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

June 30, 2022 **Refer to NMFS No:** WCRO-2022-00726

James Mazza
Chief, Regulatory Division
U.S. Department of the Army
San Francisco District, Corps of Engineers
450 Golden Gate Avenue, 4th Floor
San Francisco, California 94102-3404

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Corte Madera Creek Flood Risk Management Project in Marin County, California (Corps File No. 2017-00325N)

Dear Mr. Mazza,

Thank you for your letter of September 27, 2021, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the U.S. Army Corps of Engineers' (Corps) authorization of Corte Madera Creek Flood Risk Management Project (Project).

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.

This biological opinion is based on our review of the information provided by the Corps and the Marin County Flood Control and Water Conservation District (District), and describes our analysis of potential effects on threatened Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*) and their designated critical habitat, threatened Southern Distinct Population Segment (DPS) of North American green sturgeon (*Acipenser medirostris*) and their designated critical habitat, and designated critical habitat for endangered Central California Coast coho salmon *(O. kisutch),* in accordance with section 7 of the ESA. In the enclosed biological opinion, NMFS concludes the project is not likely to jeopardize the continued existence of CCC steelhead, nor is it likely to adversely modify CCC steelhead or CCC coho salmon critical habitat. However, NMFS anticipates take of CCC steelhead will occur during dewatering and fish relocation activities as a result of project construction. Incidental take is also anticipated to occur in the form of harm from habitat-related impacts caused by channel and bank stabilization actions. An incidental take statement with terms and conditions is included with the enclosed biological opinion.

Regarding the Southern DPS of North American green sturgeon, NMFS concludes the project is not likely to adversely affect this species and their designated critical habitat.

NMFS has also reviewed the proposed project for potential effects on EFH and determined that the action would adversely affect EFH for various life stages of fish species managed under the Pacific Coast Salmon Fishery Management Plan (FMP), Pacific Coast Groundfish FMP, and Coastal Pelagics FMP. The Project includes measures to avoid and minimize adverse effects to EFH. Thus, no EFH recommendations are provided.

Please contact Sara Azat at the California Coastal Office in Santa Rosa at sara.azat@noaa.gov or 707-575-6067 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: Kasey Sirkin, USACE San Francisco (L.K.Sirkin@usace.army.mil)
Joanna Dixon, Marin County Flood Control District (JDixon@marincounty.org)
Copy to E-folder FRN 151422WCR2021SR00146

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

Corte Madera Creek Flood Risk Management Project

NMFS Consultation Number: WCRO-2022-00726
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?
CCC steelhead	Threatened	Yes	No	Yes	No
CCC coho salmon	Endangered	No	No	Yes	No
North American green sturgeon	Threatened	No	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
Pacific Coast Groundfish	Yes	No
Coastal Pelagic Species	Yes	No

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: June 30, 2022

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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 the NMFS California Coastal Office in Santa Rosa, California.

1.2. Consultation History

The Corte Madera Creek Flood Risk Management Project (Project) has a long history of agency coordination. The Project was originally authorized under the Flood Control Act of 1944 and reauthorized in 1962. The US Army Corps of Engineers (Corps) and the Marin County Flood Control and Water Conservation District (District) have engaged the National Marine Fisheries Service (NMFS) and the following state and federal agencies during the more recent planning efforts to address flood control channel improvements:

- California Department of Fish and Wildlife (CDFW);
- U.S. Fish and Wildlife Service (USFWS);
- San Francisco Bay Regional Water Quality Control Board (Waterboard); and
- San Francisco Bay Conservation and Development Commission (BCDC).

NMFS and Corps coordination on the Project began in 2004 when NMFS sent a letter, dated March 19, 2004, to the Corps to express concern that the existing concrete flood channel and fish ladder presented a significant barrier to upstream fish passage. On April 7, 2004, the Corps responded to NMFS' letter and agreed to address flow conditions in the concrete channel and the fish ladder during the Corps' "completion" of the flood project.

In 2016, the Corps held several meetings and a site visit with NMFS and other agency representatives to discuss conceptual alternative plans for addressing flood risk along Corte Madera Creek, and to discuss general concerns and conceptual avoidance, minimization, and mitigation measures.

On January 18, 2018, the Corps hosted an interagency meeting where the Corps presented several alternative designs to reduce the flood risk at Corte Madera Creek.

On February 2, 2018, NMFS sent a letter to the Corps re-stating the need to improve fish passage in the concrete flood channel and expressed support for Alternative F presented at the Corps' January 18, 2018, interagency meeting.

In mid-October 2018, the Corps and the District issued a Draft Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for the Project. By letter dated November 30, 2018, NMFS provided comments on the Draft EIS/EIR.

On April 12, 2019, the District convened a meeting with NMFS, CDFW, Waterboard, Town of Ross, and consultants for the purposes of conveying the status of the agreement between the Corps and the District regarding the flood Project, and to discuss the refined scope of the Project and timeline.

On January 31, 2020, NMFS, the District, and their consultants met to discuss modifications to the existing concrete channel and construction of additional fish resting pools to improve fish passage.

On May 27, 2020, the District convened a meeting with NMFS, the Corps, CDFW, Waterboard, Town of Ross, stakeholders, and consultants for the purpose of updating the attendees on the flood project's process, progress, and schedule.

On July 23, 2020, the District met with NMFS to discuss elements of the Project in Frederick Allen Park.

On September 18, 2020, the District met with NMFS, the Corps, CDFW, Waterboard, and consultants to provide project updates and discuss environmental impact report (EIR) scoping comments.

On January 5, 2021, the District provided NMFS with a draft biological assessment and dewatering plan for informal review and comment. NMFS provided comments on these documents to the District and the Corps, via email, on February 11, 2021.

Between February and August, 2021, the Corps, NMFS, CDFW, the Waterboard, the District, had several discussions regarding the permitting approach and further refinements to the Project design.

By letter dated August 3, 2021, the Corps requested consultation with NMFS on an application from Panorama Consulting, Inc. on behalf of the District to construct flood reduction and habitat improvements in Corte Madera Creek. The Corp's request for formal consultation included the following attachments:

(a) *Biological Assessment for the Corte Madera Creek Flood Risk Management Project, Phase 1, Marin County, California*, prepared by Stillwater Sciences, dated June 2021;
(b) *Dewatering and Fish Rescue Plan for the Corte Madera Creek Flood Risk Management Project*, prepared by Stillwater Sciences, dated December 2020;

(c) Report titled, *Existing Fish Passage Conditions and Analysis of Resting Pool Performance* prepared by GHD Consulting and Michael Love and Associates, dated May 27, 2021; and
(d) Project Plans (60%) for the Corte Madera Creek Flood Risk Management Project, prepared by GHD and dated May 2021.

On August 17, 2021, NMFS sent the Corps, via email, a notice of insufficient information to initiate consultation with a list of the requested information. On September 22, 2021, NMFS received response from the Corps.

On September 27, 2021, the Corps provided NMFS with a revised consultation request letter and an updated BA was provided. In a separate email, dated October 1, 2021, the Corps and the District's consultant confirmed that the updated BA included the response to information requested by NMFS.

On December 22, 2021, the District provided NMFS and the Corps with the final analysis and basis of design report for the Unit 3 resting pools in the document titled: *Basis of Design Report, Corte Madera Creek Fish Passage Project, Existing Fish Passage Conditions and Analysis of Resting Pool Performance* prepared for Friends of Corte Madera Creek Watershed by GHD and Michael Love and Associates.

On February 2, 2022 the District held a meeting with NMFS to discuss the fish passage assessment and the project design. At the meeting the District provided details on updates to the design of the transition area upstream of the fish ladder. NMFS requested more information on these changes during the call and subsequent email correspondence.

On March 2, 2022, the District and NMFS confirmed the final information needed to address NMFS' questions on the project design. An updated BA with this information was provided, via email, to the Corps and NMFS on March 4, 2022. With the March 4, 2022, submittal, sufficient information was provided to NMFS to initiate formal consultation.

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). For EFH consultations, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The Corps proposes to authorize the District pursuant to Section 404 of the Clean Water Act (CWA) of 1972, as amended, 33 U.S.C. § 1344 *et seq*., and Section 10 of the Rivers and Harbors Act (RHA) of 1899, as amended, 33 U.S.C. § 403 *et seq*., to construct flood reduction and habitat improvements in Corte Madera Creek, Marin County, California. The overall purpose of the Project is to reduce flooding from Corte Madera Creek in the Town of Ross and Kentfield, California, and to provide environmental improvements. The Project has been separated into specific reaches and the reaches are described using the original Corps project units for the flood control channel, numbered 1-4, shown in Table 1 and Figure 1.

From downstream to upstream within the Project area, Corte Madera Creek consists of an earthen trapezoidal channel, a rectangular concrete channel, and a natural creek bed. Units 1 and

Table 1. Project Unit Descriptions.

Unit [a]	Length (miles)	Description of reach
Unit 4	0.15 mile	The project segment of Unit 4 starts at Lagunitas Road Bridge and extends approximately 575 feet downstream to the Denil fish ladder.
Unit 3	0.67 mile	Unit 3 begins at the Denil fish ladder at the upstream end of the concrete channel and continues for approximately 0.67 mile to the College Avenue Bridge.
Unit 2	1.0 mile	Unit 2, within the Action area, is approximately 0.51 miles long, begins at the College Avenue Bridge, and extends downstream to the mouth of Tamalpais Creek. The upper 0.33 miles of this reach is contained within a concrete channel that extends from the College Avenue Bridge to downstream of Stadium Way. The downstream 0.17 miles of the Unit 2 Action area reach is within an earthen channel. The lower portion of the USACE-designated Unit 2, which is not a part of the Action area, extends another 0.49 miles downstream to the Bon Air Road bridge.

Notes:
[a] Units are ordered from upstream (Unit 4) to downstream (Unit 2).

2 are below mean higher high water. Tidal influence extends upstream approximately 2,000 feet into Unit 3. Unit 4 is entirely upstream of tidal influence.

The Corps constructed Units 1, 2, and 3 between 1968 and 1972. Unit 1 consists of an earthen trapezoidal channel. The lower portion of Unit 2 is also an earthen trapezoidal channel. Combined the earthen trapezoidal channel of Units 1 and 2 extends 3 miles from Kentfield downstream to San Pablo Bay. The upper 1,700 feet of Unit 2 was designed and constructed as a rectangular concrete-lined channel. This concrete-lined channel (bed and banks) continues an additional 3,500 feet upstream in Unit 3 of the flood project. Combined this concrete flood channel reach in Units 2 and 3 extends approximately 5,200 linear feet in lower Corte Madera Creek. Unit 4 remains a natural channel and it extends approximately 575 feet from the top of Unit 3 to the Lagunitas Road Bridge.

Within the upper 1,900 feet of the concrete flood channel, the Corps project constructed 24 fish resting pools, designed to provide resting opportunities for salmonids during upstream migration. However, the existing fish resting pools do not function as designed and channel is impassable for adult salmonids migrating upstream under certain streamflow and tidal conditions. The Project proposes to remedy fish passage conditions in the existing flood channel by the following actions: (a) channel bed modifications in Unit 4; (b) removal of a fish ladder at the upstream end of the concrete channel in Unit 3; and (c) modifications to the concrete channel bed in Unit 3 with installation of additional fish resting pools (Figure 2).

The Project also includes modifications to the concrete channel wall in Unit 3 that will allow maintenance personnel and equipment access to the concrete channel. Maintenance will include sediment removal from the channel and fish resting pools. Other project elements include construction of a stormwater pump station outside of the concrete channel in Unit 3 and increasing the height of the concrete channel floodwall outside of the creek bed in Unit 2.

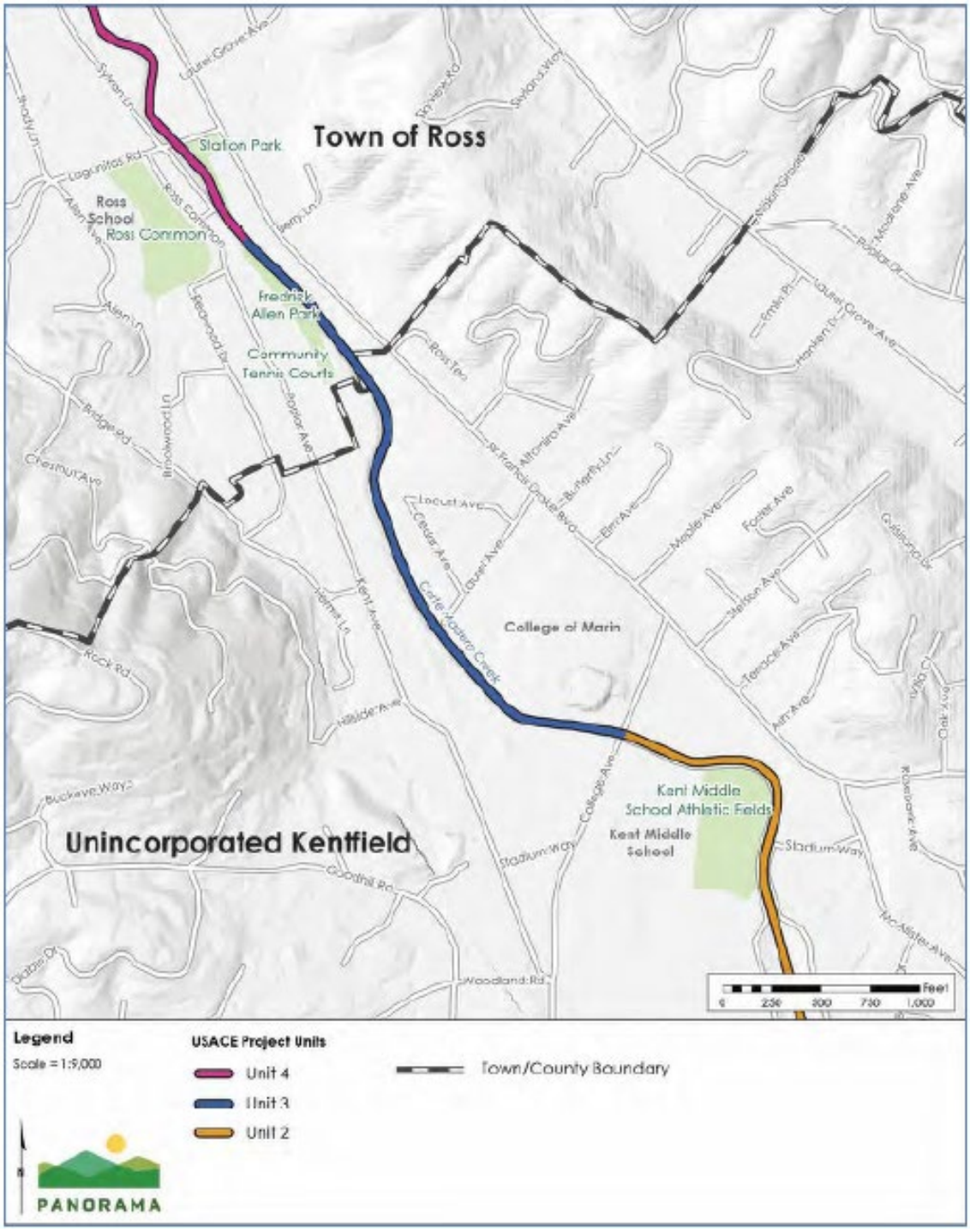

Figure 1. Corps Project Unit Designations.

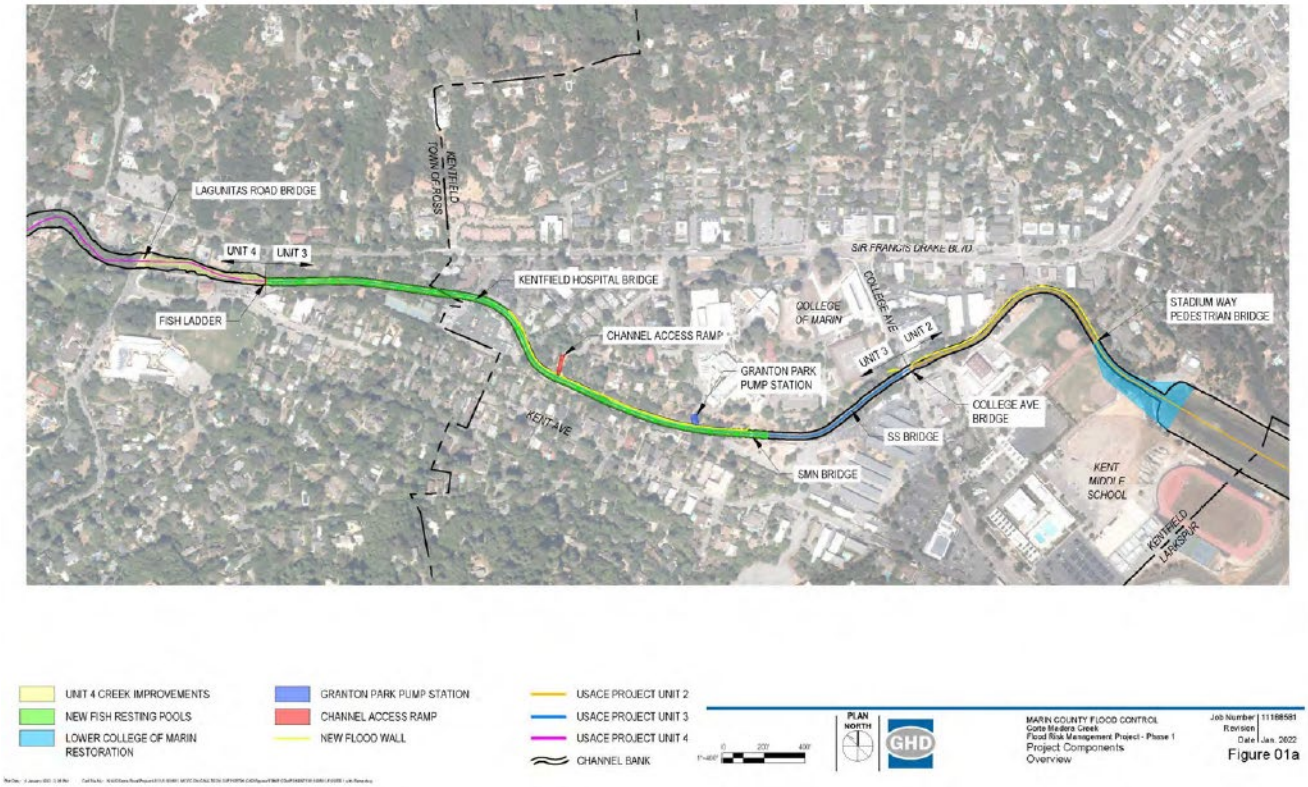

Figure 2. Map of Project Elements.

1.3.1. Channel Dewatering and Flow Diversion

To facilitate construction, the District proposes to isolate work areas with cofferdams and dewater the work sites. Cofferdams would be constructed in order to either dewater the entire reach within Units 3 and 4 or by conducting isolated dewatering in each of the units. In either scenario, a temporary gravel bag/impermeable cofferdam would be placed at the upstream and downstream ends of the work area. A screened pump or gravity intake pipe would be installed within the upstream cofferdam to divert water around the area and into a flexible pipe or discharge in the channel beyond the downstream cofferdam. The District estimates that up to 750 linear feet of channel in Unit 4 may be dewatered, and up to 4,650 linear feet of concrete flood channel in Units 2 and 3 may be dewatered. All dewatering and cofferdam installations will be limited to the period between June 15 and October 15.

Fish collection and relocation would be performed in coordination with cofferdam installation and dewatering. Block nets will be installed to isolate reaches to be dewatered and fish collected with the use of seines, dip nets and electrofishing by experienced biologists. Captured fish will be held in buckets containing cool, aerated water with no more than 25 fish per bucket. Fish will be visually identified to species and year-class estimated. Fish will not be anesthetized or measured. Fish collected from freshwater reaches will be relocated upstream of the Lagunitas Road Bridge within different habitat units to reduce crowding. Fish collected from the intertidal reach of Unit 3 will be relocated downstream of the College of Marin Science-Math-Nursing Building Bridge. The proposed Fish Capture and Relocation Plan is presented in Section 5.1.10.3 and Appendix D of the March 2022 BA.

1.3.2. Groundwater Dewatering

Temporary, localized groundwater dewatering may be necessary while the cofferdams are in place. Dewatering would be completed using sumps for groundwater collections and submersible pumps within the sumps to pump the groundwater around the work area. A groundwater diversion box plate made of fiberglass, steel, concrete, or other material would be installed to limit the groundwater in the work area to flow outside of the fish pool excavated area. Groundwater would be discharged into upland areas or downstream of the cofferdam as permitted.

1.3.3. Unit 4

Proposed construction in Unit 4 would include removal of the existing poorly functioning Denil fish ladder and creek modifications to provide a smooth and stable transition between the concrete channel in Unit 3 and the earthen channel in Unit 4. This construction involves the lowering of the creek channel floor elevation, stabilization of the creek banks, construction of three concrete retaining walls, and reinforcement of existing bank protection structures. The majority of the 575-foot long Unit 4 reach will be stabilized with a combination of the above methods.

The existing Denil fish ladder currently serves as the transition between Units 3 and 4 where the natural creek bed meets the concrete channel creek bed. To address changes in flow dynamics that result from the fish ladder removal, the Project will construct immediately upstream of the Unit 3 concrete channel, a 65-foot long (1,595 sq. ft.) engineered rock chute (slope equal to 1.3 percent) designed to allow for fish passage, accommodate peak water flow, and convey debris and sediment (See March 2022 BA Appendices A and B). The rock chute contains design elements that would provide areas of suitable water depth during various flow conditions to allow for upstream migrating fish to rest. This transition is also designed to accommodate and protect a 9-foot wide sewer siphon concrete encasement that runs diagonally under the creek bed.

Along the creek banks adjacent to the site of the engineered rock chute, there are existing wooden retaining walls. The Project would abandon the wooden walls and construct two concrete retaining walls on both banks. Like the engineered rock chute, the new retaining walls will begin at the uppermost end of the Unit 3 concrete channel and extend upstream. The right bank retaining wall will extend 94 feet upstream into Unit 4 and the left bank retaining wall will extend 64 feet upstream. Planted rock slope protection will be installed between the walls and engineered rock chute.

A constriction approximately 300 feet upstream of the Unit 3 concrete channel will be graded and widened to avoid backwatering during high flow conditions once the fish ladder is removed. The widened channel in this location will be stabilized with a 159-foot long (1,213 sq. ft.) planted rock slope and a 66-foot long concrete retaining wall at the downstream end of this section.

The removal of the fish ladder will also precipitate changes to the flow dynamics and sediment conveyance upstream of the proposed rock chute. To alleviate potential scouring, eliminate upstream incision, and mimic the future ‘natural grade’ elevation post-construction, a below-grade rock weir would be installed immediately downstream of the Lagunitas Road Bridge. The weir would consist of large boulders buried perpendicular to the creek flow covered by existing

gravel, and though designed to remain buried, if exposed would continue to direct flows to the center of the creek bed. The structure is also designed to form a pool downstream that would facilitate fish passage at various flow conditions.

A 220-foot long sheet pile wall will be placed along the left bank, behind the private residences at 25 and 27 Sir Francis Drake Boulevard, in order to protect the upper banks of Corte Madera Creek. This sheet pile wall will be installed streamside approximately 1 to 3 feet outward from existing retaining walls and backfilled with rock and soil. The top of the finished sheet pile wall would rise 2-4 feet above the existing grade.

Other portions of the Unit 4 channel would be stabilized with native vegetation plantings and rock slope protection. Biotechnical stabilization with willows and biodegradable erosion control fabric would be installed upslope of planted rock slope protection. A detailed description of the proposed work in Unit 4 is included in Section 5.1.1 of the March 2022 BA, and a hydraulic analysis of fish passage through the transition area is provided in Appendix B of the March 2022 BA.

1.3.4. Unit 3

Proposed work in Unit 3 consists of the construction of 16 new fish pools designed to improve fish passage, floodwall construction, construction of a storm-drain pump station, and construction of a concrete channel access ramp. A summary description of these project elements is provided below. A complete description the proposed fish resting pool design is provided in the document, *Basis of Design Report, Corte Madera Creek Fish Passage Project, Existing Fish Passage Conditions and Analysis of Resting Pool Performance*, December 2021 (March 2022 BA Appendix C). A complete description of the proposed floodwalls, storm drain pump station, and concrete channel access ramp is provided in Sections 5.1.2.1, 5.2.1.2, and 5.1.5 of the March 2022 BA.

1.3.4.1 Fish Pools

The Project proposes to construct 16 new fish resting pools in the concrete channel to improve upstream passage conditions for steelhead adults. The pools will be constructed of concrete recessed into the existing concrete channel. Modeling of flow velocities and sediment transport in Unit 3 was employed to inform the shape, depth and location of the pools (GHD and Love and Associates, 2021).

Unit 3 currently contains 24 small concrete fish resting pools (4 feet long and 13 feet wide) that are placed in the center of the channel and spaced approximately 64 feet apart. The 16 new fish pools would be approximately 9 feet long, 10 feet wide, and 2 feet deep, and placed along the right side (looking downstream) of the channel thalweg. The downstream-most 11 pools will be constructed in the intertidal portion of Unit 3. Pool spacing ranges between 135 feet and 165 feet, with the exception of a section of channel near Kentfield Hospital. In this section the channel makes an s-turn that produces lower water velocities with ample areas for fish to hold and rest without additional pools. Therefore, the distance between pools in the channel section near Kentfield Hospital in 435 feet. The existing pools would either be left in place or be converted into new pools depending on their location.

Each fish pool would require placement of 14 to 18 cubic yards of concrete. To construct a fish pool, a rectangular portion of the channel approximately 3 feet wider and 3 feet longer than the

overall proposed dimensions of the fish pool concept design (10 feet wide and 9 feet long) would be sawcut and demolished. The existing subgrade would be over-excavated and replaced with large diameter aggregate. A base concrete layer would be placed to create a rectangular-shaped box with coated reinforcing steel to establish a working platform and sealed concrete joints with the existing sawcut concrete channel. The concrete surface would be finished with a very rough textured trowel finish to allow for another layer for finished concrete cap. The final concrete cap would be placed with contoured finish to meet the intended design geometry. The minimum concrete thickness would be three inches to avoid future spalling. High-strength and long-life joint sealant would be installed to allow for thermal expansion but prevent groundwater intrusion or contamination with channel flows. This process would be repeated for all fish pools constructed.

1.3.4.2 Floodwalls

Two floodwall segments would be constructed in Unit 3. One segment would be built to extend the existing concrete channel floodwall vertically along the left bank. The addition would increase the height of the existing floodwall by 2 to 4 feet above the existing concrete channel over a length of approximately 1,075 feet. The floodwall would be constructed on top of the existing concrete channel as a structural extension of the existing channel structure or would be set back a few feet from the existing wall.

The second segment of floodwall would be constructed upland of the left bank immediately upstream of the College Avenue Bridge. This structure is approximately 71 feet long and designed to function as a wing wall to divert flood flows back into Corte Madera Creek at the bridge crossing. The wall would generally be 2 to 4 feet tall and would not exceed 6 feet in height. The downstream end of the new floodwall will connect with creek bank at the College Avenue Bridge. From the top of bank at the bridge, the floodwall will angle away from the creek for a distance of about 71 feet to the outer edge of the riparian corridor.

1.3.4.3 Stormwater Pump Station

A new stormwater pump station would be constructed outside and adjacent to the left bank of the Corte Madera Creek concrete channel within the reach of Unit 3. The facility will be located on District property at Laurel Avenue. The pump station will supplement the two existing storm drain pipelines in the area and would only run during high channel water levels concurrent with a storm event.

1.3.5. Unit 2

Proposed work in Unit 2 consists of a 945-foot long floodwall along the left bank. The floodwall would be generally 2 to 4 feet high, 1-foot wide, and be built on top of the existing concrete channel wall. As with the Unit 3 floodwall, the Unit 2 floodwall will function as a structural extension of the existing structure or set back from the existing wall. The purpose of the floodwall in this section is to avoid increased flood inundation in areas adjacent to Unit 2.

1.3.6. Revegetation

Up to 34 native and non-native trees may be removed from Units 2, 3, and 4 to facilitate project work. Up to 76 trees (13 of which are oaks) will be revegetated to mitigate for those removed. Sixty-three trees will be planted in Unit 4 and the 13 oaks would be planted in an off-site

location. Willows and alders would be planted along the channel margins to provide shade to the creek in Unit 4. More upland species would be planted farther away from the channel and at higher elevations. Areas of temporary construction disturbance containing grasses and bushes would be reseeded with a native seed mix.

1.3.7. Construction Schedule and Equipment

Construction is anticipated to last approximately seven months, and will occur over one or two construction seasons. The in-channel construction activities would occur between June 15 and October 15. Construction activities would occur on weekdays between the hours of 8:00 am and 5:00 pm.

Equipment use would depend on the type of construction in each project element but may include: boom trucks, Baker tanks, concrete truck and boom pump, concrete saws, crane dump trucks, drills, excavators, flatbed and pick-up trucks, generators and air compressors, graders, jackhammers, loaders, roller/compactors, pavers and suction trucks.

1.3.8. Maintenance

Once completed, the Project will require ongoing maintenance activities which include vegetation management, sediment and debris removal, storm drain pump station maintenance, and annual floodwall and structure inspection and maintenance.

1.3.8.1 Vegetation Management

Vegetation management would be employed to maintain channel flow capacity, reduce fire fuel and remove non-native invasive plant species. Removal of non-native plants and revegetating with native plants would require some ground-disturbing activities. Vegetation control and removal would be conducted by hand using chain saws, loppers, weed eaters, hedge trimmers, and other hand tools.

1.3.8.2 Fish Resting Pool and Channel Maintenance

The District proposes to maintain the functionality of the fish resting pools and channel by periodically removing debris and sediment. Debris (woody debris or urban debris) accumulation in the flood channel may disrupt flow patterns within the pools and reduce resting areas or cause sedimentation.

It is anticipated that debris removal will occur approximately once per year, but could be conducted more frequently depending on observed conditions. The pools will be inspected during the low flow dry season (August/September) to determine if sediment and debris has deposited. The preferred removal technique would be with hand tools. If hand tools are ineffective, a Vactor® (Vactor Manufacturing) or similar truck with the capability to vacuum sediments would be deployed via the permanent access ramp into the concrete flood channel.

Sediment removal would be scheduled to occur during the period between June 15 and October 15. If observations indicate debris removal is required following a high flow event, it would be performed as streamflows recede to a safe level in between storm events. During the winter and spring fish migration seasons, a timely response to debris/sediment accumulation is needed to avoid or minimize any delay in fish passage.

Sediment removal for maintenance of the fish resting pools may require dewatering if a vacuum truck is used. Channel dewatering and cofferdam installation for maintenance activities will only be conducted between June 15 and October 15, and performed as described above for construction activities. Fish collection and relocation would be also performed as described above in coordination with cofferdam installation and dewatering (see Section 1.3.1 of this opinion) for sediment maintenance.

1.3.8.3 Storm Drain Pump Station Maintenance

The new stormwater pump station on the District's property at Laurel Avenue would be inspected once a month during the dry season. Routine maintenance would be performed on the motors and generator, and debris removed. Annual tests would be conducted on the electrical and mechanical systems. Load bank tests would be performed on the generators every three years and periodic maintenance would be performed on the pump systems every six years.

1.3.8.4 Floodwall Inspections and Maintenance

The District proposes to conduct visual inspections of the Project's floodwalls just before the beginning of the flood season, immediately after each major high-water period, and at intervals not exceeding 90 days. In addition, inspections are to be made after every earthquake which occurs within 200 miles and has a Richter magnitude of 5 or above. Eroded concrete will be repaired when reinforcing steel is exposed or erosion approaches 2 inches in depth. Concrete will typically be repaired by sandblasting the eroded area and filling with Portland cement mortar. The flood channel concrete walls will be maintained and cleaned as necessary, removing barnacles and other matter that may deteriorate the channel.

1.3.9. Avoidance and Minimization Measures

The District has proposed several conservation measures designed to avoid or minimize impacts to fish and wildlife species in the project area. These measures include pollution prevention, use of a construction window to minimize impacts to migratory salmonids, a fish rescue and relocation plan, environmental awareness training, appropriate storage and disposal of sediment, and decontamination procedures for invasive species control. These protective measures are described in full in Section 5.1.10 of the March 2022 BA. The following measures are of particular importance for listed anadromous salmonids:

- Project construction activities within the channel of Corte Madera Creek will be limited to the period between June 15 and October 15.

- Dewatering and fish relocation will be performed in all areas that require construction in wetted portions of the channel. (See Appendix D of the March 2022 BA for the *Corte Madera Creek Units 3 and 4 Dewatering and Fish Relocation Plan*).

- A Stormwater Pollution Prevention Plan (SWPPP) will be developed for storage of construction and excavated material outside of the active channel. Fill and spoils stockpiles will be isolated with silt fences, straw wattles or other erosion control identified in the SWPPP.

- Excavated material (debris and soil) will undergo testing for contaminants.

- The District will provide Environmental Awareness Training for contractors and construction personnel.

- All heavy equipment will be steam-cleaned and inspected prior to entering the Corte Madera Creek watershed to control contamination with invasive species, and will be decontaminated following the completion of the Project.

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.

The Corps determined the proposed action is not likely to adversely affect the Southern DPS of North American green sturgeon, and designated critical habitat for Southern DPS green sturgeon. Our concurrence is documented in the "Not Likely to Adversely Affect" Determinations Section 2.12. This opinion discusses the potential adverse effects to the threatened CCC steelhead, designated critical habitat for CCC steelhead, and designated critical habitat for CCC coho salmon.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

The designations of critical habitat for CCC steelhead and CCC coho salmon use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414;

February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

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 the 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 consequences of the actions as a whole was formulated from the aforementioned resources, and the following biological assessment:

> Stillwater Sciences. 2022. Biological Assessment for the Corte Madera Creek Flood Risk Management Project, Phase I, Marin County, California. Final Report. March 2022.
>
> GHD and Love and Associates. 2021. Basis of Design Report, Corte Madera Creek Fish Passage Project, Existing Fish Passage Conditions and Analysis of Resting Pool Performance. Prepared for Friends of Corte Madera Creek Watershed. December 2021.

Information taken directly from published, citable documents are referenced in the text and listed at the end of this document. A complete record of this consultation is on file at NMFS North-Central Coast Office in Santa Rosa, California (ARN #151422WCR2021SR00146).

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of 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.

This biological opinion analyzes the effect of the proposed Corte Madera Creek Flood Control Project on the following Federally-listed species (DPS or ESU) and designated critical habitats:

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

CCC coho salmon (*Oncorhynchus kisutch*) ESU
Critical habitat (64 FR 24049; May 5 1999).

2.2.1. Listed Species

This biological opinion analyzes the effect of the proposed Project in Marin County, California on CCC steelhead in Corte Madera Creek. CCC steelhead are listed as threatened under the ESA (71 FR 834, January 5, 2006). The CCC steelhead DPS includes steelhead in coastal California streams from the Russian River to Aptos Creek, and the drainages of Suisun Bay, San Pablo Bay, and San Francisco Bay. In addition, this biological opinion analyzes the effects on designated critical habitat for threatened CCC steelhead (September 2, 2005; 70 FR 52488). Corte Madera Creek is designated critical habitat for CCC steelhead.

Historically, Corte Madera Creek supported CCC coho salmon. Collection of coho from the watershed date from 1926 to 1986, but this species has not been observed in Corte Madera Creek since 1986 (Leidy *et al.* 2005a). Based on this information, NMFS considers endangered CCC coho extirpated from the Corte Madera Creek watershed. However, Corte Madera Creek, including the action area of this project, is designated critical habitat for endangered CCC coho salmon (64 FR 24049).

2.2.1.1 Steelhead Life History

Steelhead are anadromous fish, spending some time in both fresh- and saltwater. The older juvenile and adult life stages occur in the ocean, until the adults ascend freshwater streams to spawn. Eggs (laid in gravel nests called redds), alevins (gravel dwelling hatchlings), fry (juveniles newly emerged from stream gravels), and young juveniles all rear in freshwater until they become large enough to migrate to the ocean to finish rearing and maturing to adults.

General reviews for steelhead in California document much variation in life history (Shapovalov and Taft 1954, Barnhart 1986, Busby *et al*. 1996, McEwan 2001). Although variation occurs in coastal California, steelhead usually live in freshwater for 1 to 2 years in central California, then spend 2 or 3 years in the ocean before returning to their natal stream to spawn. Steelhead may spawn 1 to 4 times over their life. Adult steelhead returning from the ocean typically immigrate to freshwater between December and April, peaking in January and February, and juveniles migrate as smolts from the watershed to the ocean from January through June, with peak emigration occurring in April and May (Fukushima and Lesh 1998).

Adults returning to spawn may migrate several miles, hundreds of miles in some watersheds, to reach their natal streams. Although spawning typically occurs between January and May, the specific timing of spawning may vary a month or more among streams within a region, and within streams interannually. Spawning and smolt emigration may continue through June (Busby *et al.* 1996). Female steelhead dig a nest in the stream and then deposit their eggs. After fertilization by the male, the female covers the nest with a layer of gravel. Steelhead do not necessarily die after spawning and may return to the ocean, sometimes repeating their spawning migration one or more years. The embryos incubate within the nest. Hatching time varies from about three weeks to two months depending on water temperature. The young fish emerge from the nest about two to six weeks after hatching.

Steelhead fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Cover is an important habitat component for juvenile steelhead, both as a velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Steelhead, however, tend to use riffles and other habitats not strongly associated with cover during summer rearing more than other salmonids. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. Rearing steelhead juveniles prefer water temperatures of 7.2 to 14.4 degrees Celsius (°C) and have an upper lethal limit of 23.9°C (Barnhart 1986, Bjornn and Reiser 1991). They can survive in water up to 27°C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al.* 1996). Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows, to the ocean to continue rearing to maturity.

The distribution of steelhead in the ocean is not well known. Interannual variations in climate, abundance of key prey items (e.g. squid), and density dependent interactions with other salmonid species are key drivers of steelhead distribution and productivity in the marine environment (Atcheson *et al.* 2012; Atcheson *et al.* 2013). Recent information indicates that steelhead originating from central California use a cool, stable, thermal habitat window (ranging between 8-14 degrees Celsius [°C]) in the marine environment characteristic of conditions in northern waters above the 40th parallel to the southern boundary of the Bering Sea (Hayes *et al.* 2012).

2.2.1.2 Status of CCC Steelhead

Historically, approximately 70 populations of steelhead existed in the CCC steelhead DPS (Spence *et al.* 2008, Spence *et al.* 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt *et al.* 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney *et al.* 2000, Bjorkstedt *et al.* 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River, which is considered the largest population within the DPS (Busby *et al.* 1996). Recent estimates for the Russian River are on the order of 7,000 adult fish returning to spawn (NMFS 2016), however abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Pudding, and Caspar creeks) of individual run sizes of 500 fish or less (62 FR 43937). Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt *et al.* 2005). In San Francisco Bay streams, reduced population sizes and fragmented habitat condition has likely also depressed genetic diversity in these populations. Similar losses in genetic diversity in the Napa River may have resulted from out-of-basin and out-of-DPS releases of steelhead in the Napa basin in the 1970s and 1980s. These transfers included fish from the South Fork Eel River, San Lorenzo River, Mad River, Russian River, and the Sacramento River.

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

2.2.2. Status of Critical Habitat

Corte Madera Creek in the action area is designated as critical habitat for CCC steelhead (70 FR 52488) and CCC coho salmon (64 FR 24049).

2.2.2.1 Steelhead Critical Habitat.

Critical habitat was designated for CCC steelhead on September 2, 2005 (70 FR 52488). PBFs for CCC steelhead and their associated essential features include:

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

wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

4. Estuarine areas with:
    a. areas free of obstruction and excessive predation;
    b. water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;
    c. natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and
    d. juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

The condition of CCC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat: logging, agricultural and mining activities; urbanization; stream channelization; dams; wetland loss; and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of streambank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased streambank erosion, loss of shade (higher water temperatures) and loss of nutrient inputs (Busby *et al*. 1996, 70 FR 52488, NMFS 2016). Water development has drastically altered natural hydrologic cycles in many of the streams in the DPS. Alteration of flows results in migration delays, loss of suitable habitat due to dewatering and blockage; stranding of fish from rapid flow fluctuations; entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids.

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

2.2.2.2 CCC Coho Salmon Critical Habitat

Critical habitat was designated for CCC coho salmon on May 5, 1999 (64 FR 24049). PBFs for CCC coho salmon and their associated essential features include:

1. Essential habitat types:
    a. juvenile summer and winter rearing areas;
    b. juvenile migration corridors;
    c. areas for growth and development to adulthood;
    d. adult migration corridors; and
    e. spawning areas.

2. Within these areas, essential features include adequate:
    a. substrate;
    b. water quality;
    c. water quantity;
    d. water temperature;
    e. water velocity;
    f. cover/shelter;
    g. food;
    h. riparian vegetation;
    i. space; and
    j. safe passage conditions.

The condition of CCC coho salmon critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that currently depressed population conditions are, in part, the result of the following human-induced factors affecting critical habitat[1]: logging, agriculture, mining, urbanization, stream channelization and bank stabilization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Habitat 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/quantity, lost riparian vegetation, and increased sediment delivery into streams from upland erosion (Weitkamp *et al*. 1995; Busby *et al*. 1996; 64 FR 24049; 70 FR 37160; 70 FR 52488).

The CZU Lightening Complex started as a series of lightening fires on August 16, 2020 across western Santa Cruz and San Mateo counties (California Department of Forestry and Fire Protection and California Department of Conservation 2020). The fire was fully contained on September 22, 2020; a total of 86,509 acres burned. Portions of the burned area represented some of the highest quality designated critical habitat for CCC coho salmon south of San Francisco. The long-term impacts on such valuable salmonid habitat are yet to be determined. However, there is heightened concern related to increased sediment run-off and erosion, decreased riparian vegetation, increased stream temperatures, and decreased water quality. It is likely that CCC coho salmon spawning, rearing, and migratory habitat was directly and indirectly, impacted by the fire and rain events.

A final recovery plan for CCC coho salmon was completed by NMFS in September 2012 (NMFS 2012). As with the CCC steelhead plan, the coho recovery plan describes key threats, actions needed to achieve recovery, and measurable criteria by which NMFS will determine when recovery has been reached. The plan identified the major threats to population recovery which included roads, water diversions and impoundments, and residential development. Recovery actions include restoration of floodplains and channel structure, restoring riparian conditions, improving streamflows, restoring fish passage, protecting and restoring estuarine habitat, among other actions.

[1] 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.

2.2.3. Global Climate Change

Another factor affecting the range-wide status of CCC steelhead, CCC coho salmon and their aquatic habitat at large is climate change. Impacts from global climate change are already occurring in California. For example, average annual air temperatures, heat extremes, and sea level have all increased in California over the last century (Kadir *et al*. 2013). Snow melt from the Sierra Nevada has declined (Kadir *et al*. 2013). However, total annual precipitation amounts have shown no discernable change (Kadir *et al*. 2013). Most ESUs and DPSs may have already experienced some detrimental impacts from climate change. NMFS believes the impacts on listed salmonids to date are likely fairly minor because natural, and local climate factors likely still drive most of the climatic conditions salmonids experience, and many of these factors have had much less influence on steelhead abundance and distribution than human disturbance across the landscape. Salmonid life history traits among those populations at the southern end or interior range of the DPS, may be most vulnerable to the combined stressors of climate change and anthropogenic impacts (Crozier *et al*. 2019).

The threat to listed steelhead and coho salmon from global climate change will increase in the future. Modeling of climate change impacts in California suggests that average summer air temperatures are expected to continue to increase (Lindley *et al*. 2007, Moser *et al*. 2012). Heat waves are expected to occur more often, and heat wave temperatures are likely to be higher (Hayhoe *et al*. 2004, Moser *et al*. 2012, Kadir *et al*. 2013). Total precipitation in California may decline; critically dry years may increase (Lindley *et al*. 2007, Schneider 2007, Moser *et al*. 2012). Wildfires are expected to increase in frequency and magnitude (Westerling *et al*. 2011, Moser *et al*. 2012).

Shifting climate patterns across coastal California may impair salmon and steelhead population productivity in the future. For example, in the San Francisco Bay region, warm temperatures generally occur in July and August, but as climate change takes hold, the occurrences of these events will likely begin in June and could continue to occur in September (Cayan *et al.* 2012). Climate simulation models project that the San Francisco region will maintain its Mediterranean climate regime, but will also experience a higher degree of variability of annual precipitation during the next 50 years. The greatest reduction in precipitation is projected to occur in March and April, with the core winter months remaining relatively unchanged (Cayan *et al.* 2012). These suboptimal climate conditions, combined with intense anthropogenic stressors, may precipitate further decline in listed species populations (Crozier *et al*. 2019).

Estuaries may also experience changes detrimental to salmonids and sturgeon. 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 and sturgeon are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Feely *et al.* 2004, Brewer and Barry 2008, Osgood 2008, Turley 2008, Abdul-Aziz *et al.* 2011, Doney *et al.* 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007, Santer *et al.* 2011).

Finally, climate change is also affecting water circulation and temperature patterns in the marine environment. In fall 2014, and again in 2019, a marine heatwave, known as "The Blob"[2], 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.

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 Project consists of 1.33 miles of Corte Madera Creek and the surrounding floodplain extending from the Lagunitas Road Bridge downstream to the mouth of Tamalpais Creek. The upstream extent of the action area begins approximately 300 feet upstream of the Lagunitas Road Bridge to include the stream reach where collected fish will be relocated during construction. The downstream extent of the action area is the confluence of Corte Madera Creek and Tamalpais Creek, approximately 1,500 feet downstream of the Stadium Avenue Bridge and 1,650 feet downstream of the end of construction (Figure 3). The action area contains construction sites, staging areas, cofferdams, streambed area to be dewatered, fish relocation sites, and the portion of Corte Madera Creek in which any temporary disruption to habitat (e.g., fine sediment plume or first flush stormwater) might be detectable.

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 Steelhead and Critical Habitat in the Action Area

The Corte Madera Creek steelhead population is a potentially independent population[3] within the Coastal San Francisco Bay Diversity Stratum (NMFS 2016). Steelhead primarily use the action area for migration, but juvenile steelhead have been observed and collected year-round in lower

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

[3] As defined in the Coastal Multispecies Recovery Plan (NMFS 2016), functional independent populations are larger populations that are likely to persist over a 100-year time scale in isolation and without the influence of migrants from neighboring populations.

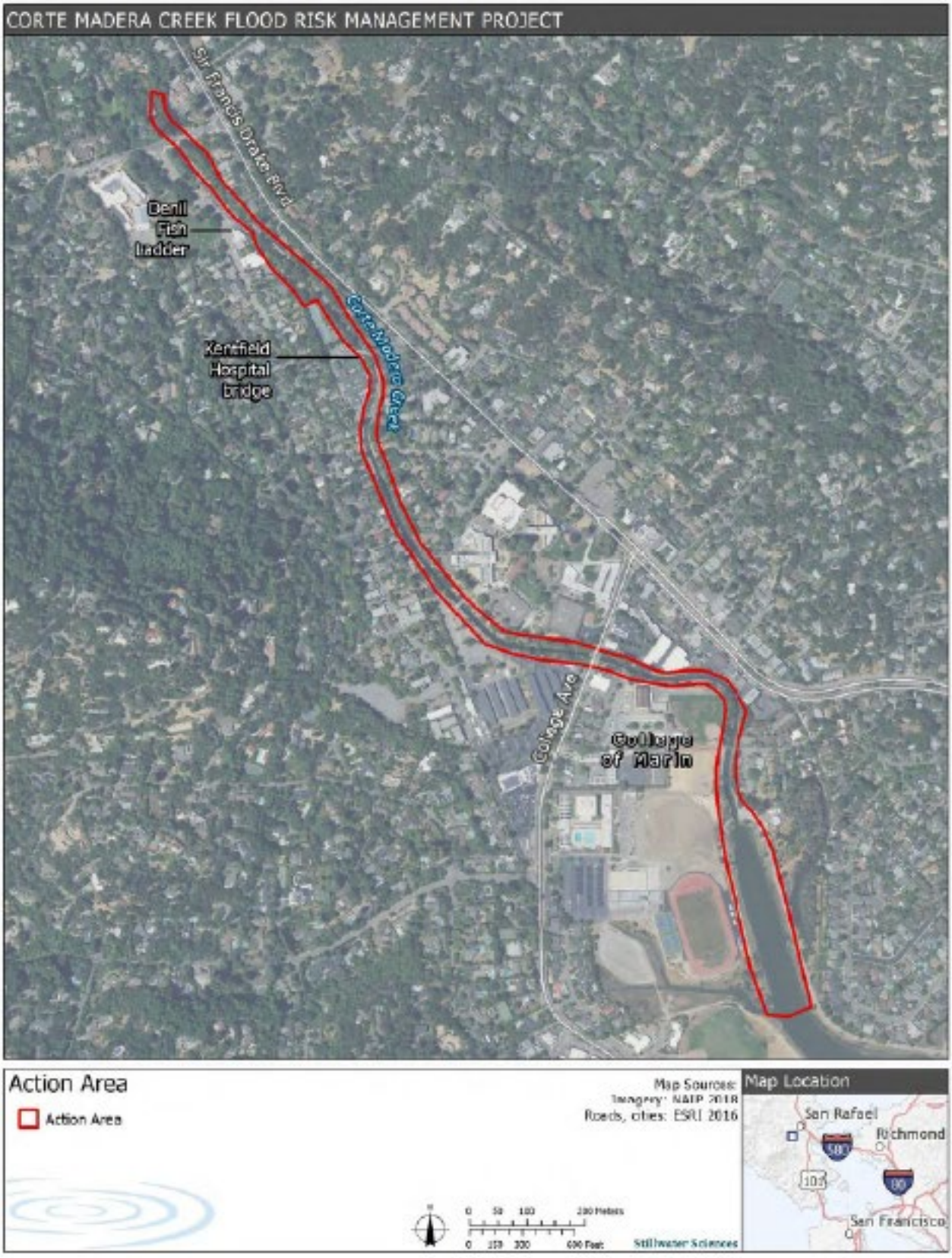

Figure 3. Action Area for Corte Madera Creek Flood Risk Reduction Project

Corte Madera Creek, including portions of the action area (Leidy *et al.* 2005b). The action area is designated as critical habitat for CCC steelhead.

Lower Corte Madera Creek was significantly modified between 1968 and 1972 by the Corps with the construction of Units 1, 2, and 3 of the Corte Madera Creek Flood Control Project. An earthen trapezoidal flood channel extending approximately 3 miles from Kentfield to San Pablo Bay was constructed in Units 1 and 2. Upstream of the earthen flood channel, the Corps constructed a concrete-lined channel extending approximately 5,200 linear feet (1,700 feet of concrete channel in Unit 2 and 3,500 feet of concrete channel in Unit 3). The upstream end of the Unit 3 concrete channel terminates with a Denil fish ladder. Construction of a concrete channel in Unit 4 was planned but was never completed due to local opposition.

Upstream fish passage for anadromous salmonids was considered when the original concrete channel was built, and a total of 24 fish resting pools were incorporated into the upper 1,900 feet of Unit 3. The resting pools are 13 feet wide by four feet long in the streamwise direction, and equally spaced in the concrete channel, approximately 64 feet apart. Under these existing conditions, fish passage for upstream migrating anadromous salmonids through Unit 3 has been assessed (GHD and Love and Associates 2021; Love and Anderson 2007), and the results show the concrete channel is a partial migration barrier. These assessments utilized an energetics model to determine the proportion of adult steelhead capable of ascending Unit 3 under various tidal conditions and streamflow levels. The model used flow velocities, water depths, steelhead swimming speeds, time to fatigue and rest, and body size as factors to assess upstream fish passage success rates. Results indicate that tidal conditions are important in influencing fish passage at different flows. During low tide conditions, nearly the entire population of steelhead are unable to ascend Unit 3 due to relatively swift water velocities and insufficient resting opportunities in the existing pools (Table 2). As the tide rises, the distance steelhead can swim upstream extends; however, at higher flows the existing pools do not provide adequate resting habitat for smaller-sized steelhead. At a high fish passage flow of 177 cfs, the existing pools fail to provide adequate resting opportunities for most of the population under all tidal conditions (Love and Anderson 2007) (Table 2).

Table 2. Estimated proportion of steelhead population capable of ascending Unit 3 at various fish passage flows and tidal conditions (Love and Anderson 2007).

	Percent Successful					
Tide	14 cfs	23 cfs	40 cfs	77 cfs	113 cfs	177 cfs
MLLW	7	2	2	2	2	1
MTL	98	85	51	13	7	1
MHHW	99	92	97	73	54	4

Within the concrete-lined portion of the flood channel, the condition of CCC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. Steelhead are anadromous and must return to freshwater to reproduce. Since all suitable rearing and spawning habitat in the Corte Madera Creek watershed exists upstream of the existing concrete flood channel, improving fish passage into that upstream habitat is imperative to support the steelhead life history, and efforts

to improve fish passage in the action area are identified as a CCC steelhead recovery action (NMFS 2016).

As described above, a concrete channel in Unit 4 was never constructed and the Corte Madera Creek channel in Unit 4 remains in relatively natural condition. At the transition from Unit 3 (concrete channel) to Unit 4 (natural channel) a wooden Denil fish ladder was installed in the 1970's as a temporary measure. It was constructed to provide fish passage over a grade control structure protecting two sewer lines that cross under the creek bed, immediately upstream of the concrete channel. This ladder was intended to be in service for one season and would have been removed with construction of Unit 4. The ladder generally functions well at low flows, but fails to provide suitable passage during the higher flow conditions due to the ladder's inadequate hydraulic capacity. Since the majority of adult upstream migration occurs during moderate and high streamflow events, this ladder is a significant impediment to upstream migration. The combination of inadequately designed fish resting pools in Unit 3 and the deficient Denil fish ladder has created very poor upstream passage conditions for steelhead in lower Corte Madera Creek and contributed to an overall reduction in steelhead productively in the watershed.

Instream habitat in the action area consists of earthen trapezoidal flood channel in a portion of Unit 2, concrete-lined channel extending from Unit 2 into and through Unit 3 (33 feet wide with 18-foot high walls), and natural channel bottom and banks in Unit 4. Channelization and urbanization adjacent to lower Corte Madera Creek has contributed to the loss of riparian vegetation in the action area. Water temperatures within the concrete channel of Unit 3 typically range from 65 to 75°F, beginning in late May and extending through September (Rich 2000). With high summer water temperatures, approximately one mile of concrete-lined channel, and tidal influence from San Pablo Bay, the action area of Corte Madera Creek provides fair to poor rearing conditions for juvenile steelhead.

In spite of substantial alterations made to lower Corte Madera Creek, steelhead have consistently been documented in the stream since the construction of the flood channel in the 1970's. Surveys in 1980, 1981, and 1992 observed juvenile steelhead in or near the action area (Leidy *et al*. 2005b). In 1993, Leidy captured juvenile steelhead in a reach of Corte Madera Creek that included the action area and estimated a density of 25 juveniles per 100 feet of stream length (Leidy 2005b). In 1997, the same researcher again captured juvenile steelhead in the action area and estimated a density of five juveniles per 100 feet (Leidy *et al*. 2005b). Fish collection and relocation efforts for construction activities by the Town of Ross resulted in the collection of juvenile steelhead from Corte Madera Creek in 2005 (Rich 2005).

Detailed information on the freshwater pool, riffle and flatwater characteristics, estuarine channel characteristics, and existing riparian vegetation within the action area can be found in Section 6 of the March 2022 BA.

2.4.2. Status of CCC Coho Salmon and Critical Habitat in the Action Area

As stated above, Corte Madera Creek historically supported a run of CCC coho salmon (Leidy *et al*. 2005a). Leidy (1984) collected and released juvenile coho salmon from sites on lower Corte Madera Creek in September 1981 and this collection is likely the last known record of native coho salmon in this watershed (Leidy *et al*. 2005a). In January 1986, fourteen adult coho salmon were observed in Corte Madera Creek, but these fish likely originated from a 1983 transplant of approximately 600 coho salmon fry from Lagunitas Creek, a nearby coastal Pacific drainage

(Emig 1986 as reported in Leidy *et al*. 2007). Based on the best available information, coho appear to be extirpated from the watershed; however, the stream is designated as critical habitat for endangered CCC coho salmon (64 FR 24049).

The condition of critical habitat for coho salmon in the action area is degraded due to the construction of the Corte Madera Creek Flood Control Project between 1968 and 1972 by the Corps. As described above for CCC steelhead, the construction of Units 1, 2, and 3 of the flood project significantly modified the channel which resulted in poor habitat for fish rearing and significant impediments to fish passage. The description of habitat and fish passage conditions in the action area presented above for CCC steelhead (see section 2.4.1) also applies to CCC coho salmon critical habitat.

2.4.3. Previous Section 7 Consultation in the Action Area

Pursuant to section 7 of the ESA, NMFS has conducted several previous interagency consultations that affected the action area of this Project. Previous consultations are presented chronologically below.

In September 2002, NMFS and the Corps completed informal consultation on the Town of Ross' removal of 1,400 cubic yards of accumulated sediment from Corte Madera Creek at the Lagunitas Road Bridge (ARN 151422SWR2002SR8318). Work was limited to the dry portion of the channel and NMFS concurred with the Corps by letter dated September 27, 2002, that the action was not likely to adversely affect CCC steelhead and not result in adverse effects to CCC steelhead or CCC coho salmon critical habitat.

In August 2006, NMFS and the Corps completed formal consultation on the Town of Ross' removal of 1,400 cubic yards of accumulated sediment from the Corte Madera Creek channel at the Lagunitas Road Bridge (ARN 151422SWR2007SR00574). NMFS concluded in the biological opinion issued on August 30, 2006, that the project was not likely to jeopardize the continued existence of CCC steelhead and not result in the adverse modification of CCC steelhead or CCC coho salmon critical habitat.

In September 2009, NMFS and the Corps completed formal consultation on the removal of 900 to 1,000 cubic yards of accumulated sediment from Corte Madera Creek under the Lagunitas Road Bridge (ARN 151422SWR2009SR00327). NMFS concluded in the biological opinion issued on September 8, 2009, that the project was not likely to jeopardize the continued existence of CCC steelhead and not result in the adverse modification of CCC steelhead or CCC coho salmon critical habitat.

In September 2009, NMFS and the California Department of Transportation (Caltrans) completed formal consultation on the replacement of the Lagunitas Road Bridge in the Town of Ross, Marin County, California (ARN 151422SWR2009SR00398). NMFS concluded in the biological opinion issued on October 15, 2009, that the project was not likely to jeopardize the continued existence of CCC steelhead and not result in the adverse modification of CCC steelhead or CCC coho salmon critical habitat.

In August 2011, NMFS and the Corps completed formal consultation on the Town of Ross' stabilization of areas along the bank of Corte Madera Creek both upstream and downstream of the Lagunitas Road Bridge (ARN 151422SWR2011SR00268). NMFS concluded in the

biological opinion issued on August 9, 2011, that the project was not likely to jeopardize the continued existence of CCC steelhead and not result in the adverse modification of CCC steelhead or CCC coho salmon critical habitat.

In October 2021, NMFS and the Corps completed informal consultation on the Lower Corte Madera Creek Restoration Project (ARN 151422WCR2021SR00147). The project is designed to restore approximately 900 linear feet of Corte Madera Creek through the removal of portions of the concrete walls along the creek bank, recontouring the channel banks, and planting the stream banks with native vegetation. NMFS concurred with the Corps by letter dated October 5, 2021, that the action was not likely to adversely affect CCC steelhead and not result in adverse effects to CCC steelhead or CCC coho salmon critical habitat.

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).

The effects of the proposed action are reasonably likely to include the injury and mortality of juvenile steelhead during fish relocation and channel dewatering, degradation of water quality, stream channel stabilization, and improved fish passage.

2.5.1. Fish Relocation for Construction and Maintenance

The Project proposes to conduct demolition and construction activities within wetted portions of Corte Madera Creek in Units 3 and 4. Additionally, future maintenance activities may involve the use of a vacuum truck to remove accumulated sediment from the fish resting pools during the dry season. Work areas would be temporarily dewatered with the installation of cofferdams and bypass systems to route flow around work areas immediately prior to construction and maintenance activities. The District proposes to conduct fish collection and relocation in coordination with dewatering and cofferdam installation to minimize the effects of dewatering the stream.

Before and during dewatering of construction areas and sediment removal sites, juvenile steelhead and other fish will be captured and relocated to Corte Madera Creek outside of work areas to avoid direct mortality and minimize the possible stranding of fish in isolated pools. Channel dewatering and fish relocation will be performed in both Unit 3 (concrete channel) and Unit 4 (natural channel). The bed and banks of Unit 4 are natural and a small number of juvenile steelhead are likely to be rearing in this reach during the period of construction between June 15 and October 15. Unit 3 is a concrete channel and this reach is less likely to support summer rearing by juvenile steelhead; however, some juvenile steelhead could be present during the June 15 to October 15 construction season. Fish collected from freshwater reaches (i.e., Unit 4 and upper portion of Unit 3) will be relocated upstream of the Lagunitas Road Bridge within different habitat units to reduce crowding. Fish collected from the intertidal reach of Unit 3 will be relocated downstream of the College of Marin Science-Math-Nursing Building Bridge.

Fish within the area to be dewatered will be captured using seines, electrofishing, and dip nets by qualified fisheries biologists. All steelhead present in the areas to be dewatered will need to be relocated or they will perish when the work area is dewatered. Steelhead relocation activities will occur between June 15 and October 15 after emigrating smolts and kelts (post-spawned adults) have left the creek and prior to the adult migration and spawning season. Therefore, NMFS expects the CCC steelhead that will be captured during these activities will be limited to pre-smolting juveniles. Previous sampling of steelhead in Corte Madera Creek (Leidy *et al*. 2005b) indicates that one or two year-classes of steelhead may be present during the summer and fall months in the action area.

Fish relocation activities pose a risk of injury or mortality to rearing juvenile salmonids. Any fish collecting gear, whether passive (Hubert 1996) or active (Hayes *et al*. 1996) has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish capture varies widely, depending on the method used, the ambient conditions, and the expertise and experience of the field crew. Since fish relocation activities by the Project will be conducted by qualified fisheries biologists, direct effects to, and mortality of, juvenile steelhead during capture are anticipated to be minimized. Based on information from other relocation efforts in California, NMFS estimates injury and mortalities would be less than three percent of those steelhead that are captured and relocated (Collins 2004, CDFG 2005, 2006, 2007, 2008, 2009, 2010a, 2010b, NMFS 2016b). Fish that avoid capture during relocation efforts may be exposed to risks described in the following section on dewatering. NMFS expects no more than three percent of the steelhead captured by the Project for dewatering will be injured or killed during relocation activities.

Data to precisely quantify the amount of steelhead that may be collected and relocated prior to construction activities and sediment removal maintenance in Corte Madera Creek is limited. In July 1993 and August 1997, Leidy electrofished upstream of the Denil fish ladder in Unit 4 of the Corte Madera Creek Flood Project and captured several juvenile steelhead (Leidy *et al*. 2005b). Leidy's results yielded densities of juvenile steelhead ranging from 5 to 25 fish per 100 feet of stream. Prior to sediment removal activities in the vicinity of the Lagunitas Road Bridge in October 2005, six juvenile steelhead were collected; however, fish collections in the same reach of Corte Madera Creek in September and October in 2006 did not encounter any juvenile steelhead. Similarly, fish relocation efforts in 2009, prior to sediment removal activities, did not encounter any juvenile steelhead at the Lagunitas Road Bridge. Based on past observations in the action area of Corte Madera Creek and low streamflow conditions expected in the period between June 15 and October 15, it is anticipated that low numbers of juvenile steelhead will be within the action area during this Project's construction activities and during future sediment removal maintenance actions.

Sites selected in Corte Madera Creek for relocating fish are expected to have similar and ample aquatic habitat as the capture site. In some instances, relocated fish may endure short-term stress from crowding at the relocation sites. Relocated fish may have to contend with other fish causing increased competition for available resources such as food and habitat area. Frequent responses to crowding by steelhead include emigration and reduced growth rates (Keeley 2003). Some of the fish released at the relocation sites may choose not to remain in these areas and move either upstream or downstream to areas that have more vacant habitat and a lower density of steelhead. As each fish moves, competition remains either localized to a small area or quickly diminishes as fish disperse. NMFS does not expect impacts from increased competition would be large enough

to adversely affect the survival chances of individual steelhead, or cascade through the watershed population based on the small area that would likely be affected and the relatively small number of individuals likely to be relocated (particularly when compared with the remainder of individuals throughout the drainage not affected by the project). As described above, sufficient habitat appears to be available in Corte Madera Creek to sustain fish relocated without crowding of other juvenile steelhead. Once construction activities and sediment maintenance events are completed and the cofferdams removed, juvenile steelhead will have the ability to return to the previously dewatered portions of the action area.

2.5.2. Dewatering for Construction and Maintenance

The Project proposes to isolate work areas with cofferdams and bypass streamflow around the work sites for construction and post-construction sediment maintenance. Up to 750 linear feet of channel may be dewatered in Unit 4 for project construction. In Unit 3, up to 4,650 linear feet of channel may be dewatered to facilitate project construction.

Bypass piping will be installed to divert streamflow from upstream of construction areas to below construction areas by gravity or by screened pumps. NMFS anticipates only minor temporary changes to the streamflow of creek outside of the dewatered construction area during the dewatering process. These fluctuations in flow are anticipated to be small, gradual, and short-term. Once the cofferdams and pipeline bypasses are installed and operational, streamflow above and below work areas should be the same as the pre-project conditions except within the dewatered work areas where streamflow is bypassed. The dewatering of the channel is expected to cause a temporary reduction in the quantity of aquatic habitat in the action area of Corte Madera Creek during the period of cofferdam installation.

Juvenile steelhead that avoid capture in the project work area following relocation efforts may die due to desiccation, thermal stress, or by being crushed by equipment or foot traffic if not found by biologists as water levels recede within the area being dewatered. However, due to fish relocation efforts, NMFS expects the number of juvenile steelhead that would die as a result of stranding during dewatering activities would be one percent or less of the steelhead within the work site prior to dewatering.

The temporary cofferdams and water diversion structures in the creek at the construction site are not expected to impact juvenile steelhead movements in Corte Madera Creek with the exception of the areas to be dewatered. During the period between June 15 and October 15, streamflows are typically at seasonal low levels and this period is outside the active migration periods of steelhead. Adult steelhead migrate upstream, typically, December through March and juveniles typically outmigrate from March through May (Section 2.4, above). Thus, the Project's temporary placement of cofferdams and streamflow bypass diversions during the four month in-channel construction period are unlikely to adversely affect movements of individual steelhead in Corte Madera Creek.

Benthic (i.e., bottom dwelling) aquatic macroinvertebrates (a salmonid prey item) within construction sites may be killed or their abundance reduced when creek habitat is dewatered (Cushman 1985). However, effects to aquatic macroinvertebrates resulting from the construction streamflow bypasses and dewatering will be temporary because in-water construction activities would be of relatively short duration. Rapid recolonization (typically one to two months) of disturbed areas by macroinvertebrates is expected following channel re-watering (Cushman

1985, Thomas 1985, Harvey 1986). Based on the foregoing, NMFS does not expect the temporary loss of aquatic macroinvertebrates as a result of dewatering activities by the Project to adversely affect CCC steelhead during or after Project implementation.

2.5.3. Mobilization of Sediment and Water Quality

During construction, project activities at Corte Madera Creek would result in disturbance of the creek bed and banks for equipment access, bank and channel contouring, construction of the new fish resting pools, floodwall construction and access ramp construction. While the cofferdams and streamflow bypass systems are in place, construction activities are not expected to degrade water quality in Corte Madera Creek because the work areas will be dewatered and isolated from the flowing waters of the creek. Post-construction, NMFS anticipates disturbed soils could affect water quality and critical habitat in the action area in the form of small, short-term increases in turbidity during re-watering (*e.g*., following removal of the cofferdams) and subsequent higher flow events during the first winter storms post-construction. Disturbed soils on the creek bank are easily mobilized when late fall and winter storms increase streamflow levels. Instream and near-stream construction activities have been shown to result in temporary increases in turbidity (reviewed in Furniss *et al*. 1991, Reeves *et al*. 1991, Spence *et al*. 1996).

Increases in sediment may affect fish in a variety of ways. High concentrations of suspended sediment can disrupt normal feeding behavior and efficiency (Cordone and Kelley 1961, Bjornn *et al*. 1977, Berg and Northcote 1985), reduce growth rates (Crouse *et al*. 1981), and increase plasma cortisol levels (Servizi and Martens 1992). High and prolonged turbidity concentrations can reduce dissolved oxygen in the water column, result in reduced respiratory functions, reduce tolerance to diseases, and can also cause fish mortality (Sigler *et al*. 1984, Berg and Northcote 1985, Gregory and Northcote 1993, Velagic 1995, Waters 1995). Even small pulses of turbid water can cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat and/or increase competition and predation, thus decreasing chances of survival. Increased sediment deposition can fill pools thereby reducing the amount of potential cover and habitat available, and smother coarse substrate particles which can impair macroinvertebrate composition and abundance (Sigler *et al*. 1984, Alexander and Hansen 1986).

Although chronic elevated sediment and turbidity levels may affect steelhead and critical habitat, sedimentation and turbidity levels associated with this Project's proposed activities and during subsequent rainfall events are not expected to rise to the levels discussed in the previous paragraph, because the Project proposes several measures to minimize the mobilization of sediment. Due to the Project's proposed use of erosion control measures throughout the construction phase, and post-construction planting of native vegetation, NMFS anticipates there will be minimal area of disturbed, exposed soils remaining post-construction. Therefore, any resulting elevated turbidity levels would be small, only occur for a short period, and be well below levels and durations shown in the scientific literature as causing injury or harm to salmonids (see for example Sigler *et al*. 1984 or Newcombe and Jensen 1996). NMFS expects any sediment or turbidity generated by the Project would not extend more than 500 feet downstream of work sites in Corte Madera Creek based on the site conditions and proposed methods to control sediment. NMFS does not anticipate harm, injury, or behavioral impacts to CCC steelhead associated with exposure to the minor elevated suspended sediment levels that would be generated by the Project.

During the excavation of the creek bed in Unit 4 and the modification of the concrete channel in Unit 3, there is the possibility of contamination to groundwater and aquatic habitat by the accidental release of hydrocarbons from construction equipment. As identified above and in BA Section 5.1.10.1, the District and construction contractor will ensure that all pollution prevention measures are following and that equipment is in good working order prior to starting work, and any accidents would be addressed immediately. With these measures in place, contamination to groundwater and aquatic habitat is not expected to occur during construction.

2.5.4. Tree Removals

The removal of trees within the action area could result in increased water temperatures in Corte Madera Creek. There are approximately 203 trees in the riparian zone within and adjacent to Unit 4; 21 of these trees would be removed during construction. Approximately 14 trees would be removed as a result of construction in Units 2 and 3.

Trees provide shading of creek habitat and help maintain the optimal, generally cool, temperatures that salmonids have adapted to. Temperature increases can affect fish physiologically through decreased oxygen availability in warmer water, and behaviorally as they may move to locate cooler temperature waters. Within Unit 4, the relatively small number of trees that would be removed during construction is anticipated to have minimal impacts to the water temperature as much of the shade canopy in this area would remain. In Unit 3, the existing trees to do not provide much shade canopy and the concrete channel itself creates increased water temperatures at low flow due to the hardened creek bed and banks, and the absence of any secondary cooling providing by groundwater seepage.

2.5.5. Sheet Pile Installation

The installation of sheet pile walls in Unit 4 would be conducted by vibratory and impact hammers. Monitoring of underwater sound levels associated with vibratory and impact hammers has been performed, previously, for projects in other watersheds (Molnar *et al*. 2020). Based on the hydroacoustic data collected from these projects sound generated by vibratory hammers to install sheet piles would not present a risk of physical injury or mortality to any juvenile steelhead that may be present within the action area during the construction period.

Impact hammers can generate underwater sound pressure waves that are potentially injurious and even fatal to fish (Molnar *et al*. 2020). As the distance from impact hammer activity increases, sound attenuation reduces the sound pressure levels, and potential harmful effects to fish also decreases. The use of impact hammers within dewatered areas also reduces the sound attenuation and further decreases the potential for fish injury. To assess the potential effects of pile driving with an impact hammer, NMFS uses a dual metric criterion of 206 dB re one micropascal peak sound pressure level for any single strike and an accumulated sound exposure level (SEL) of 187 dB re one micropascal squared-second to correlate physical injury to fish greater than 2 grams in weight from underwater sound. For pile driving associated with this project, work would not be performed in the flowing waters of Corte Madera Creek. The use of cofferdams would create sufficient distance from the proposed sheet pile wall to attenuate sound levels and no injury or mortality of juvenile steelhead in the action is expected from elevated sound levels.

2.5.6. Future Project Maintenance

Post-construction, large debris removal and sediment removal with hand tools may be performed during the winter and spring months. Although this period overlaps with the upstream and downstream migratory periods of steelhead, no injury or mortality is expected because direct contact, trapping or impingement is very unlikely to occur. No dewatering will be performed and no mechanical equipment will enter the channel outside of the June 15 to October 15 period. The removal of large debris, if needed to ensure safe fish passage and resting pool conditions, would only be conducted with equipment from the top-of-bank during the salmonid migratory season. The majority of channel maintenance activities are expected to be identified during the annual sediment inspections and performed during summer/fall low flow conditions. If sediment removal is performed with a vacuum truck, cofferdams will be installed and fish relocation performed prior to dewatering of the maintenance site. The effects of cofferdam installation for future maintenance activities are expected to be the same as those described above for project construction and presented above in Sections 2.5.1 and 2.5.2 of this opinion.

2.5.7. Access to Rearing and Spawning Habitat

While not an impassable barrier to upstream migration of steelhead, the concrete flood channel and Denil ladder in Corte Madera Creek significantly impairs steelhead migration (Love and Anderson 2007). As described in Section 2.4 of this opinion, the existing concrete channel includes reaches with relatively swift water conditions and limited resting opportunities for steelhead under low tide stages and under high streamflows. The existing Denil fish ladder also fails to provide suitable upstream passage conditions at moderate and high flows when steelhead are migrating.

The Project's proposed addition of 16 fish resting pools is expected to dramatically improve fish passage conditions in Unit 3. The constructed pools will be recessed into the concrete flood channel to a depth of 2 feet below the existing bottom. The geometry of the pools and offset from the channel centerline are expected to reduce the potential for sediment accumulation. The pools are designed to provide adequate volume for up to four adult steelhead to rest in a single pool at a wide range of tide stages and fish passage flows.

The number and location of resting pools were determined by modeling. The optimal location for each pool was identified by starting at the downstream end of Unit 3 and inserting pools with the model at locations that minimized the number of adult steelhead that become fatigued before reaching the next upstream resting pool. The resulting passage success rate at the high fish passage flow of 180 cfs and a low tide of 0.0 feet is 90.9% whereas the modeled success rate in the existing channel under these conditions is zero. The proposed Project will also remove the existing dilapidated Denil fish ladder and modify the creek bed to create a smooth transition between the concrete channel in Unit 3 and the earthen channel in Unit 4.

These proposed improvements to the Corte Madera Creek channel will allow for the unimpeded upstream passage of adult steelhead through the action area. All suitable spawning and juvenile rearing habitat for steelhead exists upstream of Unit 4; thus, it is essential for adult steelhead to successfully navigate this reach of Corte Madera Creek. Due to the flashy nature of the watershed's hydrology, high flow events in some water years may be limited to a few non-consecutive days during the adult migration season (December through April) and it is imperative for steelhead returning from the ocean to fully utilize these opportunities when water

depths are suitable for upstream passage. Since the completion of the Corps' flood project in 1972, adult access to the upper watershed has been unreliable and passage delays ranging from several hours to days due to low tide conditions or high streamflows likely affected the number of adult steelhead reaching the suitable spawning habitat. The Project's actions to eliminate delays to passage in the action area will benefit the entire steelhead population of the Corte Madera Creek watershed.

Improved access to the upper watershed is expected to increase the spatial distribution of steelhead in the Corte Madera Creek watershed, and contribute to higher productivity and abundance. This will enhance population resilience and the ability of the Corte Madera Creek population to fulfill its functional role within the Coastal San Francisco Bay Diversity Stratum of the CCC steelhead DPS. Successful completion of this project will address a significant and high priority action to facilitate recovery of CCC steelhead in Corte Madera Creek. Recovery action CMC-CCCS-5.1.1.4 calls for improved fish through the Town of Ross (NMFS 2016).

2.5.8. Stream Channel Stabilization

The Project's proposed sheet pile wall, three concrete retaining walls, planted rock slope protection, and engineered rock chute in Unit 4 are designed to stabilize the channel and maintain flood flows within the channel of Corte Madera Creek. Additionally, two floodwall segments will be constructed in Unit 3. One segment would be built to increase the height of the existing floodwall by 2 to 4 feet above the existing concrete channel and the second segment of floodwall would extend from the top of bank at the College Avenue Bridge. In Unit 2, the Project will build a 1 to 2-foot tall floodwall on top of the existing concrete channel wall (left bank) to avoid increased inundation of adjacent areas during flood events.

By design, flood control actions and associated bank stabilization projects prevent lateral channel migration, effectively forcing streams into a simplified linear configuration. Without the ability to move laterally, stream channels tend to erode and deepen vertically (Leopold 1968; Dunne and Leopold 1978). The resulting "incised" channel fails to create and maintain aquatic and riparian habitat through lateral migration, and can instead impair groundwater/stream flow connectivity and repress floodplain and riparian habitat function. Simplified stream reaches typically produce limited macroinvertebrate prey and provide poor functional habitat for rearing juvenile salmonids (Florsheim *et al*. 2008).

Construction of the Project's flood control and channel stabilization actions will preclude natural fluvial and geomorphic processes. In most low gradient streams, the channel will naturally "meander", eroding laterally to dissipate its hydraulic energy while creating a sinuous longitudinal course. Stream meandering efficiently regulates the erosive forces by lengthening the channel and reducing stream gradient, thus controlling the ability of the stream to entrain and transport available sediment. Meandering streams also create and maintain both the hydraulic and physical components of instream habitat used by fish and other aquatic species. For instance, specific to salmon and steelhead, a meandering, unconstrained stream channel sorts and deposits gravel and other substrate necessary for optimal food production and spawning success, maintains a healthy and diverse riparian corridor that supplies large woody debris (LWD) to the channel, and inundates adjacent floodplain habitat during appropriate winter/spring flows (Spence *et al.* 1996).

Project actions will significantly alter existing physical habitat along the creek bed and banks of Unit 4 by stabilizing the channel. Bank stabilization impacts the physical habitat in two general ways – by changing a dynamic, unrestrained stream that constantly evolves via hydrologic and geomorphic processes into a fixed, simplified channel, and by altering the physical land/water interface (i.e. streambank) that provides shelter, food, and other ecosystem benefits to aquatic species, including juvenile salmonids. With construction of the sheet pile wall, concrete retaining walls, and placement of planted rock slope protection in Unit 4, the Project will maintain the current channel alignment and degraded habitat condition. Although bio-engineering methods upslope of the planted rock slope protection (vegetated erosion control fabric) are expected to provide some habitat value for salmonids through shading by riparian vegetation and source of terrestrial invertebrate prey.

In Unit 3, the floodwall additions will be installed along the upper bank to extend the height of the existing concrete walls and along the left upper bank at the College Avenue Bridge. In Unit 2, a new 1 to 2-foot high floodwall will be construction on top of the existing left bank concrete channel wall. No changes will be made to address the existing concrete walls on the lower banks of Units 2 and 3 which have locked the channel into a fixed alignment and degraded habitat for salmonids. Cover and riparian shading along the banks in Units 2 and 3 are completely absence due to the concrete-lined bed and banks. Cover is an important habitat component for juvenile salmonids and smolts, both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991, Moyle 2002). Salmonid juveniles balance their use of cover and foraging habitats based on their competing needs for energy acquisition and safety (Bradford and Higgins 2001). Critical forms of cover include submerged vegetation, woody debris, and the interstitial spaces of stream bed gravel substrate (Raleigh *et al*. 1984). Juveniles will respond to threats of predation, including overhead motions, by huddling together and/or fleeing to nearby cover (Bugert and Bjornn 1991). Few young-of-the-year are found more than one meter from cover (Raleigh *et al*. 1984). Juvenile steelhead, particularly the younger, smaller individuals, have a notable response to disturbance; they rely on nearby substrate particles (i.e., gravel) for cover more so than other salmonids (Chapman and Bjornn 1969, Everest and Chapman 1972).

The Project's proposed construction of additional floodwalls on top of existing concrete channel walls is not likely to further degrade habitat conditions within Unit 3 because the lower portion of the creek bank and bed are currently concrete. However, the proposed structural extension of the concrete channel contributes the existing degraded condition and impacts experienced by steelhead will likely manifest as a continued depression in juvenile carrying capacity within the concrete-lined reaches of Units 2 and 3. Without the benefits of instream features that provide cover and habitat complexity, conditions will continue to be poor in Units 2 and 3 for steelhead foraging, refuge from predators and refuge from high velocities.

The combination of new channel stabilization structures in Unit 4 and maintenance of the existing concrete channel, the Project is expected to continue to depress juvenile steelhead carrying capacity in the action area. However, NMFS expects the amount of loss will be low due to the Project's location in the lowermost reach of Corte Madera Creek and improved fish passage conditions in the flood channel. Historically and currently the vast majority of juvenile rearing habitat for steelhead in the watershed occurs upstream of the action area in streams tributary to the upper watershed.

2.5.9. Effects on Critical Habitat for CCC Steelhead and CCC Coho Salmon

The critical habitat designation for CCC steelhead includes Corte Madera Creek and several of its tributaries (September 2, 2005; 70 FR 52488). The critical habitat designation for CCC coho salmon includes Corte Madera Creek (May 5, 1999; 64 FR 24061).

2.5.9.1 Construction Impacts

As discussed above in sections 2.5.2 and 2.5.3 of this opinion, Project construction activities are expected to result in short-term disturbances to the channel and adjacent streambank areas. Localized and temporary impacts to Corte Madera Creek in the form of increased levels of turbidity and reduction in benthic invertebrate abundance are anticipated with construction activities. Degradation of water quality in the form of increased levels of turbidity and suspended fine sediment will generally be contained during construction by the use of cofferdams. Impacts to benthic habitat and associated invertebrates may occur as the channel adjusts to the new geometry following construction.

The Project proposes to plant areas disturbed by construction activities, including sites where trees and shrubs have been removed, using appropriate native riparian species upon completion of the Project. Other areas disturbed during construction activities will be re-seeded to promote natural recruitment of native vegetation. Areas replanted and reseeded with riparian species are expected to recover within the short-term (*e.g.*, 2-5 years). Removal of riparian vegetation has the potential to affect Corte Madera Creek with increased exposure to solar radiation and reduced invertebrate prey input from terrestrial sources in Unit 4. Therefore, NMFS expects temporary impacts to PBFs of critical habitat associated with foraging and water quality due to vegetation removal within construction areas in a portion of the 575-foot long reach of Unit 4. Due to the small area subject to vegetation removal and District' proposed revegetation plan, Project construction activities are not expected to have an appreciable effect on critical habitat PBFs associated with stream shading, cover, water temperature, or nutrient input in the action area.

2.5.9.2 Upstream Fish Passage

As discussed above in section 2.5.7 of this opinion, upon completion of the Project, fish passage is expected to dramatically improve in the action area of Corte Madera Creek. The existing fish pools in Unit 3 do not provide adequate resting opportunities during low tide conditions and during moderate to high streamflow levels. With the Project's installation of 16 new fish resting pools in Unit 3 and removal of the failing Denil fish ladder, adult immigrating steelhead are expected to ascend the project reach without impairment to high quality spawning habitat in the upper Corte Madera Creek watershed under a wider range of flow conditions and tide stages.

With increased access to high quality spawning and rearing habitat in the upper watershed, the steelhead population of Corte Madera Creek is expected to increase. Adult CCC coho salmon have not been observed in Corte Madera Creek since 1986, but improved access to the upper watershed will benefit any future adult returns of this species. Larger numbers of adult salmonids successfully accessing the upper watershed will increase marine-derived nutrient input and should benefit critical habitat. Marine-derived nutrients are nutrients that are accumulated in the biomass of salmonids while they are feeding in the ocean. Salmon and steelhead can spend the majority of their life cycle in marine environments, and, thus most of their size and high rate of growth can be attributed to abundant food sources they encounter in the ocean. When these fish return to freshwater as spawning adults, they contribute the marine-derived nutrients they have

obtained through egg and carcass deposition. Iteroparous species such as anadromous trout can contribute marine-derived nutrients during multiple spawning events throughout their lifespan. The return of salmonids to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000), and has been shown to be vital for the growth of juvenile salmonids (Bilby *et al.* 1996, 1998). Evidence of the role of marine-derived nutrients and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al*. 1996). Reduction of marine-derived nutrients to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al*. 2000).

Cederholm *et al*. (1999) suggested that aquatic macroinvertebrates likely benefit from marine derived nutrients through an increase in primary productivity, thereby creating a positive feedback loop for juvenile salmonids by increasing their food supply. In California, native riparian vegetation and cultivated wine grapes obtained significant amounts of marine-derived nutrients from salmonids (Merz and Moyle 2006). Marine-derived nutrients can be restored to the food web following dam removal as observed in a single year following dam removal on the Elwah River in Washington State (Tonra *et al*. 2015). In Corte Madera Creek, an increase in adult anadromous salmonid returns to the watershed and the associated increase in contribution of marine-derived nutrients are expected to provide multiple benefits to PBFs of CCC steelhead and CCC coho salmon critical habitat.

2.5.9.3 Stream Channel Stabilization

As discussed above in section 2.5.8 of this opinion, completion of the Project's flood control and channel stabilization actions will preclude natural fluvial and geomorphic processes in the action area. Project actions will also alter existing physical habitat by stabilizing the streambed and banks in Unit 4. By design, these actions prevent lateral channel migration, effectively forcing streams into a simplified linear configuration. The resulting channel is expected to have low instream complexity, limited floodplain connectivity and repressed riparian habitat function. Simplified stream reaches typically produce limited macroinvertebrate prey and provide poor functional habitat for rearing juvenile salmonids (Florsheim *et al*. 2008). By maintaining the existing condition of concrete channel in Units 2 and 3, and expanding the area of stabilized channel in Unit 4, the Project will contribute to the degraded condition of PBFs for foraging and cover of CCC steelhead and CCC coho salmon critical habitat in the action area.

2.6. Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline (Section 2.4).

NMFS does not anticipate any cumulative effects in the action area other than those ongoing actions already described in the Environmental Baseline above. Given current baseline conditions and trends, NMFS does not expect to see significant changes in cumulative effects in the near future due to existing development and use of water in the watershed. NMFS assumes the rate of such development and water use would be similar to that observed in the last decade.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

CCC steelhead are listed as threatened under the ESA. Based on the extensive loss of historic habitat due to dams, water diversions, and the degraded condition of remaining spawning and rearing areas, CCC steelhead populations in watersheds that drain to San Francisco Bay, including Corte Madera Creek, have experienced severe declines. Due to habitat degradation associated with urbanization and water development that has altered the streamflow regime, steelhead occur in Corte Madera Creek in densities and abundance lower than historic levels. The completion of the Corps' flood control project in 1972 (Units 2 and 3) significantly impaired adult steelhead upstream migration through lower Corte Madera Creek and reduced access to spawning and rearing habitat in the upper watershed. Urban development, flood control, and transportation infrastructure has encroached on the channel of Corte Madera Creek, resulting in reduced riparian vegetation, reduced channel complexity, increased channelization, and concentrated stormwater discharge to the stream. These factors lead to a flashier stream hydrograph, increased toxic inputs, and reduced quality aquatic habitat. Aquatic habitat for CCC steelhead throughout the action area is degraded.

As described in the *Effects of the Action* (Section 2.5) of this opinion, CCC steelhead may be present within the action area of Corte Madera Creek during the placement of cofferdams and dewatering for project construction, however the number of individuals present in the action area is expected to be low due to the anticipated low summer streamflow and the degraded condition of rearing habitat within the concrete channel. Similarly, CCC steelhead may be present, post-construction, during sediment or debris removal activity in the concrete channel that occurs during the summer months; however, the number is anticipated to be low due to poor rearing habitat in this part of Corte Madera Creek. Sediment and debris removal that occurs during the winter or spring would overlap with the period when CCC steelhead are migrating either upstream to spawning grounds, or downstream to San Francisco Bay and the ocean; however, sediment and debris removal will be limited to use of hand tools or equipment from the top of bank during this period. Cofferdam installation and dewatering would be only be performed for maintenance activities during the period of June 15 to October 15 to avoid the steelhead migration season.

During the installation of cofferdams, NMFS estimates some juvenile steelhead may be collected from work sites and a small percentage of these individuals may be injured or killed during fish collection, relocation, and dewatering. NMFS does not anticipate that adult steelhead or smolts will be in Corte Madera Creek during construction activities. Based on the low mortality rates for similar capture and relocation efforts, NMFS anticipates few juvenile steelhead would be injured or killed by fish relocation and construction activities. Anticipated injury and mortality from capture and relocation is expected to be less than three percent of the fish collected. Fish that avoid capture and remain with the dewatered reach between cofferdams would likely die; however, this amount is expected to be one percent or less of the fish in areas prior to dewatering.

Post-construction, the addition of 16 new fish resting pools within the concrete channel of Unit 3 is expected to dramatically improve fish passage in the action area. The optimal locations for each new fish resting pool were identified with a model that minimized the number of adult steelhead that become fatigued before reaching the next upstream resting pool. The resulting passage success rate at the high fish passage flow of 180 cfs and a low tide of 0.0 feet is 90.9% whereas the modeled success rate in the existing channel under these conditions is zero. The proposed Project will also remove the existing dilapidated Denil fish ladder and modify the creek bed to create a smooth transition between the concrete channel in Unit 3 and the earthen channel in Unit 4. Improved access to the upper watershed is expected to increase the spatial distribution of steelhead in the Corte Madera Creek watershed, and contribute to higher productivity and abundance. This will enhance population resilience and the ability of the Corte Madera Creek population to fulfill its functional role within the Coastal San Francisco Bay Diversity Stratum of the CCC steelhead DPS. PBFs of critical habitat for CCC steelhead and CCC coho salmon associated with migration corridors free of obstruction are expected to significantly improve.

The majority of the Project's action area is located within Units 2 and 3 of the Corps-built flood control channel. The 33-foot wide concrete channel with 18-foot tall concrete walls precludes natural fluvial and geomorphic processes in the action area. Project actions will also alter existing physical habitat along the streambanks and stabilize an additional 575 linear feet of Corte Madera Creek in Unit 4. By design, these actions prevent lateral channel migration, effectively forcing streams into a simplified linear configuration. The resulting channel has low instream complexity, limited floodplain connectivity, and repressed riparian habitat function. The Project's simplification of this stream reach limits macroinvertebrate prey and provides poor functional habitat for rearing juvenile salmonids. By maintaining the existing condition of concrete channel in Units 2 and 3, and expanding the area of stabilized channel in Unit 4, the Project contributes to the degraded condition of PBFs for foraging and cover of CCC steelhead and CCC coho salmon critical habitat in the action area and maintain the depressed carrying capacity due to low habitat complexity. Some proportion (likely small) of rearing steelhead juveniles would be injured or killed as a result of degraded cover and poor forage habitat brought about by maintaining the concrete channel in Units 2 and 3, and the addition of new rock slope protection in Unit 4.

Although critical habitat will remain degraded within the concrete-lined channel into the future, the proposed action includes the construction of new resting pools which will address the reach's long-standing fish passage problem. The proposed action will not restore natural-habitat and fluvial processes in the action area, but will instead artificially create and maintain safe passage components important to salmonid migration habitat. Therefore, the ability of critical habitat to

serve its intended conservation role of supporting populations of CCC steelhead and CCC coho salmon as a whole will not be appreciably reduced.

Regarding future climate change effects in the action area, California could be subject to higher average summer air temperatures and lower total precipitation levels. Reductions in the amount of precipitation would reduce streamflow levels in Northern and Central California Coastal rivers. Estuaries may also experience changes in productivity due to changes in freshwater flows, nutrient cycling, and sediment amounts. For this project, construction would be completed in one season and the above effects of climate change are unlikely to be detected within this time frame. If the effects of climate change are detected over the short term, they will likely materialize as moderate changes to the current climate conditions with the action area. These changes may place further stress on CCC steelhead populations. The effects of the proposed action combined with the moderate climate change effects may result in conditions similar to those produced by natural ocean-atmospheric variations as described in the environmental Baseline Section of this opinion (Section 2.4) and annual variations. CCC steelhead are expected to persist throughout these phenomena, as they have in the past, even when concurrently exposed to the effects of similar projects.

In addition to the adverse effects described above, we also considered the potential impacts of increased sedimentation and turbidity, removal of riparian vegetation, and the effects of driving sheet piles. The implementation of proposed avoidance and minimization measures (section 1.3.9 of this opinion) is expected to render the potential for fish to be exposed to pollution from sediment, increased water temperatures due to loss of tree shade, and injurious sound levels during pile driving improbable. NMFS does not expect any of the aforementioned effects to combine with other effects in any significant way. Effects from construction are limited in time and area, and fish losses due to capture and relocation are minimal and only affect juvenile steelhead during the one or two years of construction. The Project's installation of new resting pools and replacement of the Denil ladder with an engineered rock chute are expected to significantly improve access for adult steelhead to spawning and rearing habitat in the upper watershed. Ultimately, the effects of the proposed Project, when added to the environmental baseline, cumulative effects, and species status, are not expected to appreciably reduce the quality and function of critical habitat at the larger DPS or ESU level, given the incorporation of safe-passage elements within the action area. Therefore, we expect the proposed action to benefit the persistence and recovery of the Corte Madera Creek population of CCC steelhead and PBFs of critical habitat by eliminating migration delays within the flood channel.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCC steelhead, or destroy or adversely modify designated critical habitat for CCC steelhead or CCC coho salmon.

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:

NMFS anticipates that a low level of incidental take of juvenile CCC steelhead in the form of injury, harm, or mortality is reasonably certain to occur as follows during dewatering and fish relocation events that occur during Project construction and during future channel maintenance activities:

> As described in the preceding opinion, based on prior experience with the relocation techniques and protocols likely to be used to conduct the dewatering and fish relocation, unintentional mortality of listed steelhead expected from capturing and handling fish is not likely to exceed three percent of the total CCC steelhead handled during construction activities and future sediment/debris removal activities. 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.

In this opinion, NMFS also determined a low-level of incidental take in the form of harm to juvenile CCC steelhead from habitat-related impacts is reasonably certain to occur due to channel and bank stabilization by the Project. NMFS expects this incidental take to be within the concrete-lined flood control channel (Units 2 and 3) and the stabilized channel reach of Unit 4. The precise number of listed juvenile steelhead that are expected to be incidentally taken resulting from these habitat-related impacts cannot be accurately quantified because: 1) only fry and juvenile steelhead are likely to be affected and these life stages are relatively small; 2) these species live in aquatic environments where visibility is often low and predators feed; and 3) exactly how many fry and juvenile steelhead expected to rear within the action area is unknown. NMFS will, therefore, use the following incidental take surrogates pursuant to 50 CFR 402.14(i)(1)(i).

The following programmatic surrogate for the amount or extent of such incidental take is the best currently available indicator that is proportional to those effects. This is because all habitat pathways of incidental take will vary in proportion to altered stream morphology, channelization, bank stabilization, and degraded riparian habitat conditions.

The extent of incidental take will be considered exceeded if the total length of the concrete-lined channel in Units 2 and 3 exceeds 5,200 linear feet on Corte Madera Creek, and/or the total length of channel stabilized in Unit 4 with retaining walls, engineered channel, sheet pile wall, and rock slope protection exceeds 575 linear feet on Corte Madera Creek.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

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

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

1. Undertake measures to ensure that harm and mortality to steelhead resulting from fish relocation and dewatering activities is low.
2. Undertake measures to minimize harm to steelhead resulting during construction and during future maintenance activities.
3. Prepare and submit a report to document the effects of construction and fish relocation activities associated with Project construction.
4. Conduct physical performance monitoring of the new fish resting pools and submit a report with the results of the performance monitoring.
5. Prepare and submit annual reports with the results of annual inspections of the fish resting pools and completed maintenance activities.

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 any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

    a. Fish rescue and relocation efforts must take place in all areas where dewatering will occur within the flowing waters of Corte Madera Creek.
    b. The District must retain a qualified biologist with expertise in the areas of anadromous salmonid biology, including identification, handling, collecting, and relocating salmonids; salmonid/habitat relationships; and biological monitoring of salmonids. Biologists working on this project shall be qualified to conduct fish collections in a manner which minimizes all potential risks to ESA-listed salmonids.

c. The biologist must monitor construction sites during placement and removal of streamflow diversions and cofferdams to ensure that any adverse effects to salmonids are minimized. The biologist must be on site during all dewatering events to capture, handle, and safely relocate ESA-listed salmonids.
d. ESA-listed fish must be handled with extreme care and kept in water to the maximum extent possible during rescue activities. All captured fish must be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream and fish must not be removed from this water except when released. To avoid predation, the biologist must have at least two containers and segregate young-of-year fish from larger age-classes and other potential aquatic predators. Captured salmonids will be relocated, as soon as possible, to a suitable instream location in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.
e. If any salmonids are found dead or injured, the biologist must contact NMFS biologist Sara Azat by phone at 707-575-6067, by email at sara.azat@noaa.gov or the NMFS Santa Rosa Area Office at 707-387-0737. The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All salmonid mortalities must be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location of collection, fork length, and be frozen as soon as possible. Frozen samples must be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than the NMFS Santa Rosa Area Office without obtaining prior written approval from the NMFS Santa Rosa Area Office. Any such transfer will be subject to such conditions as NMFS deems appropriate.

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

a. The Corps or the District must notify the NMFS Santa Rosa Area Office, by email, at least 7 days prior to implementation of fish relocation activities. Notification shall be provided to NMFS biologist Sara Azat at sara.azat@noaa.gov one week prior to fish capture activities in order to provide an opportunity for NMFS staff to observe the activities.
b. The Corps and District must allow any NMFS employee(s) or any other person(s) designated by NMFS to accompany field personnel to visit the project site during activities described in this opinion.
c. A qualified biologist must monitor in-channel construction activities and sediment/debris removal maintenance activities for the purpose of identifying and reconciling any condition that could adversely affect salmonids or their habitat. The biologist must report immediately to the District, the Corps and NMFS any condition that could adversely affect steelhead or their habitat beyond the conditions described in this opinion.
d. Sediment removal activities that occur during the period between October 16-June 14 must be performed with hand tools and small equipment. Heavy equipment may only be used from the top of bank, with limited use of mechanical equipment and without vacuum pumps.

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

a. The District must provide a written report to NMFS by January 15 of the year following construction. The report must be submitted to Sara Azat at sara.azat@noaa.gov or to

NMFS Santa Rosa Area Office Attention: Supervisor of San Francisco Bay Branch, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528. The report must contain, at a minimum, the following information:

i. **Construction related activities**: The report must include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any effect on ESA-listed fish; the number of salmonids killed or injured during the project action; and photographs taken before, during, and after the activity from photo reference points.
ii. **Fish Relocation**: The report must include a description of the location from which fish were removed and the release site including photographs; the date and time of the relocation effort; a description of the equipment and methods used to collect, hold, and transport salmonids; the number of fish relocated by species; the number of fish injured or killed by species and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities; and a description of any problems which may have arisen during the relocation activities and a statement as to whether or not the activities had any unforeseen effects.

4. The following terms and conditions implement reasonable and prudent measure 4:

a. The District shall assess the performance of the new resting pools at various fish passage flows by physically measuring water depths and water velocities. This monitoring shall be performed in pools experiencing no sedimentation as well as pools experiencing various levels of sedimentation (see Project Physical Performance Monitoring in Section 7.4.3 of the Corte Madera Creek Fish Passage Project Basis of Design Report by GHD & Love and Associates, 2021).
b. The District must provide a written report to NMFS by January 15 of the year following completion of physical performance monitoring at the new resting pools. The report must be submitted to Sara Azat at sara.azat@noaa.gov or to NMFS Santa Rosa Area Office Attention: Supervisor of San Francisco Bay Branch, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528.

5. The following terms and conditions implement reasonable and prudent measure 5:

a. The District must provide an annual written report to NMFS by January 15 of each year post-construction with the results of fish resting pool inspections and any associated sediment/debris removal activities conducted during the prior year. The report must be submitted to Sara Azat at sara.azat@noaa.gov or to NMFS Santa Rosa Area Office Attention: Supervisor of San Francisco Bay Branch, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404-6528. The report must contain, at minimum, the following information:

i. Record of the visual inspections of the fish resting pools in Unit 3 and the condition of the engineered rock chute in Unit 4.
ii. Identification of any condition that may compromise the performance of resting pools or fish passage through the engineered rock chute.

iii. Maintenance performed in Units 3 and 4, including the removal of large debris and/or sediment from the pools and channel.

2.10. Conservation Recommendations

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

- NMFS recommends that the Corps and the District make available sediment removed from the Corte Madera Creek flood channel for tidal and wetland restoration projects within the Corte Madera Creek Watershed and San Pablo Bay. Coordinated disposal of sediment to restoration projects could benefit the overall function of the watershed and resilience of the downstream wetlands to maintain off-channel fish habitat.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Corte Madera Creek Flood Risk Management Project. 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."

2.12. "Not Likely to Adversely Affect" Determinations

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b). When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur.

The Corps has determined that due to the project location and the ability to move away from the area of disturbance, the proposed action is not likely to adversely affect the following species and critical habitat:

North American green sturgeon Southern DPS (*Acipenser medirostris*)
threatened (71 FR 17757; April 7, 2006)
critical habitat (74 FR 52300; October 9, 2009).

The Southern DPS of North American green sturgeon is an anadromous, long-lived, and bottom-oriented fish species in the family Acipenseridae. Adult green sturgeon may exceed 2 meters in length and 100 kilograms in weight (Moyle 2002). Southern DPS green sturgeon spawn over cobbles and large gravels in the upper Sacramento River during the spring and early summer months. Juvenile green sturgeon spend their first few years in the Delta and San Francisco estuary before entering the marine environment as subadults. Green sturgeon feed on benthic invertebrates and fish (Adams *et al*. 2002).

The effects of the proposed action in tidally-influence areas of lower Corte Madera Creek include collection and relocation of fish associated with dewatering, degradation of water quality, and disturbance of benthic habitat during construction. Although the tidal portion of the action area is accessible to juvenile and adult green sturgeon, conditions within the concrete channel are generally poor for green sturgeon foraging and relatively shallow for a large bodied fish such as green sturgeon. Thus, green sturgeon are unlikely to be present in the concrete flood channel portion of Unit 3 during construction activities and unlikely to be collected during fish relocations.

The Project's potential effects on water quality and benthic habitat are described in Section 2.5.3 of this opinion. The installation and removal of cofferdams to isolate work areas, and the proposed removal of sediment/debris during fish pool maintenance may cause temporary increases in turbidity in the tidally-influence reach of the action area. Increased levels of turbidity in the water column associated with proposed actions are expected to be short-term, minor, and localized with tidal exchange. Green sturgeon are tolerant of elevated turbidity levels (Kjelland *et al*. 2015), in part due to their reliance on electroreceptors and sensitive barbels, instead of sight, to detect their prey. For these reasons, the potential effects of minor and localized areas of elevated turbidity are expected to be insignificant to green sturgeon. Benthic habitat disturbance in dewatered sites may result in the temporary loss of macroinvertebrates; however, following removal of the cofferdams rapid re-colonization by benthic organisms is expected. Additionally, the existing concrete channel does not provide food resources or a migratory corridor for green sturgeon, and therefore, NMFS anticipates that green sturgeon are unlikely to be present. Thus, effects of proposed construction and future sediment/debris maintenance activities on green sturgeon expected to be insignificant and discountable.

The action area is designated as critical habitat for Southern DPS green sturgeon. The PBFs of critical habitat this species includes estuarine areas for food resources, water flow, water quality, migratory corridor water depth, and sediment quality. Critical habitat in the tidally-influenced portion of the action area may be affected by degradation of water quality and disturbance to the substrate. As described above, effects to water quality are expected to be insignificant because the majority of the Project's construction activities will be performed within dewatered areas isolated by cofferdams. PBFs associated with foraging and cover are poor within the concrete channel and proposed actions are not expected to degrade these PBFs for green sturgeon. Based on the above, the potential effects of the Project on designated critical habitat for green sturgeon are considered insignificant and are not expected to result in adverse impacts to designated critical habitat in the action area.

Based on the above analysis, NMFS concurs with the Corps that the proposed action is not likely to adversely affect the Southern DPS of North American green sturgeon and their designated critical habitat.

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 Groundfish (Pacific Fishery Management Council (PFMC 2020), Coastal Pelagic Species (CPS) (PFMC 1998), and Pacific Coast Salmon (PFMC 2014) contained in the fishery management plans (FMPs) developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

NMFS determined that the proposed action would adversely affect EFH as follows for various life stages of fish species managed under the Pacific Coast Groundfish, CPS, and Pacific Coast Salmon FMPs. The project area is considered Habitat Areas of Particular Concern (HAPC) for species managed under the Pacific Coast Groundfish (estuarine) and Pacific Coast Salmon (thermal refugia, spawning habitat, and estuarine) FMPs.

3.2. Adverse Effects on Essential Fish Habitat

The project activities will result in modifications to EFH in the form of benthic disturbance, temporary disruption of the migratory corridor during construction due to the placement of cofferdams, and degradation of water quality. As described in Section 1.3, tidal influence occurs within the lower portion of Unit 3 and the upstream extent of tidal influence will also be limited while the cofferdams are in place. Temporary increases in turbidity may result, post-construction, when cofferdams are removed. Maintenance activities, such as sediment removal from the fish passage pools, may also result in additional temporary increases in turbidity.

3.2.1. Pacific Groundfish FMP

Species managed under the Pacific Groundfish FMP rely on estuarine habitat for spawning, breeding, feeding and growth to maturity. As described in Section 2.4, the proposed action in estuarine waters occurs within a man-made concrete channel which offers little habitat function for groundfish species. The tidal extent of estuarine waters will be limited while cofferdams are in place; however, post-construction managed fish species would be able to return when the cofferdams are removed. It is anticipated that temporary increases in turbidity may result from the proposed channel modifications, however these increases are expected to be temporary and not result in long term adverse impacts to Pacific Groundfish EFH or estuarine HAPC. Similarly, the proposed removal of sediment from the fish passage pools, described in Section 2.5.6, is expected to temporarily increase turbidity within the concrete channel and is expected to result in minor increases downstream.

3.2.2. Coastal Pelagic FMP

Designated EFH for coastal pelagic species includes estuarine waters, and thus, the impacts described above for species managed under the Pacific Groundfish FMP are similar.

3.2.3. Pacific Salmon FMP

Coho salmon are managed under the Pacific Salmon FMP, and as noted above, CCC coho salmon are believed to be extirpated from the action area. As described above in Section 2.5.7, the Project is expected to improve upstream passage conditions for coho salmon EFH. Modification of the concrete channel to include 16 additional fish resting pools, coupled with the removal of the marginally functioning fish ladder, is anticipated to improve the compromised fish passage conditions within the Project area and increase access to upstream salmon spawning and juvenile rearing habitat. As described in Section 2.5.3 and 2.5.6, construction activities and future sediment/debris removal may result in temporary increases in turbidity at work sites and downstream habitat, but these increases are anticipated to be localized, minor and temporary. As described in Section 2.5.8, channel and bank stabilization by the Project will maintain the currently stabilized channel and degraded habitat conditions in the action area for juvenile salmonid rearing.

3.3. Essential Fish Habitat Conservation Recommendations

Given the minimal adverse effects to EFH anticipated, and the proposed avoidance and minimization measures provided for the Project, NMFS has no practical EFH conservation recommendations to provide to avoid or reduce the magnitude of these effects.

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the District and the Friends of Corte Madera Creek. Individual copies of this opinion were provided to the Corps and the District. 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

Adams, P. B., C. B. Grimes, J. E. Hightower, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*.

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

Atcheson, M. E., K. W. Myers, N. D. Davis, and N. J. Mantua. 2012. Potential trophodynamic and environmental drivers of steelhead (*Oncorhynchus mykiss*) productivity in the North Pacific Ocean. Fisheries Oceanography 21(5):321–335.

Atcheson, M. E., K. W. Myers, D. A. Beauchamp, and N. J. Mantua. 2013. Bioenergetic Response by Steelhead to Variation in Diet, Thermal Habitat, and Climate in the North Pacific Ocean. Transactions of the American Fisheries Society 141(4):1081-1096.

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

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

Berg, L., and T.G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Bilby, R. E., B. R. Fransen, and P. A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Canadian Journal of Fisheries and Aquatic Sciences 53:164–173.

Bilby, R. E., B. R. Fransen, P. A. Bisson, and J. K. Walter. 1998. Response of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*) to the addition of salmon carcasses to two streams in southwestern Washington, USA. Canadian Journal of Fisheries and Aquatic Sciences 55:1909–1918.

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 pages.

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

Bjornn, T., S. Kirking, and W. Meehan. 1991. Relation of cover alterations to the summer standing crop of young salmonids in small southeast Alaska streams. Transactions of the American Fisheries Society 120(5):562-570.

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

Bradford, Michael J. and Paul S. Higgins. 2001. Habitat-, season-, and size-specific variation in diel activity patterns of juvenile chinook salmon (*Oncorhynchus tshawytscha*) and steelhead trout (*Oncorhynchus mykiss*). Canadian Journal of Fisheries and Aquatic Sciences 58:365-374.

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

Bugert, R.M. and T.C. Bjornn. 1991. Habitat use by steelhead and coho salmon and their responses to predators and cover in laboratory streams. Transactions of the American Fisheries Society 120: 486-493.

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

California Department of Fish and Game (CDFG). 2005. 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 United States Army Corps of Engineers, San Francisco District, January 1, 2004 through December 31, 2004. March 1.

California Department of Fish and Game (CDFG). 2006. Annual report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects conducted under Department of 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. CDFG Region 1, Fortuna Office. March 1.

California Department of Fish and Game (CDFG). 2007. Annual report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects conducted under Department of 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. Northern Region, Fortuna Office. March 1.

California Department of Fish and Game (CDFG). 2008. Annual report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects conducted under Department of 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. Northern Region, Fortuna Office. March 1.

California Department of Fish and Game (CDFG). 2009. Annual report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects conducted under Department of 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. Northern Region, Fortuna Office. March 1.

California Department of Fish and Game (CDFG). 2010a. Annual report to the National Marine Fisheries Service for Fisheries Restoration Grant Program Projects conducted under Department of 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. Northern Region, Fortuna Office. March 1.

California Department of Fish and Game (CDFG). 2010b. Unpublished data documenting history of fish trapped at Warm Springs Hatchery (Dry Creek) between 1980/81 and 2009/10.

Cal Fire and CDC (California Department of Forestry and Fire Protection and California Department of Conservation). 2020. Watershed Emergency Response Team Evaluation, CZU Lightening Complex. CA-CZU-005205. California Department of Forestry and Fire Protection and California Department of Conservation California Geological Survey. October 2020.

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

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

Cederholm, C.J., M.D. Kunze, T. Murota, and A. Sibatani. 1999. Pacific salmon carcasses: essential contributions of nutrients and energy for aquatic and terrestrial ecosystems. Fisheries 24(10):6-15.

Collins, B. 2004. Report to the National Marine Fisheries Service for instream fish relocation activities associated with fisheries habitat restoration program projects conducted under Department of the Army (Permit No. 22323N) within the United States Army Corps of Engineers, San Francisco District, during 2002 and 2003. California Department of Fish and Game, Northern California and North Coast Region.

Cordone, A.J., and D.W. Kelley. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game Volume 47(2):189-228.

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

Crozier, Lisa G., Michelle M. McClure, Tim Beechie, Steven J. Bograd, David A. Boughton, Mark Carr, Thomas D. Cooney, Jason B. Dunham, Correigh M. Greene, Melissa A. Haltuch, Elliott L. Hazen, Damon M. Holzer, David D. Huff, Rachel C. Johnson, Chris E. Jordan, Isaac C. Kaplan, Steven T. Lindley, Nathan J. Mantua, Peter B. Moyle, James M. Myers, Mark W. Nelson, Brian C. Spence, Laurie A. Weitkamp, Thomas H. Williams, Ellen Willis-Norton. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current Large Marine Ecosystem. PLoS ONE 14(7): e0217711.

Cox, B. 2000. Fish Distribution - Major Streams in Marin County. Unpublished report. California Department of Fish and Game. 2 pages.

Cox, P., and D. Stephenson. 2007. A changing climate for prediction. Science 113:207-208. http://wdfw.wa.gov/publications/00046/wdfw00046.pdf.

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

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

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

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.

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

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

Furniss, M.J., T.D. Roelofs, and C.S. Lee. 1991. Road construction and maintenance. Pages 297-323 in W. R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19. 622 pages.

GHD and Love and Associates. 2021. Basis of Design Report, Corte Madera Creek Fish Passage Project, Existing Fish Passage Conditions and Analysis of Resting Pool Performance. Prepared for Friends of Corte Madera Creek Watershed. December 2021.

Gregory, R.S., and T.G. Northcote. 1993. Surface, Planktonic, and Benthic Foraging by Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in Turbid Laboratory Conditions. Canadian Journal of Fisheries and Aquatic Sciences 50: 233-240.

Gresh, T., J. Lichatowich, and P. Schoonmaker. 2000. An estimation of historic and current levels of salmon production in the northeast pacific ecosystem. Fisheries 15(1):15-21.

Harvey, B.C. 1986. Effects of suction gold dredging on fish and invertebrates in two California streams. North American Journal of Fisheries Management 6:401-409.

Hayes, D., C. Ferreri, and W. Taylor. 1996. Active fish capture methods. 193–220. Fisheries techniques.

Hayes, S., and Coauthors. 2012. Using Archival Tags to Infer Habitat Use of Central California Steelhead and Coho Salmon. Advances in Fish Tagging and Marking Technology 76:471-492.

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

Howe, D. 2016. 5-Year Review: Summary & Evaluation of Central California Coast Steelhead. Prepared for National Marine Fisheries Service, West Coast Region. April 2016. 55 pp.

Hubert, W.A. 1983. Passive Capture Techniques. Pages 95-122 in L.A. Nielsen and D.L. Johnson, editors. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland. 468 pages.

Huff, D. D., S. T. Lindley, P. S. Rankin, and E. A. Mora. 2011. Green sturgeon physical habitat use in the coastal Pacific Ocean. PLOS One 6(9):e25156.

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, CA.

Keeley, E. R. 2003. An experimental analysis of self-thinning in juvenile steelhead trout. Oikos 102(3):543-550.

Leidy, Robert A., Gordon Becker, and Brett N. Harvey. 2005a. Historical Status of Coho Salmon in Streams of the Urbanized San Francisco Estuary, California. *California Fish and Game* 91(4): 219-254.

Leidy, Robert A., Gordon Becker, and Brett N. Harvey. 2005b. Historical Distribution and Current status of Steelhead/Rainbow Trout (*Oncorhynchus mykiss*) in Streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration, Oakland, CA. 30 pp.

Leidy, Robert A. 2007. Ecology, Assemblage Structure, Distribution, and Status of Fishes in Streams Tributary to the San Francisco Estuary, California. U.S. Environmental Protection Agency. Contribution No. 530. April 2007. 198 pp.

Leopold, L.B. 1968. Hydrology for urban land planning. Circular 559. U.S. Geological Survey, Washington, DC.

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(1):26.

Love, Michael and Associates and Jeff Anderson and Associates. 2007. Corte Madera Creek Flood Control Channel Fish Passage Assessment and Alternative Analysis. September 2007.

Love and Associates. 2021. Basis of Design Report, Corte Madera Creek Fish Passage Project, Existing Fish Passage Conditions and Analysis of Resting Pool Performance. Prepared for Friends of Corte Madera Creek Watershed. December 2021.

McEwan, D. 2001. Central Valley Steelhead. In: Brown, RL, Editor. Contributions to the biology of Central Valley salmonids, Fish Bulletin 179. Fish Bulletin 179.1. California Department of Fish and Game. p. 1-44.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. Pages 47-82 in Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan, editor. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.

Merz, J.E., and P.B. Moyle. 2006. Salmon, wildlife, and wine: marine-derived nutrients in human-dominated ecosystems of central California. Ecological applications 16(3):999-1009.

Moyle, P. B. 2002. Inland fishes of California: revised and expanded. Univ of California Press.

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

National Marine Fisheries Service (NMFS). 2012. Central California Coast Coho Salmon Recovery Plan. National Marine. Fisheries Service, West Coast Region, Santa Rosa, California.

NMFS. 2015. 5-Year Status Review of the Southern Distinct Population Segment of North American Green Sturgeon.

NMFS. 2016. Coastal Multispecies Recovery Plan. National Marine. Fisheries Service, West Coast Region, Santa Rosa, California.

NMFS. 2018. NOAA Fisheries Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*).

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

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.

Pacific Fishery Management Council (PFMC). 1998. Description and identification of essential fish habitat for the Coastal Pelagic Species Fishery Management Plan. Appendix D to Amendment 8 to the Coastal Pelagic Species Fishery Management Plan. Pacific Fishery Management Council, Portland, Oregon. December.

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.

PFMC. 2020. Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. Pacific Fishery Management Council, Portland, Oregon. August.

Raleigh, R.F., T. Hickman, R.C. Soloman, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U.S. Fish and Wildlife Service. FWS/OBS:82/10.60.

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

Rich, A. 2000. Fishery Resources Conditions of the Corte Madera Creek Watershed, Marin County, California. A.A. Rich and Associates, San Anselmo, California. Unpublished report. 120 pages plus appendices.

Rich, A. 2005. Fish relocation in Corte Madera Creek for the Town of Ross form September 29, 2005. A.A. Rich and Associates. San Anselmo, California 10 pages.

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, 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.

Santer, B.D., C. Mears, C. Doutriaux, P. Caldwell, P.J. Gleckler, T.M.L. Wigley, S. Solomon, N.P. Gillett, D. Ivanova, T.R. Karl, J.R. Lanzante, G.A. Meehl, P.A. Stott, K.E. Talyor, P.W. Thorne, M.F. Wehner, and F.J. Wentz. 2011. Separating signal and noise in atmospheric temperature changes: The importance of timescale. Journal of Geophysical Research 116: D22105.

Scavia, D., J.C. Field, D.F. Boesch, R.W. Buddemeier, V. Burkett, D.R. Cayan, M. Fogarty, M.A. Harwell, R.W. Howarth, C. Mason, D.J. Reed, T.C. Royer, A.H. Sallenger, and J.G. Titus. 2002. Climate Change Impacts on U.S. Coastal and Marine Ecosystems. Estuaries, volume 25(2): 149-164.

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.

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.

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

Shirvell, C. S. 1990. Role of instream rootwads as juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*O. mykiss*) cover habitat under varying streamflows. Canadian Journal of Fisheries and Aquatic Sciences. Vol. 47, Number 5: 852-861.

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. ManTech Environmental Research Services, Inc., Corvallis, 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., Bjorkstedt E.P., Paddock, S. and L. Nanus. 2012. Updates to biological viability critieria 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. 2022. Biological Assessment for the Corte Madera Creek Flood Risk Management Project, Phase I, Marin County, California. Final Report. March 2022.

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

Tonra, C.M., K. Sager-Fradkin, S.A. Morley, J.J. Duda, and P.P. Marra. 2015. The rapid return of marine-derived nutrients to a freshwater food web following dam removal. Biological Conservation 192:130-134.

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

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

Waters, T.F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7. American Fisheries Society, Bethesda, Maryland. 251 pages.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-24. 258 pages.

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