish to be exposed to pollution from hazardous materials and contaminants during, and after, construction improbable. Increased sedimentation and turbidity, and temporary loss and degradation of habitat in the dewatered area will cease shortly after construction in completed and will only result in minor impacts to salmonids. Riparian vegetation removed to construct the project will take up to 10 years to return to pre-project levels. During this timeframe, individual salmonids exposed to reduced cover and forage will be able to successfully complete their life cycle in the action area or alternatively nearby habitats. The small shaded area that will be created by the bridge (0.03 acres) is expected to only have negligible effects on salmonids. NMFS does not expect any of the aforementioned effects to combine with other effects in any significant way. Effects from construction are limited in time and area and fish losses due to capture and relocation are minimal and only occur to juvenile salmonids during a single construction season. Therefore, we do not expect the proposed project to affect the persistence or recovery of the Austin Creek population of CCC steelhead in the DPS, or CCC coho salmon in the ESU. We base this conclusion on our findings above which considered the status of the species, the environmental baseline, all of the potential effects of the action, and the cumulative effects.

2.7.2. Critical Habitat

Regarding future climate change effects in the action area, California could be subject to higher average summer air temperatures and lower total precipitation levels. Reductions in the amount of snowfall and rainfall would reduce streamflow levels in Northern California rivers. For this project, in-water activities would occur on a short-term basis; thus, the above effects of climate change are not likely to be detected within that period. If the effects of climate change are detected over the short term, they will likely materialize as moderate changes to the current climate conditions within the action area. As discussed above, climate change could modify water quality, stream flow levels, rearing habitat, and salmonid migration over the long-term. Because the overall reduction in rearing and migration habitat quality caused by the project is minor, or limited to a small area of the watershed, even if climate change reduced the overall habitat quality in the future, when combined with this proposed action any amplification in habitat degradation will be very small.

Effects to critical habitat from the proposed project are expected to include temporary impacts during construction activities, and altered habitat conditions post-construction from reduced riparian vegetation, and permanent habitat loss from RSP. During dewatering activities, forage supporting juvenile development will be diminished temporarily, and salmonid rearing habitat at will be reduced in area equal to the dewatered area temporarily. Critical habitat at the site will also suffer reductions in vegetation associated cover and forage during the construction and revegetation timeframe of 5-10 years. These reductions will diminish the quality of salmonid freshwater rearing and adult forage during the 5-10 year construction and revegetation timeframe. The installation and permanent placement of RSP will maintain degraded migration critical habitat PBFs and further degrade the available rearing critical habitat PBFs. The project as a whole is therefore expected to degrade migrating and rearing critical habitat PBFs in the action area by precluding natural fluvial and geomorphic processes within the action area for the foreseeable future. However, the overall degradation of migration and rearing PBFs in the action area is minor or of limited extent and suitable migration and rearing opportunities will remain. When added to the environmental baseline, cumulative effects, species status, the effects to critical habitat from the proposed action are not expected to appreciably reduce the quality and function of critical habitat of the larger CCC steelhead DPS, or CCC coho salmon ESU.

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 the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCC steelhead and CCC coho salmon, nor destroy or adversely modify their designated critical habitat.

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). "Harass" is further defined by guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "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:

Take of listed juvenile CCC steelhead and CCC coho salmon is likely to occur during fish relocation and dewatering of Austin Creek between June 15 and October 15. Construction activities associated with bridge demolition that require creek dewatering/diversion, and subsequent fish handling and relocation, will be completed in one construction season. The number of CCC steelhead and CCC coho salmon that are likely incidentally taken during dewatering activities is expected to be small, limited to the pre-smolt and YOY juvenile life stage. NMFS expects that no more than two percent of the juvenile steelhead and coho salmon present within the 105 linear foot dewatered area of Austin Creek will be injured, harmed, or killed during fish relocation activities. NMFS also expects that no more than one percent of the fish within the same dewatered area will be injured, harmed, or killed during dewatering activities. If more than three percent of the total number of juvenile steelhead captured are harmed or killed, incidental take will have been exceeded. Similarly, if more than three percent of the total number of juvenile coho salmon captured are harmed or killed, incidental take will have been exceeded.

Installation of RSP will also likely result in incidental take of both juvenile and adult CCC steelhead, and juvenile and adult CCC coho salmon. However, quantifying the number of fish harmed is difficult, given the complex and variable components at play. Individual fish behavior, and how that behavior adapts to evolving habitat conditions will primarily influence how many fish will be impacted by the proposed action, and to what degree. In this circumstance, NMFS cannot provide an amount of take that would be caused by the proposed action. In instances such as this, NMFS designates the expected level of take in terms of the extent of take allowed. Here, the best available indicators for the extent of take is related to the area of habitat lost due to stabilizing the streambank and arrest of natural fluvial and geomorphic processes. These variables are directly proportional to the extent and nature of adverse effects attributable to this portion of the proposed action. Therefore, for harm associated with RSP installation along Austin Creek, the square area of RSP will serve as an effective take indicator. Specifically, the anticipated take will be exceeded if the total area of RSP is greater than 0.06 acres on the northeastern bank, and 0.02 acres on the southern bank. This surrogate measure of incidental take identified can be reasonably and reliably measured, and monitored and serves as a meaningful reinitiation trigger.

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" refer to those actions the Director considers necessary or appropriate to minimize the impact of the incidental take on the species (50 CFR 402.02).

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of juvenile CCC steelhead and CCC coho salmon:

1. undertake measures to ensure that injury and mortality to salmonids resulting from fish relocation and dewatering activities is low;
2. undertake measures to minimize harm to salmonids from construction of the project and degradation of aquatic habitat; and
3. prepare and submit plans and reports regarding the effects of fish relocation, construction of the project, and post-construction site-performance.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. 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 or the contractor will allow any NMFS employee(s), or any other person designated by NMFS, to accompany field personnel to visit the project site during activities described in this opinion.

    b. Caltrans or the contractor will retain qualified biologists with expertise in the area of anadromous salmonid biology, including handling, collecting, and relocation salmonids; salmonid/habitat relationships; and biological monitoring of salmonids. Caltrans or the contractor shall ensure that all fisheries biologists working on this project be qualified to conduct fish locations in a manner which minimizes all potential risks to ESA-listed salmonids. Electrofishing, if used, shall be performed by a qualified biologist and conducted according to the *NOAA Fisheries Guidelines for Electrofished Waters Containing Salmonids Listed under* *the Endangered Species Act, June 2000.* See: http://www.nwr.noaa.gov/ ESA-Salmon-Regulations-Permits/4d Rules/upload/electro2000.pdf.

c. The biologists will monitor the construction site during placement and removal of cofferdams and channel diversions to ensure that any adverse effects to salmonids are minimized. The biologists will be on site during all dewatering events to capture, handle, and safely relocate salmonids to an appropriate location. The biologist will notify NMFS staff at 707-531-0706 or elena.meza@noaa.gov, one week prior to capture activities in order to provide an opportunity for NMFS staff to observe the activities. During fish relocation activities the fisheries biologist shall contact NMFS staff at the above number, if mortality of federally listed salmonids exceeds three percent of the total , at which time salmonids collected, NMFS will stipulate measures to reduce the take of salmonids.

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

e. If any salmonids are found dead or injured, the biological monitor will contact NMFS staff at 707-531-0706 or elena.meza@noaa.gov. All salmonid mortalities will be retained until further direction is provided by the NMFS biologist listed above.

    i. Tissue samples are to be acquired from each mortality prior to freezing the carcass per the methods identified in the NMFS Southwest Fisheries Science Center Genetic Repository protocols: Either a 1 cm square clip from the operculum or tail fin, or alternatively, complete scales (20-30) should be removed and placed on a piece of dry blotter/filter paper (e.g., Whatman brand). Fold blotter paper over for temporary storage. Samples must be airdried as soon as possible (do not wait longer than 8 hours). When tissue/paper is dry to the touch, place into a clean envelope labeled with Sample ID Number and seal the envelope.

    ii. Include the following information with each tissue sample using the Salmonid Genetic Tissue Repository form or alternative spreadsheet: Collection date, collection locations (County, river, exact location on river), collector name, collector affiliation/phone, sample ID number, species, tissue type, condition, fork length (mm), sex (M, F, or Unk), adipose fin clip (Y or N), tag (Y or N), any notes of comments.

iii. Send tissue samples to: NMFS Coastal California Genetic Repository, Southwest Fisheries Science Center, 110 McAllister Way, Santa Cruz, California 95060.

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

   a. To ensure that the project is built as designed and contractors adhere to construction best management practices, monitoring will be performed during construction by skilled individuals. Monitors will demonstrate prior knowledge and experience in stream channel design and restoration, fish passage design, construction minimization measures, and the needs of native fish, including salmonids. Monitoring will be performed daily. The monitor(s) will work in close coordination with project management personnel, the project design (engineering) team, and the construction crew to ensure that the project is built as designed.

   b. Any pumps used to divert live stream flow will be screened and maintained throughout the construction period to comply with NMFS' Fish Screening Criteria for Anadromous Salmonids (2000).

   c. Construction equipment used within the river channel will be checked each day prior to work within the river channel (top of bank to top of bank) and, if necessary, action will be taken to prevent fluid leaks. If leaks occur during work in the channel, Caltrans or their contractors will contain the spill and removed the affected soils.

   d. Once construction is completed, all project-introduced materials must be removed, unless otherwise noted above, leaving the creek as it was before construction. Excess materials should be disposed of at an appropriate disposal site.

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

   a. Caltrans must provide a written report to NMFS by January 15 of the year following construction. The report must be submitted to the parties addressed and described above in 1.c. The report must contain, at minimum, the following information:

   b. Project construction and fish relocation report – the report must contain the following contents:

      i. **Construction Related Activities –** The report(s) must include the dates the construction started, a discussion of design compliance including vegetation installation; discussion of any unanticipated effects or unanticipated levels of effects on salmonids, including 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 ESA-listed fish; the number of salmonids killed or injured during the proposed action; and photographs taken before, during, and after the activity from photo reference points.

ii. **Fish Relocation –** The report must include a description of the location from which fish were removed and the release site including photographs; the date and time of the relocation effort; a description of the equipment and methods use to collect, hold, and transport salmonids, if an electrofisher was used for fish collection, a copy of the logbook must be included; the number of fish relocated by species; the number of fish injured or killed by species and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities; and a description of any problems which may have arisen during the relocation activities and a statement as to whether or not the activities had any unforeseen effects.

c. **Post-Project Monitoring Reports and Surveys –** Project reports and survey information will be sent to the address above in 1.c., and must include the following contents:

i. **Post-Construction Vegetation Monitoring and Reporting –** Caltrans must develop and submit for NMFS' review a plan to assess the success of revegetation of the site. A draft of the revegetation monitoring plan must be submitted to NMFS (address specified above in 1.c.) for review and approval prior to the beginning of the in-stream work season. Reports documenting post-project conditions of vegetation installed at the site will be prepared and submitted annually on January 15 for the first five years following project completion, unless the site is documented to be performing poorly, then monitoring requirements will be extended. Reports will document vegetation health and survivorship and percent cover, natural recruitment of native vegetation (if any), and any maintenance or replanting needs. Photographs must be included. If poor establishment is documented, the report must include recommendations to improve conditions.

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). NMFS has no conservation recommendations for this project.

2.11. Reinitiation of Consultation

This concludes formal consultation for the King Ridge Bridge over Austin Creek Replacement (BRLO-5020(146)).

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If 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 written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

2.12. "Not Likely to Adversely Affect" Determinations

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the listed species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action (50 CFR 402.02). The applicable standard to find that a proposed action is not likely to adversely affect listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant or completely beneficial. Beneficial effects are contemporaneous positive effects without any adverse effects to the species of critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Discountable effects are those extremely unlikely to occur.

NMFS does not anticipate that the proposed action will adversely affect:

California Coastal (CC) Chinook salmon ESU (*O. tshawytscha*)
Threatened (70 FR 37160; June 28, 2005).

The CC Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams from the Klamath River in Humboldt County southward to the Russian River in Sonoma County. CC Chinook salmon are known to spawn in the lower mainstem of Austin Creek during mid- to late-fall periods (November/December), typically following significant precipitation events. Since 2010, Sonoma Water has captured an annual average of 93 Chinook salmon smolts in their Austin Creek migrant trap (J. Smith, personal communication, December 19, 2024). This trap is located near the mouth of Austin Creek, located far downstream of the action area. Given the life history described below, the high upstream location of the action area within the watershed, and the hydrologic conditions that likely limit the extent of CC Chinook salmon spawning in most years, NMFS assumes that CC Chinook salmon are unlikely to occupy the action area or reaches further upstream.

Chinook salmon are anadromous fish spending some time in both fresh- and saltwater. The older juvenile and adult life stages occur in the ocean, until the adults ascend freshwater streams to spawn. Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry juveniles newly emerged from stream gravels), and young juveniles all rear in freshwater until they become large enough to migrate to the ocean to finish rearing and maturing into adults. Ocean-type Chinook salmon are fall or early winter-run fish that enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of rivers, and spawn within a few weeks of freshwater entry when hydrologic conditions allow. Their offspring emigrate to estuarine or marine environments shortly after emergence from the redd (Healey 1991). The low-flow season, higher dry season water temperatures, and seasonal sandbars that develop in smaller coastal rivers in California favor an ocean-type life history (Kostow 1995). CC Chinook salmon of the Russian River and its tributaries are of the fall-run ocean-type life history. With this life history, smolts generally out-migrate as sub-yearlings during April through July (Myers et al. 1998) in some watersheds, but they typically emigrate from the Russian River tributaries and mainstem by early June due to warmer water temperature conditions. Ocean-type Chinook salmon in California tend to use estuaries and coastal areas for rearing, where brackish water areas provide rich food sources supporting healthy juvenile salmon growth rates.

When considering the proposed work window (June 15 to October 15), the life history of ocean-type Chinook salmon, the unlikelihood of adult Chinook salmon occupying the upper Austin Creek watershed, including the action area, due to hydrologic conditions prior to October 15, spawning habitat preferences (lower tributary spawners), and that juvenile smolts generally complete their out-migration by early June, the effects of the project and project activities are anticipated to be discountable.

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 associated physical, chemical, and biological 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-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 (50 CFR 600.905(b)).

This analysis is based, in part, on the EFH assessment provided by Caltrans and descriptions of EFH for 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 Proposed Action

Pacific Coast Salmon EFH will be adversely affected by the proposed action within Austin Creek.

3.2. Adverse Effects on Essential Fish Habitat

The potential adverse effects of the project on EFH for Pacific Coast Salmon have been described in the preceding biological opinion and include temporary disturbances to the streambed, bank, and flow from project site dewatering; temporary elevated turbidity levels from suspended sediment and degraded water quality; loss of riparian vegetation; and streambank habitat degradation and preclusion of natural fluvial and geomorphic channel dynamics. As described in the biological opinion above, the project site dewatering and turbidity effects are anticipated to be temporary and minor due to the small amount of area impacted relative to the total quantity of habitat available in the action area. The project includes measures to protect water quality before, during, and after construction, and although riparian vegetation will be degraded, on-site revegetation of native trees and vegetation will occur to replace vegetation lost during construction activities to restore the area post-construction. However, the streambank degradation, preclusion of natural fluvial and geomorphic channel dynamics will persist into the future.

3.3. Essential Fish Habitat Conservation Recommendations

Based on information developed in our effect analysis (see preceding biological opinion), NMFS has determined that the proposed action would adversely affect EFH for federally managed CCC coho salmon within the Pacific Salmon FMP. Section 305(b)(4)(A) of the MSA authorizes NMFS to provide EFH Conservation Recommendations that will minimize adverse effects of an activity on EFH. Although adverse effects are anticipated as a result of the proposed project, the proposed avoidance and minimization measures, and best management practices, in the accompanying biological opinion are sufficient to avoid, minimize, and/or mitigate for the anticipated effects. Therefore, no additional EFH Conservation Recommendations are necessary that would otherwise offset the adverse effects to EFH.

3.4. 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 are Caltrans or their contractors. Other interested users could include the California Department of Fish and Wildlife, the Regional Water Quality Control Board, citizens of affected areas, others interested in the conservation of aquatic riparian resources. Individual copies of this opinion were provided to Caltrans. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR part 600.

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

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

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

5. References

70 FR 52488: Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. Federal Register 70:52488-52536. September 2, 2005.

81 FR 7414. 2016. Listing endangered and threatened species and designating critical habitat; implementing changes to the regulations for designating critical habitat. Federal Register 81:7414-7440.

Abdul-Aziz, O.I, N.J. Mantua, 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.

Adams, P. B., M. J. Bowers, H. E. Fish, T. E. Laidig, and K. R. Silberberg. (1999). Historical and current presence-absence of coho salmon (*Oncorhynchus kisutch)* in the central California coast evolutionarily significant unit. Administrative Report SC-99-02. National Marine Fisheries Service, Santa Cruz/Tiburon Laboratory, Tiburon.

Alexander, G.R., and E.A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9-23.

Baker, P., and F. Reynolds. 1986. Life history, habitat requirements, and status of coho salmon in California. California Department of Fish and Game.

Baldwin, D. H., J. F. Sandahl, J. S. Labenia, and N. L. Scholz. 2003. Sublethal effects of copper on coho salmon: impacts on nonoverlapping receptor pathways in the peripheral olfactory nervous system. Environmental Toxicology and Chemistry: An International Journal 22(10):2266-2274.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. United States Fish and Wildlife Service Biological Report 82 (11.60). 21 pages.

Beamish, R.J., editor. 2018. The ocean ecology of Pacific salmon and trout. American Fisheries Society, Bethesda, Maryland.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. State Water Resources Control Board, Fisheries Engineering Research Program, Portland, Oregon. Contract No. DACW57-68-C-006.

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 42:1410-1417.

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 Evolutionarily 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.

Bjornn, T.C., M.A. Brusven, M.P. Molnau, J.H. Milligan, R.A. Klamt, E. Chacho, and C. Schaye. 1977. Transport of granitic sediment in streams and its effect on insects and fish. University of Idaho, Forest, Wildlife, and Range Experiment Station, Bulletin 17, Moscow, Idaho.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.

Brewer, P.G., and J. Barry. 2008. Rising Acidity in the Ocean: The Other CO2 Problem. Scientific American website article: https://www.scientificamerican.com/article/rising acidity-in-the-ocean/. September 1, 2008.

Brinkmann, M., D. Montgomery, S. Selinger, J.G.P. Miller, E. Stock, A.J. Alcaraz, J.K. Challis, L. Weber, D. Janz, M. Hecker, and S. Wiseman. 2022. Acute Toxicity of the Tire Rubber-Derived Chemical 6PPD-quinone to Four Fishes of Commercial, Cultural, and Ecological Importance. Environmental Science & Technology Letters 9(4):333-338.

Brown, L. R., P. B. Moyle, and R. M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14(2):237-261.

Brungs, W.A., and B.R. Jones. 1977. Temperature criteria for freshwater fish: protocol and procedures. EPA-600-3-77-061. Environmental Research Laboratory-Duluth, Office of Research and Development, US Environmental Protection Agency. 136 p.

Bryant, M.D. 1983. The role and management of woody debris in west coast salmonid nursery streams. North American Journal of Fisheries Management 3:322-330.

Burgner, R.L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. (1992). Distribution and origins of steelhead trout in offshore waters of the North Pacific Ocean. International North Pacific Fisheries Commission, Bulletin #51, Vancouver, B.C.

Busby, P.J., T.C. Wainwright, G.J. Bryant., L. Lierheimer, R.S. Waples, F.W. Waknitz and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho,Oregon and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-27. 261 pages.

Bustard, D.R., and D.W. Narver. (1975). Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 32(5):667-680.

Caltrans 2000. First Flush Study 1999-2000 Report, CTSW-RT-00-016, June 2000, 289 pages, https://dot.ca.gov/-/media/dot-media/programs/environmental analysis/documents/env/ctsw-rt-00-016-a11y.pdf

Caltrans 2003a. Storm Water Monitoring & Data Management Discharge Characterization Study Report, CTSW-RT-03-065.51.42, Nov. 2003, 93 pages, https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/ctsw-rt-03-065-a11y.pdf

Caltrans 2003b. Roadside Vegetated Treatment Sites (RVTS) Study, CTSW-RT-03- 028, Caltrans Division of Environmental Analysis, Nov. 2003, 63 pages, https://dot.ca.gov/-/media/dot-media/programs/environmental-analysis/documents/env/ctsw-rt-03-028-a11y.pdf

Caltrans 2024. Biological Assessment for the King Ridge Road Bridge Replacement Project. Prepared for the National Marine Fisheries Service. North-Central Coast Office. Santa Rosa, California. April.

Cayan, D., M. Tyree, and S. Iacobellis. 2012. Climate Change Scenarios for the San Francisco Region. Prepared for California Energy Commission. Publication number: CEC-500-2012-042. Scripps Institution of Oceanography, University of California, San Diego.

California Department of Fish and Game (CDFG). 2006. Stream Inventory Report, Big Austin Creek. 730 pages. April.

Challis, J., H. Popick, S. Prajapati, P. Harder, J. Giesy, K. McPhedran, and M. Brinkmann. 2021. Occurrences of tire rubber-derived contaminants in cold-climate urban runoff. Environmental Science & Technology Letters 8(11):961-967.

Chapman, D.W., and T.C. Bjornn (1969). Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176 in T. G. Northcote (ed.). Symposium on Salmon and Trout in Streams; H.R. Macmillan Lectures in Fisheries. University of British Columbia, Institute of Fisheries.

Chow, M., J.I. Lundin, C.J. Mitchell, J.W. Davis, and G. Young. 2019. An urban stormwater runoff mortality syndrome in juvenile coho salmon. Aquatic Toxicology 214. 10 pp.

Clar, C. R. 1954. Out of the river mist. River Mist Distributors.

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, R.W. Wagner, and A.D. Jassby. 2011. Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change. PLoS ONE 6(9):13.

Cluer, B., T. Holley, and H. Canelis. 2010. Results from Implementing New Instream Mining Methods 2003-2009 in Austin Creek, CA. National Marine Fisheries Service, Santa Rosa, CA.

Cooper J. R., J. W. Gilliam, R. B. Daniels, and W. P. Robarge. 1987. Riparian areas as filters for agricultural sediment. Soil Science Society of America Journal. 51:416–420.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game 47:189-228.

Cox, P., and D. Stephenson (2007). "A changing climate for prediction." Science 113: 207-208.

Crouse, M. R., C. A. Callahan, K. W. Malueg, and S. E. Dominguez. 1981. Effects of fine sediments on growth of juvenile coho salmon in laboratory streams. Transactions of the American Fisheries Society 110:281-286.

Crozier, L. G., M. M. McClure, T. Beechie, S. J. Bograd, D. A. Boughton, M. Carr, T. D. Cooney, J. B. Dunham, C. M. Greene, M. A. Haltuch, E. L. Hazen, D. M. Holzer, D. D. Huff, R. C. Johnson, C. E. Jordan, I. C. Kaplan, S. T. Lindley, N. J. Mantua, P. B. Moyle, J. M. Myers, M. W. Nelson, B. C. Spence, L. A. Weitkamp, T. H. Williams, and E. Willis-Norton. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS One 14(7):49.

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

Diffenbaugh N.S., D.L. Swain, and D. Touma. 2015. Anthropogenic warming has increased drought risk in California. PNAS Early Edition. www.pnas.org/cgi/doi/10.1073/pnas.1422385112.

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, N. Knowlton, J. Polovina, N.N. Rabalais, W.J. Sydeman, L.D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4:11-37.

Dunne, T., and L. B. Leopold. 1978. Water in environmental planning. Macmillan.

DWR (California Department of Water Resources). 2013. San Francisco Bay Hydrologic Region. California Water Plan Update 2013. State of California Natural Resource Agency Department of Water Resources, Sacramento, California.

Eisler, R. (2000). Handbook of chemical risk assessment: health hazards to humans, plants, and animals. Volume 1, Metals. Boca Raton, FL, Lewis Press.

Environmental Protection Agency (EPA). 2024. Acute Aquatic Life Screening Value for 6PPD-quinone in Freshwater, May 2024, EPA-822-R-24004. U.S. EPA Office of Water, Health and Ecological Criteria Division, Ecological Risk Assessment Branch, Washington, DC.

Everest, F.H., and D.W. Chapman (1972). Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout. Journal of the Fisheries Research Board of Canada 29: 91-100.

Fardel, A., P. E. Peyneau, B. Béchet, A. Lakel, and F. Rodriguez. 2020. Performance of two contrasting pilot swale designs for treating zinc, polycyclic aromatic hydrocarbons and glyphosate from stormwater runoff. Science of the Total Environment 743:15.

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

Feist, B.E., E.R. Buhle, D.H. Baldwin, J.A. Spromberg, S.E. Damm, J.W. Davis, and N.L. Scholz. 2017. Roads to Ruin: Conservation Threats to Sentinel Species across an Urban Gradient. Ecological Applications 27(8):2382-2396.

Feist, B.E., E.R. Buhle, D.H. Baldwin, J.A. Spromberg, S.E. Damm, J.W. Davis, N.L. Scholz. 2018. Roads to Ruin: Conservation Threats to Sentinel Species across an Urban Gradient. Ecological Applications 27(8):2382-2396.

Fischenich, J. C, and Copeland, R. R. (2001). "Environmental considerations for vegetation in Flood control channels," ERDC TR-01-16, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Fischenich, J. C. (2003). "Effects of riprap on riverine and riparian ecosystems," ERDC/EL TR 03-4, U.S.Army Engineer Research and Development Center, Vicksburg, MS.

Florsheim, J.L., J.F. Mount, and A. Chin. 2008. Bank erosion as a desirable attribute of rivers. BioScience 58(6):519-529.

Foitzik, M.-J., Unrau, H.-J., Gauterin, F., Dörnhöfer,¨J., Koch, T., 2018. Investigation of ultra fine particulate matter emission of rubber tires. Wear 394–395, 87–95. https://doi.org/10.1016/j.wear.2017.09.023.

French, B. F., D. H. Baldwin, J. Cameron, J. Prat, K. King, J. W. Davis, J. K. McIntyre, and N. L. Scholz. 2022. Urban Roadway Runoff Is Lethal to Juvenile Coho, Steelhead, and Chinook Salmonids, But Not Congeneric Sockeye. Environmental Science & Technology Letters 9(9):733-738.

Frölicher, T.L., E. M. Fischer, and N. Gruber. 2018. Marine heatwaves under global warming. Nature (Letter). 560:360.

Fukushima L., and E.W. Lesh. 1998. Adult and juvenile anadromous salmonid migration timing in California streams. California Department of Fish and Game 84(3):133-145.

Furniss, M. J., T. D. Roelofs, and C. S. Lee. (1991). Road construction and maintenance. Pages 297-323 *in* W. R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. United States Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-66. 598 pages.

Greer, J. B., E. M. Dalsky, R. F. Lane, and J. D. Hansen. 2023. Establishing an in vitro model to assess the toxicity of 6PPD-quinone and other tire wear transformation products. Environmental Science & Technology Letters 10(6):533-537.

Gregory, R., and T. 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.

Halofsky, J.E., D.L. Peterson, and B.J. Harvey. 2020. Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. Fire Ecology 16(1):4.

Hansen, J. A., J. C. Marr, J. Lipton, D. Cacela, and H. L. Bergman. 1999a. Differences in neurobehavioral responses of chinook salmon (Oncorhynchus tshawytscha) and rainbow trout (Oncorhynchus mykiss) exposed to copper and cobalt: behavioral avoidance. Environmental Toxicology and Chemistry: An International Journal 18(9):1972-1978.

Hansen, J. A., J. D. Rose, R. A. Jenkins, K. G. Gerow, and H. L. Bergman. 1999b. Chinook salmon (Oncorhynchus tshawytscha) and rainbow trout (Oncorhynchus mykiss) exposed to copper: neurophysiological and histological effects on the olfactory system. Environmental Toxicology and Chemistry: An International Journal 18(9):1979-1991.

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.

Hayes, D.B., C.P. Ferreri, and W.W. Taylor. (1996). Active fish capture methods. Pages 193-220 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd edition. American Fisheries Society. Bethesda, Maryland. 732 pages.

Hayes, S.A., M.H. Bond, C.V. Hanson, E.V. Freund, J.J. Smith, E.C. Anderson, A.J. Ammann, and B.R. MacFarlane (2008). Steelhead growth in a small central California watershed:

Upstream and estuarine rearing patterns. Transactions of the American Fisheries Society 137: 114-128.

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

Hecht, S. A., D. H. Baldwin, C. A. Mebane, T. Hawkes, S. J. Gross, and N. L. Scholz. 2007. An overview of sensory effects on juvenile salmonids exposed to dissolved copper: Applying a benchmark concentration approach to evaluate sublethal neurobehavioral toxicity.

Hokanson, K. E. F., C. F. Kleiner, and T. W. Thorslund. (1977). Effects of constant temperatures and diel temperature fluctuations on specific growth and mortality rates and yield of juvenile rainbow trout, Salmo gairdneri. Journal of the Fisheries Research Board of Canada 34:639- 648.

Holtby, L. B., B. C. Anderson, and R. K. Kadowaki. 1990. Importance of smolt size and early ocean growth to interannual variability in marine survival of coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 47(11):2181-2194.

Hubert, W. A. (1996). Passive capture techniques. Fisheries Techniques. B.R.M.a.D.W. Willis. Bethesda, Maryland, American Fisheries Society: 732.

HRD 2024. Draft Drainage Report for the King Ridge Road Bridge Replacement. Prepared for Sonoma County. Sonoma County, California. September.

Johannessen, C., P. Helm, B. Lashuk, V. Yargeau, and C. D. Metcalfe. 2022a. The Tire Wear Compounds 6PPD-Quinone and 1,3-Diphenylguanidine in an Urban Watershed. Arch Environ Contam Toxicol 82(2):171-179.

Johannessen, C., P. Helm, B. Lashuk, V. Yargeau, and C. D. Metcalfe. 2022b. The tire wear compounds 6PPD-quinone and 1, 3-diphenylguanidine in an urban watershed. Archives of environmental contamination and toxicology:1-9.

Kadir, T., L. Mazur, C. Milanes, and K. Randles. 2013. Indicators of Climate Change in California. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment Sacramento, California. 258 pages.

Katz, J., and D. Hines. 2007. Downstream migrant trapping results and steelhead (*Oncorhynchus mykiss*) smolt abundance estimate for Lower Austin Creek, 2007. Unpublished monitoring report prepared for Trout Unlimited., Santa Rosa, CA.

Keeley, E.R. (2003). An experimental analysis of self-thinning in juvenile steelhead trout. Oikos 102:543-550.

Knighton, A. D. 1998. Fluvial Forms and Processes: A New Perspective. Arnold, London. 383 pp.

Lau, J.K., T.E. Lauer, and M.M. Weinman. 2006. Impacts of Channelization on Stream Habitats and Associated Fish Assemblages in East Central Indiana. The American Midland Naturalist 156(2):319-330.

Laurel Marcus and Associates. 2005. Austin Creek Watershed Assessment. Prepared for the Sotoyome Resource Conservation District. Laurel Marcus and Associates, Oakland, CA.

Lennox, A. and J.B. Rasmussen. 2016. Long-term effects of channelization on a cold-water stream community. Canadian Journal of Fisheries and Aquatic Sciences73(10):1530 1537.

Leopold, L. B. 1968. Hydrology for urban land planning – A guidebook on the hydrologic effects of urban land use. Geological Survey circular 554. U.S. Department of the Interior, U.S. Geological Survey, Washington, D.C. 21 p.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B. May, D. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5(1):26.

Lisle, T.E. 1986. Effects of woody debris on anadromous salmonid habitat, Prince of Wales Island, Southeast Alaska. North American Journal of Fisheries Management 6:538-550.

Lo, B. P., V. L. Marlatt, X. Liao, S. Reger, C. Gallilee, A. R. Ross, and T. M. Brown. 2023. Acute toxicity of 6PPD-quinone to early life stage juvenile chinook (Oncorhynchus tshawytscha) and coho (Oncorhynchus kisutch) salmon. Environmental Toxicology and Chemistry 42(4):815-822.

Martini-Lamb, J. and Manning, D. J., editors. 2024. Russian River Biological Opinion Status and Data Report Year 2022 - DRAFT. Sonoma County Water Agency, Santa Rosa, CA.

Mayer, P. M., et al. (2024). Where the rubber meets the road: Emerging environmental impacts of tire wear particles and their chemical cocktails. Science of The Total Environment 927: 171153.

McCarthy, S. G., J. J. Duda, J. M. Emilen, G. R. Hodgson, and D. A. Beauchamp. (2009). Linking Habitat Quality with Trophic Performance of Steelhead along Forest Gradients in the South Fork Trinity River Watershed, California. Transactions of the American Fisheries Society 138:506–521.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. National Marine Fisheries Services, Northwest Fisheries Science Center and Southwest Fisheries Science Center.

McEwan, D.R. 2001. Central Valley steelhead. California Department of Fish and Game, Fish Bulletin 179(1):1-44.

McIntyre, J. K., D. H. Baldwin, D. A. Beauchamp, and N. L. Scholz. 2012. Low-level copper exposures increase visibility and vulnerability of juvenile coho salmon to cutthroat trout predators. Ecological Applications 22(5):1460-1471.

McIntyre, J. K., J. W. Davis, C. Hinman, K. H. Macneale, B. F. Anulacion, N. L. Scholz, and J. D. Stark. 2015. Soil bioretention protects juvenile salmon and their prey from the toxic impacts of urban stormwater runoff. Chemosphere 132:213-219.

McIntyre, J.K., J.I. Lundin, J.R. Cameron, M.I. Chow, J.W. Davis, J.P. Incardona, and N.L. Scholz. 2018. Interspecies Variation in the Susceptibility of adult Pacific salmon to Toxic Urban Stormwater Runoff. Environmental Pollution 238:196-203.

McIntyre, J. K., J. Spromberg, J. Cameron, J. P. Incardona, J. W. Davis, and N. L. Scholz. 2023. Bioretention filtration prevents acute mortality and reduces chronic toxicity for early life stage coho salmon (Oncorhynchus kisutch) episodically exposed to urban stormwater runoff. Science of the Total Environment 902:165759.

McMahon, T. E. (1983). Habitat suitability index models: coho salmon. United States Fish and Wildlife Service, FWS/OBS-82/10.49.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. Pages 47-82 *in* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats.

W.R. Meehan, editor. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.

Mitsch, W.J., and J.G. Gosselink. 2000. Wetlands, 3rd ed. John Wiley & Sons, New York.

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.

Moyle, P. B. (2002). Inland fishes of California. Berkeley and Los Angeles, CA, University of California Press.

Moyle, P.B., JA. Israel, and SE. Purdy (2008). Salmon, steelhead, and trout in California; status of an emblematic fauna. Report commissioned by California Trout. University of California Davis Center for Watershed Sciences, Davis, CA.

Murphy, M. L., and W. R. Meehan (1991). Stream ecosystems. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society, Special Publication Number 19. W. R. Meehan. Bethesda, MD, American Fisheries Society**:** 17-46.

Myrick, C., and J.J. Cech, Jr. (2005). Effects of temperature on the growth, food consumption, and thermal tolerance of age-0 nimbus-strain steelhead. North American Journal of Aquaculture 67: 324-330.

Navicikis-Brasch, A. S., M. Maurer, T. Hoffman-Ballard, S. Bator, and J. Diamond. 2022. Stormwater Treatment of Tire Contaminants Best Management Practices (BMP) Effectiveness, Prepared for: Washington State Department of Ecology.

Newcombe, C. P., & Jensen, J. O. 1996. Channel suspended sediment and fisheries: a synthesis for quantitative assessment of risk and impact. North American Journal of Fisheries Management, 16(4), 693-726.

Nielsen, J. L. (1992). Microhabitat-specific foraging behavior, diet, and growth of juvenile coho salmon. Transactions of the American Fisheries Society 121:617-634.

Nielson, J.L. and M.C. Fountain (2006). Microsatellite diversity in sympatric reproductive ecotypes of Pacific steelhead (*Oncorhynchus mykiss*) from the Middle Fork Eel River, California. Ecology of Freshwater Fish 8: 159-168.

NMFS (National Marine Fisheries Service). 2011. North-Central California Coast Recovery Domain 5-Year Review: Summary and Evaluation of Central California Coastal Steelhead DPS Northern California Steelhead DPS. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Region, Long Beach, California. 67 pages.

NMFS (National Marine Fisheries Service). 2012. Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

NMFS (National Marine Fisheries Service). 2016. NOAA Fisheries Service Coastal Multispecies Recovery Plan. California Coast Chinook salmon, Northern California steelhead, Central California Coast steelhead. October 2015.

NMFS (National Marine Fisheries Service). 2016a. 5-Year Review: Summary and Evaluation of Central California Coast Steelhead. National Marine Fisheries Service, West Coast Region. 55 pages.

NMFS (National Marine Fisheries Service). 2023. NOAA News. New marine heatwave emerges off West Coast, resembles “the Blob”. September 2019; updated April 2023. https://www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob

NMFS (National Marine Fisheries Service). 2023a. NOAA Fisheries Guidelines for Salmonid Passage at Stream Crossings in California, NMFS West Coast Region, Engineering and Physical Sciences Branch, Portland, Oregon.

Osgood, K.E. 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. National Oceanic and Atmospheric Administration, National Marine Fisheries Service. NOAA Technical Memorandum NMFS-F/SPO-89. 130 pages.

Osterback, A.K., C.H. Kern, E.A. Kanawi, J.M. Perez, and J.D. Kiernan (2018). The effects of early sandbar formation on the abundance and ecology of coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Oncorhynchus mykiss*) in a central California coastal lagoon. Canadian Journal of Fisheries and Aquatic Sciences. DOI: 10.1139cjfas-2017-0455.

Pearce, S., O’Connor, M., McKee, L., and Jones, B., 2003. Channel Geomorphology Assessment: A component of the watershed management plan for the Sulphur Creek watershed, Napa County, California. A Technical Report of the Regional Watershed Program, SFEI Contribution 68. San Francisco Estuary Institute, Oakland, CA.

Peter, K. T., Z. Y. Tian, C. Wu, P. Lin, S. White, B. W. Du, J. K. McIntyre, N. L. Scholz, and E. P. Kolodziej. 2018. Using High-Resolution Mass Spectrometry to Identify Organic Contaminants Linked to Urban Stormwater Mortality Syndrome in Coho Salmon. Environmental Science & Technology 52(18):10317-10327.

Pohrt, R., 2019. Tire wear particle hot spots – review of influencing factors. Facta Universitatis, Series: Mechanical Engineering 17, 17–27. https://doi.org/10.22190/FUME190104013P.

Pollock, M. M., T. J. Beechie, and C. E. Jordan. 2007. Geomorphic changes upstream of beaver dams in Bridge Creek, an incised stream channel in the interior Columbia River basin, eastern Oregon. Earth Surface Processes and Landforms 32(8):1174-1185.

Reeves, G.H., J.D. Hall, T.D. Roelofs, T.L. Hickman, and C.O. Baker. 1991. Rehabilitating and modifying stream habitats. Pages 519-557 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19. 751 pages.

Rodgers, T. F., Y. Wang, C. Humes, M. Jeronimo, C. Johannessen, S. Spraakman, A. Giang, and R. C. Scholes. 2023. Bioretention cells provide a 10-Fold reduction in 6PPD-quinone mass loadings to receiving waters: evidence from a field experiment and modeling. Environmental Science & Technology Letters 10(7):582-588.

Ruggiero, P., C. A. Brown, P. D. Komar, J. C. Allan, D. A. Reusser, H. Lee, S. S. Rumrill, P. Corcoran, H. Baron, H. Moritz, and J. Saarinen. 2010. Impacts of climate change on Oregon's coasts and estuaries. Pages 241-256 in K.D. Dellow and P. W. Mote, editors. Oregon Climate Assessment Report. College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, Oregon.

Sandahl, J. F., D. H. Baldwin, J. J. Jenkins, and N. L. Scholz. 2007. A sensory system at the interface between urban stormwater runoff and salmon survival. Environmental Science & Technology 41(8):2998-3004.

Sandercock, F. K. (1991). Life history of coho salmon. Pages 397-445 *in* C. Groot, and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver, B.C.

Satterthwaite, W.H., M.P. Beakes, E.M. Collins, D.R. Swank, J.E. Merz, R.G. Titus, S.M. Sogard, and M. Mangel (2009). Steelhead life history on California's Central Coast: Insights from a state-dependent model. Transactions of the American Fisheries Society 138: 532–548.

Santer, B. D., *et al.* (2011). "Separating signal and noise in atmospheric temperature changes: The importance of timescale." Journal of Geophysical Research: Atmospheres 116(D22).

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 U.S. Coastal and Marine Ecosystems. Estuaries, volume 25(2): 149-164.

Schneider, S.H. 2007. The unique risks to California from human-induced climate change. Source: www.climatechange.ca.gov; presentation on May, 22, 2007, by Stephen H. Schneider, Melvin and Joan Lane Professor for Interdisciplinary Environmental Studies; Professor, Department of Biological Sciences; Senior Fellow, Woods Institute for the Environment Stanford University. 23 pages.

Schmetterling, D. A., C. G. Clancy, & T.M. Brandt. 2001. Effects of riprap bank reinforcement on stream salmonids in the Western United States. Fisheries 26(7):6–13.

Scholz, N.L., M.S. Myers, S.G. McCarthy, J.S. Labenia, J.K. McIntyre, G.M. Yitalo, L.D. Rhodes, C.A. Laetz, C.M. Stehr, B.L. French, B. McMillan, D. Wilson, L. Reed, K.D. Lynch, S. Damm, J.W. Davis, and T.K. Collier. 2011. Recurrent Die-Offs of Adult Coho Salmon Returning to Spawn in Puget Sound Lowland Urban Streams. PloS ONE 6(12).

Shapovalov, L., and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game Fish Bulletin 98:1-375.

Shirvell, C.S. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) cover habitat under varying stream flows. Canadian Journal of Fisheries and Aquatic Sciences 47:852-860.

Sigler, J. W., T. C. Bjornn, and F.H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and coho salmon. Transactions of the American Fisheries Society 113:142-150.

Smith, A.K. (1973). Development and application of spawning velocity and depth criteria for Oregon salmonids. Transactions of the American Fisheries Society 102: 312- 316.

Smith, J.J., and H. Li, W. (1983). Energetic factors influencing foraging tactics of juvenile steelhead trout, *Salmo gairdneri*. In: D.L.G. Noakes, D.G. Lingquist, G.S. Helfman, and J.A. Ward (eds.) Predators and prey in fishes. The Hague, The Netherlands.

Sogard, S.M., T.H. Williams, and H. Fish. 2009. Seasonal Patterns of Abundance, Growth, and Site Fidelity of Juvenile Steelhead in a Small Coastal California Stream, Transactions of the American Fisheries Society, 138:3, 549-563.

Sonoma County. 2020. Low Impact Development (LID) Technical Design Manual

Sonoma County Resource Conservation Department. 2022. Sonoma RCD: Annual Report 2021-2022. 26 pages. https://issuu.com/sonomarcd/docs/srcd_annualreport2021-22.

Sonoma Water and California Sea Grant. 2022. Implementation of California Coastal Salmonid Population Monitoring in the Russian River Watershed. Santa Rosa, CA. 70 pp. + appendices.

Spence, B.C., E.P. Bjorkstedt, J.C. Garza, J.J. Smith, D.G. Hankin, D. 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 Technical Memorandum NOAA-TM-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, Inc. Corvallis, Oregon. December. Report. National Marine Fisheries Service, Portland, Oregon.

Spromberg, J. A., D. H. Baldwin, S. E. Damm, J. K. McIntyre, M. Huff, C. A. Sloan, B. F. Anulacion, J. W. Davis, and N. L. Scholz. 2016. Coho salmon spawner mortality in western US urban watersheds: bioinfiltration prevents lethal storm water impacts. Journal of Applied Ecology 53(2):398-407.

Sutton, R., L.D. Sedlak, M. Box, C. Gilbreath, A. Holleman, R. Miller, L. Wong, A. Munno, K. X, Zhu, and C. Rochman. 2019. Understanding Microplastic Levels, Pathways, and Transport in the San Francisco Bay Region, SFEI-ASC Publication #950, October 2019, 402 pages. https://www.sfei.org/sites/default/files/biblio_files/Microplastic%20Levels %20in%20SF%20Bay%20-%20Final%20Report.pdf.

Swain, D. L., B. Langenbrunner, J. D. Neelin, and A. Hall. 2018. Increasing precipitation volatility in twenty-first-century California. Nature Climate Change 8(5):427-433.

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

Thrower, F.P., J.J. Hard, and J.E. Joyce (2004). Genetic architecture of growth and early life-history transitions in anadromous and derived freshwater populations of steelhead. Journal of Fish Biology. 65: 286-307.

Tian Z., H. Zhao, K.T. Peter, M. Gonzalez, J. Wetzel, C. Wu, X. Hu, J. Prat, E.Mudrock, R. Hettinger, A. E. Cortina, R.G. Biswas, F.V.C Kock, R. Soong, A. Jenne, B. Du, F. Hou, H. He, R. Lundeen, A. Gibreath, R. Sutten, N.L. Scholz, J.W. Davis, M.C. Dodd, A. Simpson, J.K. McIntyre, and E.P. Kolodziej. 2020. A ubiquitous tire rubber-derived chemical induces acute mortality in coho salmon. Science 10.1126/science.abd6951.

Tian, Z. Y., H. Q. Zhao, K. T. Peter, M. Gonzalez, J. Wetzel, C. Wu, X. M. Hu, J. Prat, E. Mudrock, R. Hettinger, A. E. Cortina, R. G. Biswas, F. V. C. Kock, R. Soong, A. Jenne, B. W. Du, F. Hou, H. He, R. Lundeen, A. Gilbreath, R. Sutton, N. L. Scholz, J. W. Davis, M. C. Dodd, A. Simpson, J. K. McIntyre, and E. P. Kolodziej. 2021. A ubiquitous tire rubber-derived chemical induces acute mortality in coho salmon. Science 371(6525):185-189.

Tian, Z. Y., M. Gonzalez, C. A. Rideout, H. N. Zhao, X. M. Hu, J. Wetzel, E. Mudrock, C. A. James, J. K. McIntyre, and E. P. Kolodziej. 2022. 6PPD-Quinone: Revised Toxicity Assessment and Quantification with a Commercial Standard. Environmental Science & Technology Letters 9(2):140-146. DOI: 10.1021/acs.estlett.1c00910

Turley, C. 2008. Impacts of changing ocean chemistry in a high-CO2 world. Mineralogical Magazine 72(1):359-362.

U.S. Department of Commerce, NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California. 194 pages.

U.S. Environmental Protection Agency (USEPA) (2001). Issue Paper 5: Summary of technical literature examining the effects of temperature on salmonids. Region 10, Seattle, WA. EPA 910-D-01-005. 113pp.

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

Washington State Department of Ecology, 2022, pp. 1–234, *6PPD in Road Runoff Assessment and Mitigation Strategies*.

Waters, T. F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. 249 pages.

Weitkamp, L., A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. (1995). Status review of coho salmon from Washington, Oregon, and California. U.S. Department Of Commerce, NOAA Technical Memorandum, NMFSNWFSC- 24.

Wesche, T.A., C.M. Goertler, and C.B. Frye. 1987. Contribution of Riparian Vegetation to Trout Cover in Small Streams. North American Journal of Fisheries Management 7:151- 153.

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

Williams, T. H., S. T. Lindley, B. C. Spence, and D. A. Boughton. 2011. Status review for Pacific salmon and trout listed under the Endangered Species Act: Southwest. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 2 February 2016 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 Shaffer Road, Santa Cruz, California 95060.

Williams, A.P., J.T. Abatzoglou, A. Gershunov, J. Guzman-Morales, D.A. Bishop, J.K. Balch, and D.P. Lettenmaier. 2019. Observed Impacts of Anthropogenic Climate Change on Wildfire in California. Earth's Future 7:892–910. https://doi.org/10.1029/2019EF001210.

Williams, A.P., E.R. Cook, J.E. Smerdon, B.I. Cook, J. Abatzoglou, K. Bolles, S.H. Baek, A.M. Badger, and B. Livneh. 2020. Large contribution from anthropogenic warming to an emerging North American megadrought. Science 268:314-318.

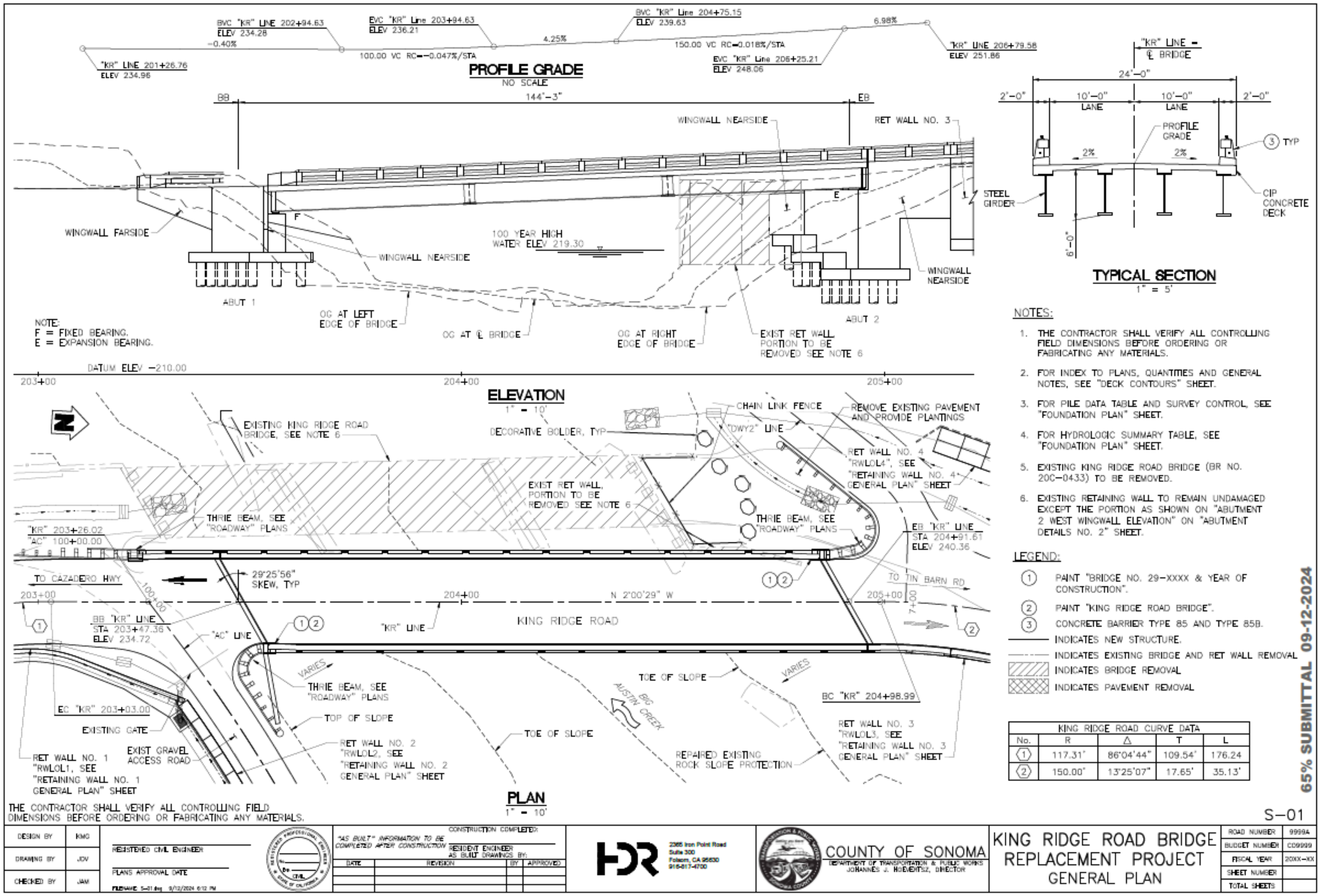
Williams, A.P., B. I. Cook, and J. E. Smerdon. 2022. Rapid intensification of the emerging southwestern North American megadrought in 2020–2021. Nature Climate Change 12:232–234.

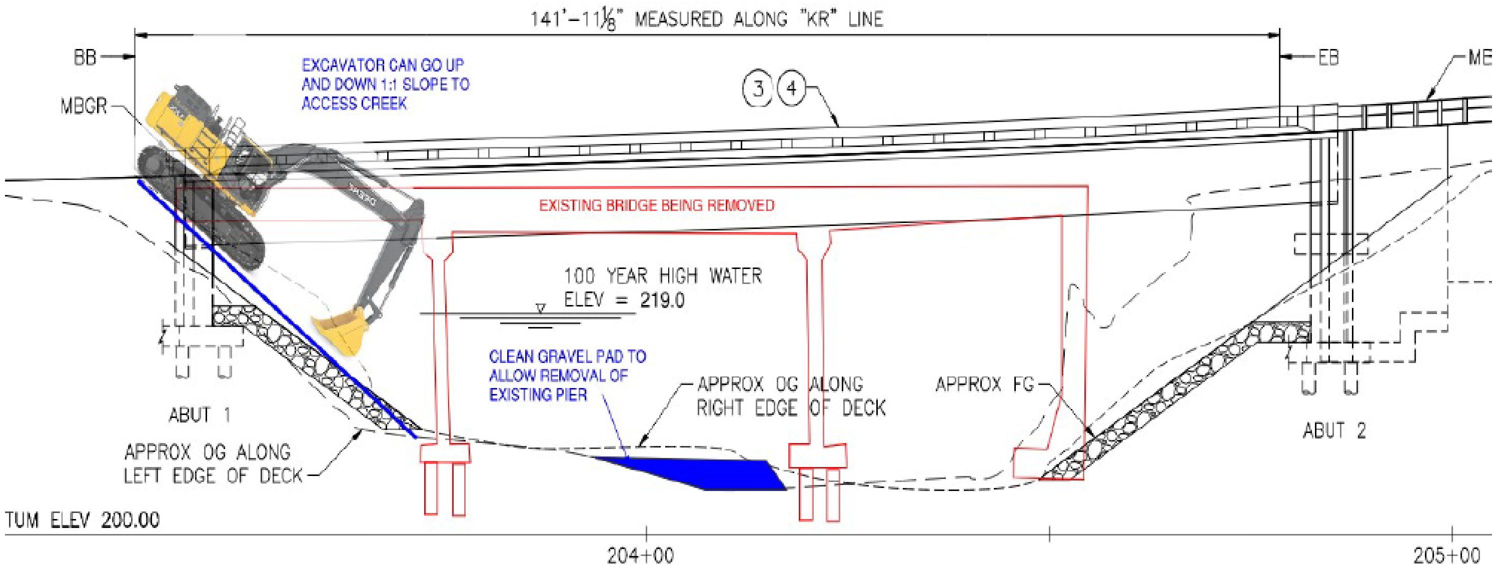
Wurtsbaugh, W.A. and G.E. Davis (1977). Effects of temperature and ration level on the growth and food conversion efficiency of *Salmo gairdneri*, Richardson. Journal of Fish Biology 11: 87-98.

Zedonis, P.A. and T.J. Newcomb (1997). An evaluation of flow and water temperatures during the spring for protection of salmon and steelhead smolts in the Trinity River, California. United States Fish and Wildlife Service, Arcata, CA.

6. APPENDICES

6.1. Appendix A: Existing/Proposed Bridge Plan Sheet





141'–11⅛" MEASURED ALONG "KR" LINE
BB
EB
ME
MBGR
EXCAVATOR CAN GO UP AND DOWN 1:1 SLOPE TO ACCESS CREEK
3
4
EXISTING BRIDGE BEING REMOVED
100 YEAR HIGH WATER ELEV = 219.0
CLEAN GRAVEL PAD TO ALLOW REMOVAL OF EXISTING PIER
APPROX OG ALONG RIGHT EDGE OF DECK
APPROX FG
ABUT 1
ABUT 2
APPROX OG ALONG LEFT EDGE OF DECK
TUM ELEV 200.00
204+00
205+00

6.2. Appendix B: Bioswale Plan Sheet