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

April 11, 2023 **Refer to NMFS No:** WCRO-2023-00362

Bryan Matsumoto
Senior Project Manager
U.S. Department of the Army Corps of Engineers
450 Golden Gate Avenue
San Francisco, California 94102

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the West Marin Drainage Rehabilitation

Dear Mr. Matsumoto:

Thank you for your letter of March 30, 2023, 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 Marin County Department of Public Works' (County) West Marin Drainage Rehabilitation.

The enclosed biological opinion is based on our review of the proposed action that would be authorized by the U.S. Army Corps of Engineers' (Corps) Section 404 of the Clean Water Act of 1972, as amended, 33 U.S.C. § 1344 et seq., and describes NMFS' analysis of potential effects on endangered Central California Coast (CCC) coho salmon *(Oncorhynchus kisutch)*, threatened CCC steelhead (*O. mykiss*), and designated critical habitat in accordance with section 7 of the ESA. In the enclosed opinion, NMFS concludes activities authorized under the Corps' permit are not likely to jeopardize the continued existence of these species; nor is it likely to adversely modify critical habitat. However, NMFS anticipates that take of juvenile CCC coho salmon and CCC steelhead is reasonably certain to occur as a result of the proposed action. Therefore, an incidental take statement with terms and conditions is included with the enclosed opinion.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)] for this action. NMFS has determined that the proposed action would adversely affect EFH for various life stages of fish species managed with the Pacific Coast Salmon Fishery Management Plan (FMP). However, because the proposed action contains adequate measures to avoid or reduce these adverse effects, NMFS has no EFH Conservation Recommendations to provide at this time.

Please contact Jodi Charrier of the California Coastal Office in Santa Rosa at 707-575-6069 or jodi.charrier@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

e-file: 151422WCR2023SR00073

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

West Marin Drainage Rehabilitation

NMFS Consultation Number: WCRO-2023-00362
Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Central California Coast (CCC) coho salmon *(Oncorhynchus kisutch)*	Endangered	Yes	No	No	No
CCC steelhead (*O. mykiss*)	Threatened	Yes	No	No	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: April 11, 2023

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1. INTRODUCTION

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

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 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 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at California Coastal NMFS office.

1.2. Consultation History

March 1, 2022 - Kallie Kull of the Marin County Department of Public Works' (County) e-mailed Jodi Charrier of NMFS to discuss the Point Reyes – Petaluma Road milepost (MP) 12.33 site.

June 7, 2022 - Horizon presented a Project overview to Jodi Charrier via video call, including specific discussion of the Point Reyes – Petaluma Road MP 12.33 site.

June 10, 2022 – The County presented a project overview to the Lagunitas Creek Technical Advisory Committee (Lag TAC), which included Jodi Charrier.

On October 21, 2022 - The County shared a project presentation and responded to preliminary questions from NMFS via email.

January 30, 2023 – Bryan Matsumoto of the Corps requested via email an informal Section 7 consultation with Bob Coey from NMFS. The email included the County's November, 2022, *West Marin Drainage Rehabilitation Project Biological Assessment* (BA, Horizon 2022).

The Corps sent a check-in email to NMFS on March 29, 2023, inquiring about the status of the January 30th consultation request.

March 30, 2023 - Jodi Charrier (NMFS) reviewed the Corps' incoming request and replied via email with the recommendation that the Corps change their effects determination from "not likely" to "likely to adversely affect federally listed species" and resubmit their request for a formal Section 7 consultation. Bryan Matsumoto (Corps) responded via email on the same day with the acknowledgement that the proposed project would require dewatering and relocation of salmonids and therefore modified their Section 7 consultation request from informal to formal.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

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 recently assessed 140 culverts for structural integrity along 14 miles of roadway, including three distinct road segments: (1) Point Reyes Petaluma Road between Highway 1 and Platform Bridge Road in Point Reyes Station; (2) Lucas Valley Road west from Milepost (MP) marker 5.29 at Big Rock to the intersection with Nicasio Valley Road in Nicasio; and (3) Nicasio Valley Road from the intersection with Sir Francis Drake Boulevard in San Geronimo Valley to the intersection with Lucas Valley Road. The County identified 32 road culverts and 3 slip-outs requiring urgent improvements due to dilapidated conditions that could incur flooding risk, safety issues, and environmental impacts. Reducing sedimentation is one of the primary goals of the project, and the County is working with the Marin Countywide Stormwater Pollution Prevention Program to comply with the County's targets for meeting the Regional Water Quality Control Board's sediment total maximum daily load (TMDL) for Lagunitas Creek. Work is proposed to occur in 2023 during the June 1- October 31 work window.

Seeger Dam (Nicasio Reservoir) was constructed in 1961 and is a barrier to fish migration. The Nicasio Road and Lucas Valley Road sites are located upstream of Seeger Dam and are thus not accessible to federally listed salmonids. Therefore, this opinion will only focus on potential impacts to listed species and designated critical habitat due to the proposed road improvements between MP 11.17 and 13.67 on the Point Reyes-Petaluma Road, which parallels Lagunitas Creek. Project activities along this 2.5-mile stretch of roadway include 3 culvert replacements, and 8 sites with inlet/outlet and riprap improvements.

Culvert maintenance treatment types for the West Marin Drainage Rehabilitation Project include: extending culvert outfall pipes to avoid flanking or undermining; grouting or lining culvert interiors; paving culvert inverts; replacing damaged sections or failed pipes in-kind; installing larger diameter pipes where culverts are undersized; repairing existing inlet drop structures placing rock riprap at culvert inlets and/or outlets; constructing concrete headwalls; and improving fish passage. Section 2 (including Tables 1 and 2) of the BA provides a detailed description of project sites, treatment types, improvement criteria, and work windows and is hereby incorporated into this opinion by reference (Horizon 2022).

The proposed improvement at the culvert at MP 12.33 of Point Reyes-Petaluma Road on Black Mountain Creek, a tributary to Lagunitas Creek, is the only site that has potential to contain listed salmonids. The other sites along Point Reyes-Petaluma Road are seasonal streams and ephemeral drainages that cannot support salmon due to insufficient hydrological surface connectivity, channel structure, and barriers to fish movement. Proposed improvements for fish passage at the MP 12.33 culvert include using 6-inch diameter rock to create a roughened bottom through 36 linear feet of the culvert interior, and preserving the existing pools near the culvert inlet and outfall. Estimated impacts include: dewatering of approximately 450 square feet of channel, placement of 0.5 cubic yards of rock and soil to fill a scour hole on the upstream side of culvert, and use of 5 cubic yards of cast-in-place concrete. Although this culvert's conveyance capacity is currently designed for a 10-year peak flowrate (vs. NMFS' recommended 100-year conveyance), this site doesn't have a history of flooding, even under the largest storm events. Therefore, a large-scale capital improvement project necessary to replace the culvert is not warranted at this time.

Culvert maintenance and slip-out repair activities will be conducted during the dry season when drainage ditches and tributaries are dry or channels exhibit minimal to intermittent flow. However, if maintenance is necessary where water is present, dewatering activities such as pumping of pools, the use of cofferdams, or a clean water bypass may be necessary. If cofferdams are used, they will be installed upstream and downstream of the work site and will divert all flow around the work site through a pipe. If a pump is necessary, the pump will operate at the rate of flow that passed through the site naturally. Pipes and pumps will be screened according to NMFS' specifications. All temporary dewatering materials will be removed from the maintenance site upon completion and normal flows will be restored immediately upon completion of work at that location.

Construction staging and stockpile areas will be limited to areas within the County's right-of-way, including road shoulders, pull-outs, and closed lanes designated as construction areas. Vegetation within the staging and stockpiling areas will be trimmed and removed as needed and the limits of the work area will be clearly defined for the contractor.

Out of the approximate construction footprint of 0.92 acre (40,075 square foot [sq.ft.]) for all 35 sites, the proposed project will result in approximately 0.134 acre (5,837 sq.ft.) of permanent impacts associated with the installation of headwalls, rock riprap, culvert repair, and culvert replacements. The proposed project will result in approximately 0.057 acre (2,570 sq.ft.) of

temporary impacts to waters of the U.S. due to channel dewatering and excavation for installation of concrete headwalls.

Avoidance and Minimization Measures

To mitigate temporary impacts from construction, the contractor will implement typical construction avoidance and minimization measures, including those addressing erosion and sediment control, work windows, hazardous materials, spill prevention, relocation of listed species and dewatering. Section 2.3 of the BA, including Table 3, contains a detailed description of these measures and is hereby incorporated into this opinion by reference (Horizon 2022).

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 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 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 coho salmon and CCC steelhead use(s) 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 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.

To conduct the assessment, NMFS examined an extensive amount of information from a variety of sources. Detailed background information on the biology and status of listed species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, and governmental and non-governmental reports. Additional information regarding the effects of the project's actions on the listed species in question, their anticipated response to these actions, and the environmental effects of the actions as a whole was formulated from the aforementioned resources and the BA (Horizon 2022) for this project. For information that has been taken directly from published, citable documents, those citations have been referenced in the text and listed at the end of this document.

The issues NMFS is obliged to address in this opinion are wide-ranging, complex, and often not directly referenced in scientific literature. We base many of our conclusions on explicit assumptions informed by the available evidence. By this, we mean to make a reasonable effort to compile the best scientific and commercial empirical evidence related to the analysis and to then apply general and specific information on salmonid biology from the published literature to make inferences and establish our conclusions. In some cases, we have used the results of recent project specific studies or analyses conducted in the action area. In other situations, only more

general local data are available on species presence or absence, and habitat condition. Where necessary, we have used this information and combined it with more general information from the scientific literature to infer salmonid response to the proposed action. In several instances, we make reasonable inferences that rely mainly on information in the scientific literature, because local data are not available.

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 faced by CCC coho salmon and CCC steelhead, 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 critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

NMFS assesses four population viability[1] parameters to discern the status of the listed DPS 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 and S-CCC steelhead DPSs and the factors responsible for the current status of these listed species

We use these population viability parameters as surrogates for "reproduction, numbers, and distribution" 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.

This opinion analyzes the effects of the proposed action on the following listed species' ESU, DPS, and designated critical habitat:

CCC coho salmon ESU
Endangered (70 FR 37160; June 28, 2005)
Critical habitat designation (64 FR 24049; May 5, 1999);

[1] 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).

Central California Coast steelhead DPS
Threatened (71 FR 834, January 5, 2006)
Critical Habitat Designation (70 FR 52488, September 2, 2005).

2.2.1. CCC Coho Salmon Status

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. There are now 11 functionally independent populations (meaning they have a high likelihood of surviving for 100 years absent anthropogenic impacts) 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 not viable, hampered by low abundance, range constriction, fragmentation, and loss of genetic diversity.

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. Abundance declined further to 100,000 fish by the 1960s, then to an estimated 31,000 fish in 1991. In the next decade, abundance estimates dropped to approximately 600 to 5,500 adults (NMFS 2005). CCC coho salmon have also experienced acute range restriction and fragmentation. Adams *et al.* (1999) found that in the mid-1990s, 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 with no historical records. Recent genetic research has documented reduced genetic diversity within subpopulations of the CCC coho salmon ESU (Bjorkstedt *et al.* 2005), likely resulting from inter-breeding between hatchery fish and wild stocks.

Available data from the few remaining independent populations suggests population abundance continues to decline, and many independent populations essential to the species' abundance 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 to support dependent populations for several decades. The viability of many of the extant independent CCC coho salmon populations over the next couple of decades is of serious concern. These populations may not have sufficient abundance levels to survive additional natural or human caused environmental change. The overall risk of CCC coho salmon extinction remains high, and the most recent status review reaffirmed the ESU's endangered status (Rogers 2016).

The substantial decline in the Russian River coho salmon abundance led to the formation of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) in 2001. Under this program, offspring of wild captive-reared coho salmon are released as juveniles into tributaries within their historic range with the expectation that some of them will return as adults to naturally reproduce. Coho salmon have been released into several tributaries within the lower Russian River watershed as well as in Salmon, Walker, and Redwood Creeks.

The five CCC coho diversity strata defined by Bjorkstedt *et al.* (2005) no longer supports viable populations. The Russian River and Lagunitas Creek populations are relative strongholds for the

species compared to other CCC coho salmon populations. According to Williams *et al.* (2016), CCC coho salmon abundance has improved slightly since 2011 within several independent populations, although all populations remain well below their recovery targets. Within the Lost Coast – Navarro Point stratum, current population sizes range from 4 to 12 percent of proposed recovery targets. Recent sampling within Pescadero Creek and San Lorenzo River, the only two independent populations within the Santa Cruz Mountains strata, suggest coho salmon have likely been extirpated within both basins.

In positive developments, excess broodstock adults from the Russian River and Olema Creek were stocked into Salmon Creek and the subsequent capture of juvenile fish indicates successful reproduction occurred. Scott Creek experienced the largest coho salmon run in a decade from 2014 to 2015, and researchers recently detected juvenile coho salmon within four dependent watersheds (San Vincente, Waddell, Soquel and Laguna creeks) where they were previously thought to be extirpated. In the fall of 2020, over 10,000 juvenile coho were released into Pescadero Creek.

2.2.2. CCC Steelhead Status

Historically, approximately 70 populations[2] of steelhead existed in the CCC steelhead DPS (Spence *et al.* 2008, Spence *et al.* 2012). About 37 of these were considered independent, or potentially independent (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 - thelargest population within the DPS (Busby *et al.* 1996). Though still below historic levels, the trend of adult returns to the Warm Springs and Coyote Valley fish facilities on the Russian River has improved since the 1980s and ‘90s. 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, 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 fragmentation of habitat has likely also led to loss of genetic diversity in these populations.

A 2008 viability assessment of CCC steelhead concluded that populations in watersheds that drain to San Francisco Bay are highly unlikely to be viable, and the limited information availabledid not indicate that any other CCC steelhead populations were demonstrably viable

[2] Population as defined by Bjorkstedt *et al.* 2005 and McElhaney *et al.* 2000 as, in brief summary, a group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group. Such fish groups may include more than one stream.

(Spence *et al*. 2008). Although there were average returns (based on the last ten years) of adult CCC steelhead during 2007/08, research monitoring data from the 2008/09 and 2009/10 adult CCC steelhead returns show a decline in returning adults across their range compared to the previous ten years. The lack of adequate spawner surveys within the Russian River precludes the estimation of wild steelhead escapement within the basin; however, hatchery returns suggest the vast majority of returning fish are of hatchery origin. Information from years of the Coastal Monitoring Program in the Santa Cruz Mountains suggests that population sizes there are higher than previously thought. However, the long-term downward trend in the Scott Creek population, which has the most robust estimates of abundance, is a source of concern. Population-level estimates of adult abundance are not available for any of the seven independent populations (i.e., Novato Creek, Corte Madera Creek, Guadalupe River, Saratoga Creek, Stevens Creek, San Francisquito Creek, and San Mateo Creek) inhabiting the watersheds of the coastal strata.

The scarcity of information on CCC steelhead abundance continues to make it difficult to assess whether conditions have changed appreciably since the previous status review assessment (Williams *et al*. 2016). The most recent status update concludes that steelhead in the CCC DPS remain "likely to become endangered in the foreseeable future", as new and additional information does not appear to suggest a change in extinction risk (Howe 2016). NMFS concluded that the CCC steelhead DPS shall remain listed as threatened (81 FR 33468; May 26, 2016).

2.2.3. Status of Critical Habitat

PBFs for CCC steelhead critical habitat within freshwater include:

- freshwater spawning sites with water quantity and quality conditions and substratesupporting spawning, incubation and larval development;
- freshwater rearing sites with:
    - water quantity and floodplain connectivity to form and maintain physical habitatconditions and support juvenile growth and mobility;
    - water quality and forage supporting juvenile development;
    - natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, andundercut banks;
- freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanginglarge wood, aquatic vegetation, large rocks and boulders, side channels, and undercutbanks 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 include 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, 24059; May 5, 1999).

The condition of designated critical habitat for CCC coho salmon and steelhead, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. 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 and bank stabilization, 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 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.

Based on NMFS familiarity with the landscapes in which these critical habitats occur, these impacts continue to persist today. Widespread water diversions in rivers and streams, as well as the pumping of groundwater hydraulically connected to streamflow, has dramatically altered the natural hydrologic cycle in many of the streams within the CCC coho salmon and steelhead DPS/ESUs which can delay or preclude migration and dewater aquatic habitat. Stream channelization, commonly caused by streambank hardening and stabilization, represents a very high threat to instream and floodplain habitat throughout much of the designated critical habitat for these species, as detailed within CCC coho salmon and steelhead recovery plans (NMFS 2016, and 2012, respectively). Streambank stabilization confines stream channels and precludes natural channel movement, resulting in increased streambed incision, reduced habitat volume and complexity.

2.2.4 Additional Threats to Listed Species and Critical Habitat

2.2.4.1 Global Climate Change

Another factor affecting the range wide status of CCC coho salmon and steelhead, and aquatic habitat at large is climate change. 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).

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

Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level increased in California over the last century (Kadir *et al.* 2013). Snowmelt from the Sierra Nevada has declined (Kadir *et al.* 2013). Although CCC coho salmon and steelhead 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 1000 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*. 2016, Williams *et al*. 2019).

The threat to CCC coho salmon and steelhead 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 and the magnitude and frequency of dry years may increase (Lindley *et al*. 2007; Schneider 2007; Moser *et al*. 2012). Similarly, 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).

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 an 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"[4], 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 of salmonids.

[4] https://www.fisheries.noaa.gov/feature-story/new-marine-heatwave-emerges-west-coast-resembles-blob

2.2.4.2 Water Quality

Recently published work has identified stormwater from roadways and streets as causing mortality of adult coho salmon in the wild (Scholz *et al*. 2011) and laboratory settings (McIntyre *et al*. 2018). Subsequent laboratory studies showed this morality also occurred in juvenile coho salmon (Chow *et al*. 2019) as well as juvenile steelhead and Chinook salmon (Brinkmann *et al.* 2022). These recent publications have identified a degradation product of tires (6PPD-quinone) as the causal factor in this mortality (Tian *et al*. 2022, Brinkmann *et al*. 2022, Tian *et al.* 2020; Peter *et al*. 2018). The parent compound (6PPD) is widely used by multiple tire manufacturers and the tire shreds/dust that produce the degradation product have been found to be ubiquitous where both rural and urban roadways drain into waterways (Feist *et al.* 2018, Sutton *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 for the West Marin Drainage Rehabilitation includes a 200-foot buffer around each of the 32 culverts and 3 slip-outs along Nicasio, Lucas Valley, and Point Reyes-Petaluma Roads in Marin County, California.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1 Status of CCC Coho Salmon and Steelhead in the Action Area

As mentioned in Section 1.3, the Proposed Federal Action, the Nicasio Road and Lucas Valley Road sites are located upstream of Seeger Dam and are thus not accessible to federally listed salmonids. The proposed road improvements between MP 11.17 and 13.67 on the Point Reyes-Petaluma Road, parallels Lagunitas Creek, which contains CCC coho salmon and steelhead. The proposed improvement at the culvert at MP 12.33 of Point Reyes-Petaluma Road on Black Mountain Creek, a tributary to Lagunitas Creek, is the only site that has potential to contain listed salmonids. The other sites along Point Reyes-Petaluma Road are seasonal streams and ephemeral drainages that cannot support salmon due to insufficient hydrological surface connectivity, channel structure, and barriers to fish movement.

The Lagunitas Creek watershed supports approximately 10 percent of the remaining CCC coho salmon population, including the southernmost wild, independent population along the Pacific

Coast. Although coho salmon are declining throughout the ESU, the Lagunitas Creek population is considered persistent and moderately abundant (NMFS 2012). According to the recovery plan, CCC steelhead within the Lagunitas Creek watershed in the North Coast diversity stratum are considered an essential independent population with a low risk of extinction (NMFS 2016). Annually, since 1995, between 25-172 coho salmon redds have been observed in Lagunitas Creek (MW 2019). Marin Water reported 120 steelhead redds and 43 live steelhead from 2015 to 2016; 35 steelhead redds and 23 live steelhead from 2016 to 2017; and 166 steelhead redds and 204 live steelhead from 2017 to 2018 (MW 2016, 2018, 2019).

During reconnaissance surveys of the MP 12.33 culvert site from 2019-2021, steelhead of varying life stages were observed in the culvert inlet and outlet scour pools. In December 2021, a single spawning coho salmon was observed in the downstream scour pool. Aquatic habitat was assessed in April 2022 from the Black Mountain Creek confluence with Lagunitas Creek, upstream through the road culvert site and Black Mountain Ranch property, to where the creek slope steepened beyond 12 percent gradient (approximate) and lacked an adequate hydroperiod and suitable flows to support fish. The assessment determined suitable salmon habitat was restricted to three small pools, including the culvert inlet and outlet scour pools and a third pool downstream of the culvert location. The creek provides no perennial habitat for fish beyond the three pools near the culvert site.

2.4.2 Status of Critical Habitat in the Action Area

Designated critical habitat for CCC coho salmon and steelhead in the action area includes the mainstem of Lagunitas Creek between MP 11.17 and 13.67 on the Point Reyes-Petaluma Road and Black Mountain Creek, an intermittent tributary of Lagunitas.

While Black Mountain Creek remains dry most of the year, a spring-fed seep approximately 400 linear feet upstream from the road maintains a perennial, segmented, reach directly upstream and downstream of Point Reyes-Petaluma Road. Flow from this seep fills scour pools at the MP 12.33 culvert inlet and outlet, and a third, smaller pool approximately 60 feet farther downstream. These pools are disconnected and isolated for most of the year and provide the only perennial aquatic habitat along Black Mountain Creek. The scour pool located directly downstream from the road culvert and the small pool 60 feet downstream from the culvert provide the highest value fish habitat. The aquatic habitat value of the pool upstream of the culvert is extremely limited due the relatively small area, shallow pool depth, and general lack of cover.

Approximately 400 feet upstream from the culvert, and 100 feet downstream from the culvert, conditions are typically drier during the dry season, with no surface water present. About 900 feet upstream of the culvert, the >15 percent slope precludes access to salmonids. A small ledge at the culvert outlet where previous pipe repairs resulted in a 3 to 6-inch jump from the outlet pool into the pipe at base flow. However, the upstream landowner reported observing adult salmon in the creek approximately 150 feet upstream from the culvert in winter 2021-2022, therefore this jump is not a salmonid migration barrier under base or higher flow conditions.

Overall, the Black Mountain Creek carrying capacity for salmonids is severely limited due to intermittent flow, limited wetted habitat during the juvenile emergence period, a general lack of pools and perennial habitat, and steep channel gradient upstream from the road crossing.

A study of the Lagunitas Creek watershed documented winter habitat as a major limiting factor for coho salmon because they experience substantial annual population declines between fall and spring (Stillwater Sciences 2008). This is also true for steelhead and is due largely to poor woody debris recruitment and limited floodplain engagement (NMFS 2016). Loss of spawning habitat above dams, fish passage barriers at road crossings, high fine sediment loads, low summer streamflow, high summer water temperature, a shortage of cover in the form of large woody debris, and loss of riparian vegetation are also impediments to critical habitat within the action area (CDFW 2004).

The RWQCB established flow and temperature conditions for Marin Water (MW) to comply with to mitigate for impacts to Lagunitas Creek following the enlargement of Kent Lake. Upstream of the action area, MW releases water from Kent Lake to ensure year-round minimum stream flows in Lagunitas Creek. MW also releases periodic flows which are intended to facilitate passage of anadromous fish through shallow areas in the creek and are required on November 15, December 1, January 1, and February 1 in the absence of a natural storm event preceding those dates (MW 2018). Based on extensive sampling within the park the majority of streams fall within the suitable range of water temperatures for salmonids during most of the year (NPS 2013, 2016, 2017).

The RWQCB listed Tomales Bay and major Tomales Bay tributaries, including Lagunitas Creek, as impaired for nutrients, pathogens, and sedimentation (SWRCB 2010). The main sources of water quality degradation in the action area are bacteria and nutrient loading from nonpoint sources associated with ranches, dairies, septic systems, and stormwater runoff (Wallitner 2013; Pawley and Lay 2013). Turbidity monitoring in Lagunitas Creek during water years 2011-2012, 2013-2014, and 2015-2016 indicates that turbidity levels are below the 25-NTU thresholds 90+ percent of the time (NPS 2013, 2016, 2017). Exceedances were detected during post-storm, high-flow events.

Since 1996, several partners including NOAA's Restoration Center, MW, the California Department of Fish and Wildlife (CDFW), the Marin Resource Conservation District (MRCD), SPAWN, the Marin Agricultural Land Trust (MALT), and the National Park Service (NPS) have undertaken restoration projects within the Lagunitas Creek watershed. Projects have included: sediment control, woody debris enhancement, rearing habitat enhancement, modification to grazing strategies, fish passage improvement, riparian exclusion fences, and watershed protection agreements with private landowners. In 2011, MW began implementing the Lagunitas Creek Winter Habitat and Floodplain Enhancement Project, carrying out actions at 10 sites to enhance winter habitat and floodplain function. In summer 2018, SPAWN initiated floodplain restoration and riparian habitat enhancement on NPS lands in the Jewell and Tocaloma areas of Lagunitas Creek. This reach of Lagunitas Creek has been identified as an opportunity to restore high value off-channel habitat for juvenile salmonids.

2.4.3 Climate Change Impacts in the Action Area

As noted in the *Marin County Climate Action Plan*, Marin County is located in a transition zone. Projections for areas to the north indicate wetter and warmer conditions, while projections for areas to the south indicate drier and warmer conditions, making it particularly difficult to project impacts. (Marin County 2015). Current projections indicate that temperatures will continue to increase, and Marin County may experience drier summers and wetter winters with heavier rain events (Marin County 2015). An increase in heavier rain events may cause inland flooding, which increases storm surge frequency and stormwater runoff and could increase soil erosion in the action area, specifically in areas with high concentrated use that are devoid of vegetation. Changes in precipitation patterns could also affect potential for soil compaction by altering soil moisture conditions across the landscape.

A projected increase in temperature could result in increases in extreme heat conditions, inland flooding, rising sea levels, and a shift in water demand and supply (Marin County 2015). Drought, flooding, and water supply could be altered in the action area; however, all ranches in the action area are at an elevation where sea level rise would not have a direct impact. Specific changes in water resources in the action area as a result of climate change are difficult to predict. An increase in heavier rain events may cause inland flooding, which increases storm surge frequency and stormwater runoff and could potentially increase pollution in surface waters.

Climate change may alter the temperature and annual rainfall amounts in the action area, although these changes are difficult to project. Impacts could include loss of wetland habitats from drought and encroachment of trees and scrub into coastal prairie (Bagne *et al.* 2012). Drought also has the potential to increase the risk of wildfire, which would affect all vegetation in the location where a fire occurs. In October 2020, the Woodward Fire burned almost 5,000 acres located within PRNS (outside of the action area).

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 (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

2.5.1 Fish Collection, Relocation, and Dewatering

Approximately 450 square feet of stream channel at the MP 12.33 culvert will require temporary dewatering, and capturing and relocating fish may be necessary. Streamflow will be diverted around the project site and fish will be captured and relocated to a stream reach outside of the work area.

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 effects of seining and dip-netting on juvenile fish include stress, scale loss, physical damage, suffocation, and desiccation. Electrofishing can kill juvenile fish, and researchers have found serious sub-lethal effects including spinal injuries (Nielsen 1998, Nordwall 1999).

The primary contributing factors to stress and death from handling are differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC (64ºF) or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in holding facilities, if the tanks are not emptied on a regular basis. Although sites selected for relocating fish will likely have similar water temperature as the capture site and should have ample habitat, in some instances relocated fish may endure short-term stress from crowding at the relocation sites. Relocated fish may also have to compete with other native and non-native fishes for available resources such as food and habitat. Some of the fish at the relocation sites may move and reside in areas that have more suitable habitat and lower fish densities. As each fish moves, competition is expected to remain localized to a small area or quickly diminish as fish disperse. Capturing and handling all fish causes them stress, though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived.

Streamflow diversion and dewatering could harm individual rearing juvenile salmonids by concentrating or stranding them in residual wetted areas before they are relocated. Juvenile fish that avoid capture in the project work area will likely die during dewatering activities due to desiccation or thermal stress. These impacts are typically short duration, lasting a few hours at a time during active construction. Water withdrawal without an adequate fish screen can entrain juvenile fish, which typically injures or kills them.

Stress to juvenile coho salmon and steelhead caused by dewatering and handling is not likely to be sufficient to reduce their individual fitness or performance. Restricting the work window to June 15 through October 31 will largely limit the effects to stream rearing juveniles. Sites selected for relocation should have similar water temperatures as the capture sites, and should have adequate habitat to allow for survival of transported fish. NMFS cannot accurately estimate the number of fish that may be affected by competition, but does not expect this short-term stress to reduce the individual performance of juvenile coho salmon or steelhead, or cascade through watershed populations of these species based on the small areas to be affected and the relatively small number of steelhead to be relocated. The AMMs proposed for fish capture and release, use of pump-intake screens during the de-watering phase, and fish passage around the isolation area are based on standard NMFS guidance to reduce the adverse effects of these activities (NMFS 2011). Key conservation measures in the guidance such as avoiding work during times of high stream temperatures significantly reduces mortality that can occur during work area isolation. Use of properly sized screens during water withdrawal will reduce or nearly eliminate injury or death of fish caused by entrainment.

Given the variable densities of coho salmon and steelhead throughout the culvert area, the number of coho salmon steelhead encountered and estimates of mortality will vary with project

location, timing, and magnitude. Fish relocation activities will occur during the summer low-flow period after emigrating smolts have left the proposed project sites and before adult fish travel upstream in the winter. Therefore, coho salmon and steelhead that may be captured will be juveniles, generally young-of-the-year and one-year age classes. Since fish relocation activities will be conducted by qualified fisheries biologists following NMFS electrofishing guidelines (NMFS 2000), injury and mortality of juvenile salmonids during capture and relocation will be minimized. The guidelines provided by NMFS and applicable AMMs are expected to be effective at removing coho salmon and steelhead from work sites and therefore we anticipate that that less than one percent of coho salmon and steelhead in an area will remain in a project site following dewatering. Any fish that remain would likely die during dewatering. Data on fish relocation efforts between 2002 and 2009 show mortality rates from fish capture and relocation are approximately two percent for coho salmon and steelhead (Collins 2004; CDFW 2005, 2006, 2007, 2008, 2009, 2010). Therefore, unintentional mortality of juvenile coho salmon and steelhead expected from dewatering, capture, and handling procedures is not likely to exceed three percent.

2.5.2 Impaired Water Quality

Construction in and near streams has the potential to cause turbidity and sedimentation, as well as the release of contaminants into aquatic habitat. Although the culvert at MP 12.33 is the only site that my incur direct impacts to CCC coho salmon and steelhead, the other proposed site improvements between MP 11.17 and 13.67 on the Point Reyes-Petaluma Road, could potentially temporarily increase suspended sediment concentrations and turbidity downstream into Lagunitas Creek. It is anticipated that juvenile coho salmon and steelhead within the action area may be exposed to small, short-term, pulses of turbidity. These pulses may occur either: 1) when previously armored sediment in a dry channel is mobilized as the action area re-waters the following fall; or 2) immediately during construction activities that require dewatering.

Deposition of fine sediments can reduce incubation success (Bell 1991), interfere with primary and secondary productivity (Spence *et al.* 1996), and degrade cover for juvenile salmonids (Bjornn and Reiser 1991). Chronic, moderate turbidity can harm newly-emerged salmonid fry, juveniles, and even adults by causing physiological stress that reduces feeding and growth and increases basal metabolic requirements (Bjornn and Reiser1991, Servizi and Martens 1991, Spence *et al.* 1996). Sedimentation leads to increased substrate embeddedness and a reduction in the depth, volume, and frequency of pools. The overall effect of high levels of sediment input is a substantial reduction in the quality and extent of spawning gravels and deep-water refugia for adults and reduced survival of eggs and alevin (Meehan and Bjorn1991). Sediment deposition can alter macroinvertebrate community composition and reduce the density, biomass, and diversity of aquatic invertebrates available to foraging juveniles. As visual predators, turbid conditions can reduce the foraging efficiency of salmonids thereby reducing growth rates if conditions continue for long periods (Shaw and Richardson 2001).

Water quality monitoring performed in Humboldt County at eleven newly replaced stream culverts provides information that is useful in assessing the relative magnitude of construction effects on in-stream water quality. During the first winter following construction activities, turbidity levels downstream of the eleven culverts increased an average of 19 percent when compared to measurements directly above the culvert (Humboldt County 2002, 2003 and 2004).

Although the culvert monitoring results show decreasing sediment effects as projects age from year 1 to year 3, a more important consideration is that most measurements fell within levels that were likely to only cause slight behavioral changes [e.g., increased gill flaring (Berg and Northcote 1985), elevated cough frequency (Servizi and Marten 1992), and avoidance behavior (Sigler *et al*. 1984)]. A turbidity level greater than 5 nephelometric turbidity units (NTU) is considered visible and levels above 25 NTU have been shown to cause reductions in salmonid growth (Sigler *et al*. 1984). Turbidity levels necessary to impair feeding are likely in the 100-150 NTU range (Harvey and White 2008; Gregory and Northcote 2003). Only one of the eleven sites in Humboldt County recorded levels exceeding 100 NTU (NF Anker Creek, year 1), whereas the majority (81 percent) of downstream readings was less than 20 NTU.

Downstream sediment effects from the proposed drainage rehabilitation activities are expected to extend downstream no further than a few hundred feet below project sites. Given the similar scope and disturbance effects of projects, NMFS anticipates turbidity effects will fall below thresholds that result in the injury or mortality of listed salmonids. Instead, the most likely result of turbidity levels will be minor behavioral responses by affected fish that are unlikely to appreciably reduce their fitness. Project activities are proposed to occur during work windows that coincide with the lowest flows of the year. Conducting work during these times results in less mobilization of fine sediments, therefore NMFS expects that any exposure to temporary turbidity pulses will not result in a reduction in survival rates.

Construction operations in, over, and near surface waters have the potential to release debris, hydrocarbons, concrete, wood preservatives, fuels, and similar contaminants into streams. 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 decompose, or by introducing toxic chemicals such as hydrocarbons or metals into aquatic habitat. Oils and similar substances from construction equipment can contain a wide variety of polynuclear hydrocarbons (PAHs) and metals. PAHs can be acutely toxic to salmonid fish and other aquatic organisms at high levels of exposure and can cause sublethal adverse effects to aquatic organisms at lower concentrations (Heintz *et al*. 1999; Incardona *et al*. 2004; Incardona *et al*. 2005; Incardona *et al*. 2006).

All freshwater life stages of coho salmon and steelhead within the action area may also be exposed to degraded water quality due to stormwater runoff on approach roadways and impervious surfaces in urban areas. Stormwater runoff to streams is a likely consequence of a project when activities include: 1) new impervious surfaces; 2) repairs or replacement of an existing impervious surface; 3) increases in existing impervious surface area; and 4) new or replacement discharge/outfall structures. As mentioned in Section 2.2.4.2, recent publications have identified a degradation product of tires (6PPD-quinone) as the causal factor in salmonid mortality at concentrations of less than a part per billion (Tian *et al.* 2022, Brinkmann *et al.* 2022, Tian *et al.* 2020; Peter *et al.* 2018).

Projects will apply AMMs to address spills appropriately and prevent the introduction of contaminants into Lagunitas Creek. Limiting the work window to the dry season from June 15 to October 15 will limit hazardous material exposure to juvenile coho salmon and steelhead and eliminate potential for contaminants to adversely affect more sensitive life stages. Proper storage,

treatment, and disposal of construction materials and discharge management is expected to substantially reduce or eliminate contaminants entering streams from runoff. Any poured concrete will be excluded from the wetted channel for a period of 30 days after it is poured. During that time, the poured concrete shall be kept moist, and runoff from the concrete shall not be allowed to enter the stream. Due to these measures, conveyance of toxic chemicals into waters from projects implemented under the West Marin Drainage Rehabilitation will be minimized.

We cannot estimate the precise number of individual CCC coho salmon and steelhead that will experience adverse effects from exposure to construction materials, contaminants, or stormwater. We cannot predict the number or duration of stormwater runoff events, nor the number of individual fish that will be exposed during those events. Furthermore, not all exposed individuals will experience adverse effects. However, available information indicates that impaired water quality that would likely occur as a result of project activities will be limited to a few small, localized areas. Coho salmon and steelhead densities within the action area are low. AMMs require construction contractors to manage runoff so that existing runoff conditions (i.e., rate of runoff) are maintained and to reduce pollutants entering local streams. Therefore, the individuals of listed coho salmon and steelhead (adults, smolts, eggs, alevins, juveniles) that will potentially experience harm (injury or mortality due to poor water quality) in these small, localized areas is considered to be very low such that the effects are expected to be insignificant or discountable.

2.5.3 Beneficial Aspects of Project

Repair of slip-outs and culverts provides a long-term benefit to coho salmon and steelhead and their designated critical habitat by reducing sedimentation into Lagunitas Creek. Eliminating these sediment sources aligns with the goals and objectives established in the Lagunitas Creek Watershed Sediment TMDL (SWQCB 2019). The objective of the TMDL is to reduce fine sediment (primarily sand) deposition in Lagunitas Creek and its tributaries, as needed to support recovery of coho salmon and steelhead runs. Repairing the culvert interior at MP 12.33, creating a roughened bottom through the culvert, and reducing the vertical distance from the plunge pool into the culvert would improve upstream mobility for salmonids at this location.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation [50 CFR 402.02 and 402.17(a)]. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Additional development and accompanying infrastructure construction is expected to occur in the Lagunitas Creek watershed (Marin Economic Commission 2001) based on the general and specific plans of local communities and Marin County. In the Lagunitas Creek watershed, additional development is likely to lead to increasing water demands, which may impact stream flows if current allocations are not being fully utilized. NMFS is not aware of the total number of pending water diversion applications in the Lagunitas Creek basin but water rights within the Lagunitas Creek basin have been fully allocated

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.

Although the action area for the West Marin Drainage Rehabilitation includes a 200-foot buffer around each of the 32 culverts and 3 slip-outs along Nicasio, Lucas Valley, and Point Reyes-Petaluma Roads, the project locations along Nicasio and Lucas Valley Roads are above a fish barrier where there will be no impacts to listed salmonids or critical habitat. Therefore, this opinion focuses on potential impacts to listed species and designated critical habitat due to the proposed road improvements between MP 11.17 and 13.67 on the Point Reyes-Petaluma Road, which parallels Lagunitas Creek. Project activities along this 2.5-mile stretch of roadway include 3 culvert replacements, and 8 sites with inlet/outlet and riprap improvements. One culvert rehabilitation on Black Mountain Creek will require dewatering and fish relocation. The other 10 projects are located upland of Lagunitas Creek, mostly in ephemeral drainages

As independent populations, federally endangered CCC coho salmon and threatened CCC steelhead within the Lagunitas Creek watershed, including the tributary Black Mountain Creek, are important to the recovery of the ESU and DPS, respectively. The Lagunitas Creek watershed supports approximately 10 percent of the remaining CCC coho salmon population. This population is also considered the southernmost wild, independent population along the Pacific Coast and is critical to the survival and recovery of the species. The proposed action location is within a core priority area for protection and restoration as detailed in the CCC coho salmon recovery plan (NMFS 2012).

Steelhead populations within Lagunitas Creek are severely depressed compared to historic conditions. Abundance data within the CCC steelhead DPSs are historically scarce but existing data shows small populations subsist within the action area. This depressed condition is due to dams, water diversions, mining operations, groundwater extraction, urban and agricultural runoff, urban and agricultural development, and invasive species. Drought conditions from 2012 to present likely exacerbated these impacts by increasing water temperatures and stream-drying, limiting habitat connectivity. This likely decreased juvenile steelhead survival and more recent

survey data suggests populations within the action area are at an all-time low. Despite the impaired habitat conditions, suitable spawning habitat still exists in Lagunitas Creek.

Geographically, the Lagunitas Creek watershed represent a relatively small portion of the overall CCC coho salmon and CCC steelhead geographic range. Small populations are more vulnerable to demographic and environmental fluctuations than are larger populations (Gilpin and Soule 1986, Pimm *et at.* 1988), while each small population also acts as a buffer against extinction of the species. The species' relatively broad distribution throughout the species' ranges is a positive indicator because species with broad distributions may allow a species to avoid environmental fluctuations and stochastic events as a whole (Pimm *et al.* 1988), even if they suffer local extirpation. However, the value of these watersheds to salmonids remains significant given the current degraded condition of habitat throughout the ESU and DPS. Because degraded habitat conditions, and thus lowered carrying capacity, throughout the species' range are not expected to improve dramatically in the near future, remaining areas of habitat which appear to support relatively large sub-populations are judged highly important.

The CCC steelhead populations that use the action area, while substantially reduced from historical numbers, appear to be relatively stable. CCC coho salmon abundance has improved slightly since 2011 within several independent populations (including Lagunitas Creek), although all populations remain well below their recovery targets. These populations are likely to persist with enough resiliency to rebound from limited impacts for the foreseeable future. However, due to their low numbers, the continuation of impacts from current baseline conditions to the population's numbers, distribution, or reproduction could limit their chance of survival and recovery. The recovery of these populations will therefore depend upon programs that protect and restore aquatic habitats in watersheds and the continued reduction of impacts from land use and water withdrawal. The implementation of the proposed avoidance and minimization measures combined with the long-term beneficial effects of West Marin Drainage Rehabilitation activities are expected to maintain or improve the status of aquatic habitat within the action area.

The number of individual salmonids that may be adversely affected or killed during proposed action activities is expected to make up a very small portion of the individuals within the action area, a smaller portion of the Lagunitas watershed populations, and subsequently an even smaller portion of the overall ESU and DPS. Of the ESA-listed species considered in this opinion, only juvenile coho salmon and steelhead are likely to be captured during work area isolation. The ultimate effect of changes in the distribution and productivity of salmon and steelhead will vary with life stage, the duration and severity of the stressor, the frequency of stressful situations, the number and temporal separation between exposures, and the number of contemporaneous stressors experienced (Newcombe and Jensen 1996; Shreck 2000). Projects that dewater streams are likely to impair local movements of juvenile fish for hours or days, and downstream migration maybe similarly impaired. Because the quality of habitat in and around the action area is adequate to support rearing salmonids, NMFS expects fish will be able to find food and cover in the action area downstream of project sites as needed during dewatering activities.

It is unlikely that the small loss of juvenile salmon and steelhead from freshwater life history stages resulting from this proposed action, (i.e., dewatering and fish relocation and impaired water quality), would impact future adult returns such that impacts would occur to the

populations' resilience and persistence over time. As noted in the effects section, effects from the proposed action are likely to be limited to small areas within the action area. In addition, given the small reduction in the growth and survival of fish that will be directly affected, primarily at the fry, parr, and smolt life stages, the relatively low intensity and severity of that reduction at the population level, any adverse effects to fish growth and survival are likely to be inconsequential to the populations inhabiting the action area. Moreover, the proposed action is also reasonably certain to lead to some degree of beneficial effects due to a long-term reduction in erosion and turbidity in downstream locations.

The adverse effects of each proposed individual action will be too infrequent, short-term, and limited to harm or kill more than a small number of juvenile fish at a particular site or even across the range of a single population. Thus, it is unlikely that the small losses of fish resulting from this proposed actin would impact future adult returns. The resilience and persistence of these populations, their numbers, reproduction, and distribution, are unlikely to be meaningfully reduced by the proposed action. Consequently, we do not expect that implementation of the proposed action is likely to reduce appreciably the likelihood of both the survival and recovery of the CCC coho salmon ESU, or the CCC steelhead DPS in the wild by reducing their numbers, reproduction, or distribution.

The action area contains critical habitat for CCC coho salmon and steelhead. In our adverse modification analysis, we consider the condition of critical habitat, the potential effects of the program on critical habitat, and whether those effects are expected to directly or indirectly diminish the value of critical habitat for the conservation of CCC coho salmon and steelhead. These elements (condition of critical habitat across the DPS/ESU, in the action area, and in the watersheds; and the effects of the project on critical habitat) are considered further below.

Across the DPS/ESU, CCC coho salmon and steelhead critical habitat has been degraded by habitat alteration and development. While conditions vary across their geographic range, critical habitat is generally impaired by channel modification, habitat alteration and fragmentation, dams and water diversions, groundwater extraction, and estuarine habitat loss. These factors also affect critical habitat within the Lagunitas Creek watershed, which has been impaired by urban and agricultural runoff, development, and dams. Both watershed-wide factors and action area-specific factors affect critical habitat in the action areas leading to reduced habitat complexity, poor water quality, impaired fish passage, and unsuitable spawning and rearing habitat.

Effects to CCC coho salmon and steelhead critical habitat from the West Marin Drainage Rehabilitation are expected to include temporary impacts during project construction and long-term effects from reduced sedimentation. The temporary impacts are expected to be associated with disturbances to the river bed, banks, riparian corridor, and surface flow at the MP 12.33 culvert site. As discussed above, these temporary impacts are likely to adversely affect PBFs of CCC coho salmon and steelhead critical habitat for a short term, but the small, localized area impacted is expected to recover quickly once the project area is rewatered and revegetated. Additionally, limits on the timing, proximity, and magnitude of projects will prevent the temporary effects from multiple projects from having additive impacts on CCC coho salmon and steelhead critical habitat. Long-term effects resulting from improved flow conditions through culverts will decrease overall erosion, sedimentation and turbidity into downstream locations in Lagunitas Creek. Applying AMMs and will minimize and short-term adverse effects by

minimizing project footprints, requiring consideration of upstream and downstream impacts, and incorporating salmonid-friendly design elements. After considering the adverse effects on, their temporary nature or limited extent, as well as the habitat enhancement features that must be incorporated into many project types, NMFS concludes that the value of critical habitat as a whole for species conservation will not be appreciably reduced.

Climate change is likely already affecting species and critical habitat in the action area in the near term. As noted above, climate change has likely exacerbated drought conditions in California. Conditions for coho salmon and steelhead and their habitat are likely to worsen due to climate change over the coming decades. For example, extreme storms, higher average summer air temperatures, and lower total precipitation levels may increase in magnitude, potentially resulting in warmer stream temperatures and reduced streamflow in summer months. However, extrapolating these general forecasts to the smaller action area is difficult, given local nuances in geography and other weather-influencing factors.

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 coho salmon and CCC steelhead or 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 interim 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:

A low-level of incidental take of juvenile CCC coho salmon and CCC steelhead in the form of injury or mortality is reasonably certain to occur during dewatering and fish relocation events associated with implementation of the West Marin Drainage Rehabilitation activities:

> Unintentional mortality of listed CCC coho salmon and CCC steelhead during capture, handling, and relocation is not likely to exceed three percent of the total fish handled. The amount of incidental take during dewatering and fish relocation will be considered exceeded if more than three percent of the total fish handled are injured or killed during any dewatering and fish relocation event.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

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

The following reasonable and prudent measures are necessary and appropriate to minimize take of CCC coho salmon and CCC steelhead:

1. Undertake measures to ensure that injury and mortality to steelhead resulting from fish collection, relocation, and dewatering activities is low.
2. Undertake measures to minimize harm to steelhead from project construction and degradation of aquatic habitat.
3. Measures shall be taken to monitor the amount and extent of incidental take by reporting the results of fish relocation activities as well as other project details.

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. The Corps or the County 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.

The following terms and conditions implement reasonable and prudent measure 1:

a) The County will retain qualified biologists with expertise in the area of anadromous salmonid biology, including handling, collecting, and relocating salmonids; salmonid/habitat relationships; and biological monitoring of salmonids. The County will ensure that all biologists working on projects are qualified to conduct fish collections in a

manner which minimizes all potential risks to steelhead. Electrofishing, if used, will be performed by a qualified biologist and conducted according to the NMFS Guidelines for Electrofishing 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 .

b) The biologists will monitor the construction sites 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 steelhead to an appropriate location.

c) Coho salmon and steelhead 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 steelhead will be relocated, as soon as possible, to a suitable instream location in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.

d) If any salmonids are found dead or injured, the biological monitor will contact the NMFS North Central Coast Office in Santa Rosa, California at (707) 575-6050. The purpose of the contact is to review the activities resulting in take, determine if additional protective measures are required, and to ensure appropriate collection and transfer of salmonid mortalities and tissue samples. All salmonid mortalities will be retained. Tissue samples are to be acquired from each salmonid mortality per the methods identified in the NMFS Southwest Fisheries Science Center Genetic Repository protocols (contact the above NMFS office at the phone number provided) and sent to: NOAA Coastal California Genetic Repository, Southwest Fisheries Science Center, 110 McAllister Way, Santa Cruz, CA 95060.

e) Any injuries or mortality that exceeds three percent shall be reported to the NMFS Santa Rosa Office by email within 48 hours and construction activities shall cease until a NMFS biologist is on site to oversee the remainder of any fish relocation activities.

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

a) The County will allow any NMFS employee(s) or any other person designated by NMFS, to accompany field personnel to visit the project sites during activities described in this opinion.

b) Trimming and removal of riparian vegetation will be limited to the minimum necessary to complete the work.

c) Fill material for cofferdams will be fully confined with the use of plastic sheeting,

sandbags, or with other non-porous containment methods, such that sediment does not come into contact with streamflow or in direct contact with the natural streambed. All loose material for cofferdams or access ramps will be completely removed from the channel by October 15.

d) Any pumps used to divert live streamflow, outside the dewatered work areas, will be screened and maintained throughout the construction period to comply NOAA Fisheries' *Juvenile Fish Screen Criteria for Pump Intakes* (1996) See https://media.fisheries.noaa.gov/dam-migration/fish_screen_criteria_for_pumped_water_intakes.pdf.

e) Treated wood may not be used in any temporary platforms or scaffolds in the creek channel. Lumber used for temporary construction operations must be unfinished and untreated wood. All materials used for temporary platforms or scaffolds must be completely removed from the channel by October 15

f) In area where concrete is used, a dry work area must be maintained to prevent conveyance of runoff from curing concrete to the surface waters of the adjacent stream at all times. Water that inadvertently contacts uncured concrete must not be discharged into surface waters.

g) Construction equipment used within the creek channels will be checked each day prior to work within the creek 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 (top of bank to top of bank), the County will contain the spill and remove the affected soils.

h) Once construction is completed, all project-introduced material (pipe, gravel, cofferdam, etc.) must be removed, leaving the river as it was before construction. Excess materials will be disposed of at an appropriate disposal site.

i) To minimize the exposure of listed anadromous salmonids to 6-PPD quinone and other contaminants, new roadway and other infrastructure projects adjacent to streams with listed anadromous salmonids must include measures to treat stormwater runoff from impervious surfaces. Measures shall be designed and implemented to avoid or minimize direct discharge of road-generated runoff to streams by diverting surface flow through vegetated areas (*i.e.*, bioswales), or similar features prior to discharge into waterways with listed fish.

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

a) In order to monitor the impact of incidental take, the County must notify the NMFS Santa Rosa Office by letter or email within 30 days after project completion each year and describe in detail any incidental take that occurred during the project. This shall include the species taken, date taken, type of take (injury or mortality), number taken, and fork length of any mortalities.

i) Any injuries or mortality that exceeds three percent shall be reported to the NMFS Santa Rosa Office by email within 48 hours and construction activities shall cease until a NMFS biologist is on site to oversee the remainder of any fish relocation activities.
ii) Any salmonid or steelhead mortalities must be retained, placed in an appropriately sized whirl-pack or zip-lock bag, labeled with the date and time of collection, fork length, location of capture, and frozen as soon as possible. Frozen samples must be retained until specific instructions are provided by NMFS.

b) The County will prepare an implementation monitoring report following the year that construction activities occur and submit to NMFS by January 1. The monitoring report should include the following:

i) Project identification;
ii) County contact persons;
iii) Start and end dates of construction activities;
iv) Summary of habitat conditions – Include photos (including both river banks, upstream and downstream views) of the project site before, during and after construction activities;
v) Results of downstream turbidity monitoring before, during and after construction.

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).

- No conservation recommendations have been identified.

2.11. Reinitiation of Consultation

This concludes formal consultation for the West Marin Drainage Rehabilitation.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (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."

3. MAGNUSON–STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

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

3.1. Essential Fish Habitat Affected by the Project

Pacific coast salmon EFH may be adversely affected by the proposed action. Specific habitats identified in PFMC 2014 for Pacific coast salmon include Habitat Areas of Particular Concern (HAPCs), identified as: 1) complex channels and floodplain habitats; 2) thermal refugia; and 3) spawning habitat. HAPCs for coho salmon include all waters, substrates and associated biological communities falling within the critical habitat areas described above in the accompanying opinion. Essentially, all CCC coho salmon habitat in Lagunitas Creek, located within the proposed action area is considered HAPC as defined in PFMC 2014.

3.2. Adverse Effects on Essential Fish Habitat

The potential adverse effects of the project on EFH have been described in the preceding opinion and include temporary loss of wetted habitat, and temporary reduction of water quality (via short-term pulses of turbidity). Therefore, the effects of the project on ESA-listed species are anticipated to be the same as the effects to EFH in the action area.

3.3. Essential Fish Habitat Conservation Recommendations

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 temporary potential adverse effects are anticipated as a result of the project activities, the proposed

minimization and avoidance measures, and AMMs 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 at this time that would otherwise offset the adverse effects to EFH.

3.4. Supplemental Consultation

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

4. Data Quality Act Documentation and Pre-Dissemination Review

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps and the County. Individual copies of this opinion were provided to the Corps and the County. 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

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

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. NMFS Administrative Report SC-99-02. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Tiburon, California. April 1999.

Bagne, K., P. Ford, and M. Reeves. 2012. Grasslands. US Department of Agriculture, Forest Service, Climate Change Resource Center.

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

Bell, M.C. 1991. Fisheries handbook of engineering requirements and biological criteria. United States Army Corps of Engineers, Portland, OR.

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. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center. 210 pp.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of salmonids in W.R. Meehan (ed.), Influence of forest and rangeland management on salmonids fishes and their habitats. Special Publication 19. Bethesda, MD: American Fisheries Society.

Brewer, P.G., and J. Barry. 2008. Rising Acidity in the Ocean: The Other CO2 Problem. Scientific American October 7, 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. 14:237-261.

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 pp.

California Department of Fish and Wildlife (CDFW). 2004. Recovery Strategy for California Coho Salmon. Report to the California Fish and Game Commission.

CDFW. 2005. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted Under Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San Francisco District January 1, 2004 through December 31, 2004. Fortuna, CA.

CDFW. 2006. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted Under Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San Francisco District January 1, 2005 through December 31, 2005. Fortuna, CA.

CDFW. 2007. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted under the Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San Francisco District January 1, 2006 through December 31, 2006. C.R. 1. Fortuna, CA.

CDFW. 2008. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted under the Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San Francisco District January 1, 2007 through December 31, 2007. C.R. 1. Fortuna, CA.

CDFW. 2009. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted Under Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San Francisco District January 1, 2008 through December 31, 2008. Fortuna, CA.

CDFW. 2010. Annual Report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects Conducted Under Department of the Army Regional General Permit No. 12 (Corps File No. 27922N) within the U.S. Army Corps of Engineers, San

Francisco District January 1, 2009 through December 31, 2009. Fortuna, CA.

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.

Collins, B.W. 2004. Section 10 annual report for permit 1067. Fortuna, California Department of Fish and Game, Sacramento, California.

Crozier L.G., M.M. McClure, T. Beechie, S.J. Bograd, D.A. Boughton, and M. Carr. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711. https://doi.org/10.1371/journal.pone.0217711

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, and L.D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4:11-37.

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

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

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

Gilpin, M.E. and M.E. Soule. 1986. Minimum viable populations: Processes of species extinction. In: Conservation Biology. M.E. Soule (editor). Sinauer Associates, Massachusetts.

Gregory, R.S., and T.G. Northcote. 2003. Surface, planktonic, and benthic foraging by juvenile Chinook salmon (Oncorhynchus tshawytscha) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences. 50:233-240.

Harvey, B.C. and J.L. White. 2008. Use ofbenthic prey by salmonids under turbid conditions in a laboratory stream. Transactions of the American Fisheries Society 137:1756-1763.

Hayes, J.P., M.D. Adam, D. Bateman, E. Dent, W.H. Emmingham, K.G. Mass, and A.E. Skaugset. 1996. Technical commentary: Integrating research and forest management in

riparian areas of the Oregon coast range. Western Journal of Applied Forestry 11:85-89.

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

Heintz, R.A., J.W. Short, and S.D. Rice. 1999. Sensitivity of fish embryos to weathered crude oil: Part II. Increased mortality of pink salmon (Oncorhynchus gorbuscha) embryos incubating downstream from weathered Exxon Valdez crude oil. Environmental Toxicology and Chemistry 18:494-503.

Horizon Water and Environment (Horizon). 2022. West Marin Drainage Rehabilitation Project Biological Assessment. Covering Coho salmon, Steelhead, California red-legged frog, Northern Spotted Owl, Tiburon paintbrush, and Marin western flax. Prepared for Marin County of Department of Public Works. November 2022. 102 pp.

Howe, D. 2016. 2016 5-year review: summary & evaluation of Central California Coast Steelhead. National Marine Fisheries Service West Coast Region. April 2016.

Hubert, W.A. 1996. Passive capture techniques. In B. Murphy and D. Willis (eds.) Fisheries Techniques. Bethesda, Maryland, American Fisheries Society.

Humboldt County. 2002. Memo from Ann Glubczynski, County of Humboldt Public Works, to Margaret Tauzer, National Marine Fisheries Society, titled "2002 Monitoring Report – Five Fish Passage Enhancement Projects". June 27, 2002. 1 page.

Humboldt County. 2003. Memo from Ann Glubczynski, County of Humboldt Public Works, to Margaret Tauzer, National Marine Fisheries Society, titled "2003 Monitoring Report - Eleven Culvert Replacements for Fish Passage." June 23, 2003. 2 pages.

Humboldt County. 2004. Memo from Ann Glubczynski, County of Humboldt Public Works, to Margaret Tauzer, National Marine Fisheries Society, titled "2004 Monitoring Report - Eleven Culvert Replacements for Fish Passage." June 10, 2004. 2 pages.

Incardona, J.P., Collier, T.K., and Scholz, N.L. 2004. Defects in cardiac function precede morphological abnormalities in fish embryos exposed to polycyclic aromatic hydrocarbons. Toxicology and Applied Pharmacology 196:191-205.

Incardona, J.P., Carls, M.G., Teraoka, H., Sloan, C.A., Collier, T.K., and Scholz, N.L. 2005. Aryl hydrocarbon receptor-independent toxicity of weathered crude oil during fish development. Environmental Health Perspectives 113:1755-1762.

Incardona, J.P., Day, H.L., Collier, T.K., and Scholz, N.L. 2006. Developmental toxicity of 4-ring polycyclic aromatic hydrocarbons in zebrafish is differentially dependent on AH receptor isoforms and hepatic cytochrome P4501A metabolism. Toxicology and Applied

Pharmacology 217:308-321.

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.

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

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-42. 156 pp.

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.

Marin County. 2015. Marin County Climate Action Plan (2015 Update). Prepared by ICF International.

MW (Marin Water). 2016. Adult Salmonid Monitoring in the Lagunitas Creek Watershed – 2015-16. Prepared by Ettlinger, E., G.M. Andrew, D. Hossfeld, and E. Ruiz. Marin Municipal Water District. September 2016. Corte Madera, CA

MW. 2018. Adult Salmonid Monitoring in the Lagunitas Creek Watershed – 2016-17. Prepared by Andrew, G.M. and E. Ettlinger. Marin Municipal Water District, in Association with the National Park Service, Point Reyes National Seashore and the Salmon Protection and Watershed Network (SPAWN). March 2018. Corte Madera, CA.

MW. 2019. Adult Salmonid Monitoring in the Lagunitas Creek Watershed – 2017-18. Prepared by Ettlinger, E. and G. Guaiumi. Marin Municipal Water District, in Association with the National Park Service, Point Reyes National Seashore and the Salmon Protection and Watershed Network (SPAWN). January 2019. Corte Madera, CA.

Meehan, W.R. and T.C. Bjorn. 1991. Salmonid distributions and life histories. Pages 47-82 in W.R. Meehan (ed.) Influences of forest and rangeland management on salmonid fishes and their habitats. Special Publication 19, American Fisheries Society, Bethesda MD.

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, Sacramento, California.

National Marine Fisheries Service (NMFS). 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. National Marine Fisheries Service, Protected Resources Division, Santa Rosa, California.

NMFS. 2005. Final rule designating critical habitat for seven evolutionarily significant units of Pacific salmon and steelhead in California. National Marine Fisheries Service, Federal Register. Federal Register, Volume 70, page 52488.

NMFS. 2011. Anadromous salmonid passage facility design. NMFS, Northwest Region, Portland, Oregon. http://www.habitat.noaa.gov/pdf/salmon_passage_facility_design.pdf.

NMFS. 2012. Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. Southwest Region, Santa Rosa, California. September 2012.

NMFS. 2016. NOAA Fisheries Service Coastal Multispecies Recovery Plan. California Coast Chinook Salmon, Northern California Steelhead, Central California Coast Steelhead. October 2016.

National Park Service (NPS). 2013. Freshwater Quality Monitoring in the San Francisco Bay Area Network. 2011-2012 Biennial Report. Natural. Resource Report. NPS/SFAN NRR – 2013/8011. National Park Service. Point Reyes Station, CA.

NPS. 2016. Freshwater Quality Monitoring in the San Francisco Bay Area Network. 2013-2014 Biennial Report. Natural. Resource Report. NPS/SFAN NRR – 2016/1188. National Park Service. Point Reyes Station, CA.

NPS. 2017. Freshwater Quality Monitoring in the San Francisco Bay Area Network. Biennial Report on Water Years 2015 and 2016. Natural. Resource Report. NPS/SFAN NRR – 2017/1471. National Park Service. Point Reyes Station, CA.

Nielsen, J.L. 1998. Electrofishing California's endangered fish populations. Fisheries 23:6-12.

Nordwall, F. 1999. Movements of brown trout in a small stream: effects of electrofishing and consequences for population estimates. North American Journal of Fisheries Management 19:462-469.

Osgood, K.E. (editor). 2008. Climate Impacts on U.S. Living Marine Resources: National Marine Fisheries Service Concerns, Activities and Needs. U.S. Dep. Commerce, NOAA Tech. Memo. NMFSF/ SPO-89, 118 p.

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

Peter, K.T., Z. Tian, C. Wu, P. Lin, S. White, B. 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 and Technology 52:10317-10327.

Pimm, S.L., H.L. Jones, and l. Diamond. 1988. On the risk of extinction. American Naturalist. 132(6):757-785.

Rogers, R. 2016. 5-Year Review: Summary & Evaluation of Central California Coast Coho Salmon National Marine Fisheries Service, West Coast Region. April 2016.

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.

Scavia, D., J.C. Field, D.F Boesch, R.W. Buddmeier, 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 25:149-164.

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).

Schneider, S.H. 2007. The unique risks to California from human-induced climate change. California State Motor Vehicle Pollution Control Standards; Request for Waiver of Federal Preemption, presentation. May 22, 2007.

Servizi, J.A., and D.W. Martens. 1992. Sublethal responses of coho salmon (Oncorhynchus kisutch) to suspended sediments. Canadian Journal of Fisheries and Aquatic Sciences 49:1389-1395

Shaw, E.A. and J.S. Richardson. 2001. Direct and indirect effects of sediment pulse duration on stream invertebrate assemblages and rainbow trout (Oncorhynchus mykiss) growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:2213-2221.

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

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.

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, 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-TM-NMFS-SWFSC-423. NOAA Technical Memorandum NMFS. 194 pp.

Spence, B.C., E.P. Bjorkstedt, S. Paddock, and L. Nanus. 2012. Updates to biological viability criteria for threatened steelhead populations in the North-Central California Coast Recovery Domain. National Marine Fisheries Service. Southwest Fisheries Science Center, Fisheries Ecology Division. March 23.

Stillwater Sciences. 2008. Limiting Factors Analysis, Limiting Factors for Coho Salmon and Steelhead. Prepared for Marin Conservation District. Prepared by Stillwater Sciences. March 2008.

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.

Tian Z., H. Zhao, K.T. Peter, M. Gonzalez, J. Wetzel, C. Wu, X. Hu, J. Prat, E.Mudrock, R. Hettinger, A. . 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., M. Gonzalez, C.A. Rideout, H.N. Zhao, X. 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.

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

Wallitner, K. 2013. Freshwater Quality Monitoring in the San Francisco Bay Area: 2011-2012 Biennial Report. Natural Resource Technical Report. NPS/SFAN/NRTR—2013/801. National Park Service. Fort Collins, CO.

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. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-24. 258 pp.

Westerling, A.L., B.P. Bryant, H.K. Preisler, T.P. Holmes, H.G. Hidalgo, T. Das, and S.R. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climate

Change 109(1):445-463.

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 West Coast Region National Marine Fisheries Service from Southwest Fisheries Science Center, Fisheries Ecology Division. Santa Cruz, California.

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.