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

October 15, 2019 **Refer to NMFS No.:** WCRO-2019-02728

James Mazza
Acting Chief, Regulatory Division
U.S. Department of the Army
San Francisco Corps of Engineers, San Francisco District
450 Golden Gate Avenue, 4th Floor, Suite 0134
San Francisco, California 94102-3406

Re: Endangered Species Act Section 7(a)(2) Biological Opinion for the Hafner Creek Repair Project, Sonoma California

Dear Mr. Mazza:

Thank you for your letter on September 8, 2019, and email of October 1, 2019, 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 Hafner Creek Repair Project, Sonoma County, California (Project). The Corps proposes to permit the Project pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act.

The enclosed biological opinion is based on our review of the Corps' permitting of the Project, and describes NMFS' analysis of potential effects on Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), and their designated critical habitat, in accordance with Section 7 of the ESA. Threatened CCC steelhead and California Coastal Chinook salmon utilize habitat within the Project's action area, and Sausal Creek is designated critical habitat for CCC steelhead. In the enclosed biological opinion, NMFS concludes the project is not likely to jeopardize the continued existence of threatened CCC steelhead, nor is it likely to adversely modify critical habitat designated for this species. However, NMFS is aware that take of these species may occur because of the project, and thus, an incidental take statement that applies to this project is included with the enclosed biological opinion.

Please contact Dan Wilson at 707-578-8555 or dan.wilson@noaa.gov if you have any questions concerning this Section 7 consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

cc: E-File ARN 151422WCR2019SR00204

Enclosure

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

NMFS Consultation Number: WCRO-2019-02728
Action Agency: U.S. Army Corps of Engineers

Table 1. Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central California Coast steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	No

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: October 15, 2019

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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 portions of this document in accordance with Section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402. 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 (Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the NMFS office in Santa Rosa, California.

1.2 Consultation History

On September 8, 2019, NMFS received via letter a request from the United States Corps of Engineers (Corps) to permit the Project under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. On September 19, 2019, NMFS conducted a site visit the Applicant. During the site visit, the Applicant submitted new engineering designs of the proposed project. On September 20, 2019, NMFS responded to the Corps via letter, stating that NMFS did not concur with the Corps' determination that the proposed project would not likely adversely affect listed species. On October 1, 2019, NMFS received an email request from the Corps to initiate formal consultation with NMFS. Based on information received on September 8, 19, and October 1, 2019, NMFS notified the Corps on October 1, 2019, that all information required to initiate formal consultation had been received, and consultation was initiated on that date.

1.3 Description of Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Munselle Civil Engineering proposes a riverbank stabilization project (Project) that will provide a short-term solution to a major erosion issue threatening vineyard road in Jimtown, California. Project activities are proposed for a section of Sausal Creek approximately 170 feet long. Bank stabilization will include the use of rock slope protection (rip-rap), large woody debris (LWD), bank grading, and revegetation of the site to stabilize the eroding vertical riverbank.

The proposed project is intended to repair a portion of the northwest bank of Sausal Creek, which has been eroding and sliding into the creek, causing loss of soil and trees over time. This repair will consist of removal of debris from the slide area, and rebuilding the failed creek bank to the same approximate dimensions it was at the start of 2019. The proposed repair will include rock riprap keyed in place at the toe and inter-planted with approximately 116 live willow stakes

at a maximum slope of 1foot high:1foot vertical, compacted native fill planted with approximately 58 live willow stakes, seeded, strawed, and key trenches constructed at the upstream and downstream ends of the repair. Additionally, live willow stakes will be planted on the south bank of Sausal Creek to increase the riparian cover there and revegetate the banks. Current slide debris includes multiple fallen trees, which will be incorporated into the repair.

The repair will be done using an excavator and hand tools, and the work will take approximately two to four weeks, to be conducted during the dry season. Because the work will be taking place during the dry season, temporary irrigation will be installed for the plantings. The existing vineyard irrigation across the gravel access road will be keyed in for the plantings irrigation. There will be no additional net cut; fill will consist of approximately 175 cubic yards of 18-inch diameter rock riprap, approximately 140 cubic yards of compacted native fill, and approximately 40 cubic yards of clean gravel.

The biological assessment (WRA 2019) for the Project outlines 10 avoidance and minimization measures to be implemented during the construction. These include measures to minimize disturbance at the site, avoid impacts to water quality, protection of riparian areas and minimizing effects to sensitive species. In summary, vehicle access will be restricted to minimize disturbance of the site. Staging and storage of materials will be located outside of the river including spoils developed from the project. Measures also include riparian avoidance and mitigation. A complete list of these avoidance and minimization of project impacts can be found in WRA (2019).

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, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and Section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, Section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed

species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification", which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

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

- Identify the range-wide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Range-wide Status of the Species

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

This biological opinion analyzes the effects of the action on the following listed salmonids and their designated critical habitat:

- **Threatened CCC steelhead (*O. mykiss*) Distinct Population Segment (DPS)**
  Listing determination (71 FR 834; January 5, 2006)
  Critical habitat designation (70 FR 52488; September 2, 2005).

2.2.1 CCC steelhead status

Historically, approximately 70 populations[1] of steelhead existed in the CCC steelhead DPS (Spence *et al.* 2008, Spence *et al.* 2012). Many of these populations (about 37) were independent, or potentially independent, meaning they had a high likelihood of surviving for 100 years absent anthropogenic impacts (Bjorkstedt *et al.* 2005). The remaining populations were dependent upon immigration from nearby CCC steelhead DPS populations to ensure their viability (McElhaney *et al*. 2000, Bjorkstedt *et al*. 2005).

While historical and present data on abundance are limited, CCC steelhead numbers are substantially reduced from historical levels. A total of 94,000 adult steelhead were estimated to spawn in the rivers of this DPS in the mid-1960s, including 50,000 fish in the Russian River - the largest population within the DPS (Busby *et al.* 1996). Recent estimates for the Russian River are on the order of 4,000 fish (NMFS 1997). Abundance estimates for smaller coastal streams in the DPS indicate low but stable levels with recent estimates for several streams (Lagunitas, Waddell, Scott, San Vicente, Pudding, Caspar creeks) of individual run sizes of 500 fish or less (62 FR 43937). Some loss of genetic diversity has been documented and attributed to previous among-basin transfers of stock and local hatchery production in interior populations in the Russian River (Bjorkstedt *et al*. 2005). In San Francisco Bay streams, reduced population sizes and fragmentation of habitat has likely also led to loss of genetic diversity in these populations. For more detailed information on trends in CCC steelhead abundance, see: Busby *et al*. 1996, NMFS 1997, Good *et al*. 2005, Spence *et al*. 2008, Williams *et al.* 2011, and Williams *et al.* 2016.

CCC steelhead have experienced serious declines in abundance and long-term population trends suggest a negative growth rate. This indicates the DPS may not be viable in the long term. DPS populations that historically provided enough steelhead immigrants to support dependent populations may no longer be able to do so, placing dependent populations at increased risk of extirpation. However, because CCC steelhead remain present in most streams throughout the DPS, roughly approximating the known historical range, CCC steelhead likely possess a resilience that is likely to slow their decline relative to other salmonid DPSs or ESUs in worse condition. The 2005 status review concluded that steelhead in the CCC steelhead DPS remain "likely to become endangered in the foreseeable future" (Good *et al*. 2005). On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

A more recent viability assessment of CCC steelhead concluded that populations in watersheds that drain to San Francisco Bay are highly unlikely to be viable, and that the limited information available did not indicate that any other CCC steelhead populations could be demonstrated to be

[1] Population as defined by Bjorkstedt *et al*. 2005 and McElhaney *et al*. 2000 as, in brief summary, a group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group. Such fish groups may include more than one stream. These authors use this definition as a starting point from which they define four types of populations (not all of which are mentioned here).

viable[2] (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 shows a decline in returning adults across their range compared to the last ten years (Jahn, personal communication, 2010). The most recent status update concludes that steelhead in the CCC steelhead DPS remains "likely to become endangered in the foreseeable future" (Howe, 2016), as new and additional information available since Williams *et al.* (2011) does not appear to suggest a change in extinction risk.

2.2.2 Status of CCC steelhead critical habitat

In designating critical habitat, NMFS considers, among other things, the following requirements of the species: 1) space for individual and population growth, and for normal behavior; 2) food, water, air, light, minerals, or other nutritional or physiological requirements; 3) cover or shelter; 4) sites for breeding, reproduction, or rearing offspring; and, generally; and 5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (50 CFR 424.12(b)). In addition to these factors, NMFS also focuses on Physical or Biological Features (PBF)[3] and/or essential habitat types within the designated area that are essential to the conservation of the species and that may require special management considerations or protection (81 FR 7414).

PBFs for critical habitat, and their associated essential features within freshwater include:

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

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 currently depressed population conditions are, in part, the result of

[2] Viable populations have a high probability of long-term persistence (> 100 years).

[3] NMFS previously used the term "Primary Constituent Elements", but has now shifted to using "Physical or Biological Features. 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 primary constituent elements, physical or biological features, or both."

the following human-induced factors affecting critical habitat[4]: 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). In addition, widespread diverting of rivers and streams, as well as the pumping of groundwater hydraulically connected to stream flow, has dramatically altered the natural hydrologic cycle in many of the streams within steelhead DPSs, which can delay or preclude migration and dewater aquatic habitat.

2.2.3 Additional Threats to Critical Habitat

Another factor affecting the rangewide status of steelhead, and aquatic habitat at large, is climate change. Global climate change presents an additional potential threat to salmonids and their critical habitats. 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). Listed salmonids 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 CCC steelhead experience, and many of these factors have much less influence on steelhead abundance and distribution than human disturbance across the landscape.

The threat to salmonids 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).

For Northern California, most models project heavier and warmer precipitation. Extreme wet and dry periods are projected, increasing the risk of both flooding and droughts (DWR 2013). Estimates show that snowmelt contribution to runoff in the Sacramento/San Joaquin Delta may decrease by about 20 percent per decade over the next century (Cloern *et al.* 2011). Many of

[4] 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.

these changes are likely to further degrade CCC steelhead habitat by, for example, reducing stream flow during the summer and raising summer water temperatures. Estuaries may also experience changes detrimental to salmonids. Estuarine productivity is likely to change based on changes in freshwater flows, nutrient cycling, and sediment amounts (Scavia *et al.* 2002, Ruggiero *et al.* 2010). In marine environments, ecosystems and habitats important to juvenile and adult salmonids are likely to experience changes in temperatures, circulation, water chemistry, and food supplies (Brewer and Barry 2008; Feely 2004; Osgood 2008; Turley 2008; Abdul-Aziz *et al*. 2011; Doney *et al*. 2012). The projections described above are for the mid to late 21st Century. In shorter time frames, climate conditions not caused by the human addition of carbon dioxide to the atmosphere are more likely to predominate (Cox and Stephenson 2007; Santer *et al.* 2011).

2.3 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 encompasses the west streambank, the active channel of Sausal Creek, and the stream reach downstream of the proposed project. The total stream reach where listed species and critical habitat may be affected is within the proposed project limits is 170 feet, and an additional 700 feet below the project for a total of 870 feet.

We include the stream reach below the project for a distance of 870 feet due to potential effects that this project may have on the downstream river reach. This reach includes the stream channel and associated floodplain downstream to the box culvert under Pine Flat Road, a significant control point for channel migration. This reach is included due to potential sediment releases, and channel migration changes that could impact species and habitat below the Project. We end the action area at box culvert because channel meandering and migration processes below the culvert are unlikely affected by the Project and more influenced by the box culvert. Additional areas included in the action area include the access road located on the west and northern portion of the project area, and staging areas of the project.

2.4 Environmental Baseline

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 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The Sausal Creek watershed drains an area of approximately 12.7 square miles, with the action area located at the downstream end of the canyon reach where the alluvial fan transitions to the valley floor. Stream flow in the action area varies from dry in the late spring to fall to high flow events in the winter (WRA 2019). WRA (2019) reports that 270 feet of lateral streambank

erosion has occurred within the action area, with much of this retreat having occurred in the winter of 2018 to 2019. This bank erosion is a threat to an adjacent vineyard/winery road. In part, human impacts such as channelization of Sausal Creek, bridge construction at Pine Flat Road, the construction of Coyote Valley Dam, and past gravel mining have caused the channel to incise and contribute to streambank failure observed in Sausal Creek. While the bluff/streambank at the proposed project site is relatively new, on-site and off-site human activity has increased channelization and decreased the size of the floodplain on the opposite (eastern) riverbank.

Status of Listed Species and Critical Habitat in the Action Area

CDFG (1974) reports moderate to high densities of steelhead in Sausal Creek during early August 1974. They report 25 juvenile steelhead/100 feet of stream in Grapevine Creek and upper Sausal Creek, densities of about 100 juvenile steelhead/100 feet in Sausal Creek between the mouth of Grapevine Creek and the mouth of George Young Creek, and densities of 50 steelhead/100 feet of stream "from the mouth of George Young Creek downstream to where the creek dries up, ¼ mile above the Pine Flat Road Bridge." In the three years 2000-2002, Merritt Smith Consulting (2003) sampled the segment of Sausal Creek where CDFW earlier reported that the creek begins to annually dry up (i.e., in the vicinity of Pine Flat Road Bridge). Merritt Smith Consulting (2003) reports that this segment was intermittent by July in each of the three years, but that low to moderate levels of juvenile steelhead were present during both summer and fall surveys. In the spring of 2019, following a very wet winter, WRA (2019) report stranded steelhead young of year steelhead just upstream of the Pine Flat Road Bridge and within the action area.

Factors, which have and are currently affecting salmonids within the action area are extensive habitat degradation, a long history of artificial propagation with the use of non-native stocks, and recent droughts and poor ocean conditions (Weitkamp et al. 1995). Logging, agriculture and mining activities, urbanization, stream channelization, dams, wetland loss, water withdrawals and unscreened diversions for irrigation have contributed to the decline of salmonids within the Russian River watershed. Sub-watersheds such as the Sausal Creek have altered streambank and channel morphology, elevated summer stream temperatures, low quality spawning and rearing habitats, reduced connectivity of habitats and recruitment of large organic debris.

Critical Habitat within the action area

Stream bed incision has reduced salmonid habitat function within the action area. Streambank failure affects geomorphic features which affects spawning habitat quality for adult salmonids. Additional impacts due to channelization and bed incision in Sausal Creek include the loss of bank stability and riparian vegetation and increased stream temperatures, which reduces rearing habitat quality for juvenile steelhead. Poor habitat quality in this reach has likely led to reduced numbers of juvenile salmonids utilizing this area and a reduced number of steelhead within this portion of the Russian River watershed.

Habitat conditions throughout the Sausal Creek watershed have been impacted by agricultural development and rural development over the past 150 years. Many landowners have encroached on the floodplain, reduced the riparian areas along the creek and many divert stream flow for vineyards and domestic purposes. In general, these actions have created the existing stream conditions throughout the valley reaches of the Sausal Creek. Based on historical data, some upper portions of Sausal Creek and its tributaries provide good quality habitat for salmonids, these include upper Sausal Creek and Grapevine Creek (CDFW 1974).

Previous Section 7 Consultations and Section 10 Permits in the Action Area

In 2007, NMFS consulted with the Natural Resource Conservation Service on a stream bank stabilization project that planted willow matting and reduced the bank slope of Sausal Creek downstream of the action area (ARN 151422SWR2007SR00386).

2.5 **Effects of the Action**

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

Impacts to Critical Habitat

Sausal Creek is designated critical habitat for CCC steelhead. In general, physical and biological features[5] of critical habitat for steelhead found within the action area include sites for migration, spawning, and rearing. Effects of the Project on designated critical habitat include elevated turbidity, streambank and floodplain habitat degradation, and precluding natural fluvial and geomorphic channel dynamics.

The applicant proposes to place large rip-rap (*i.e.* boulders) over the exposed streambank, while utilizing bio-engineering techniques of willow spring planting through the riprap and LWD embedded below the ordinary high water line. In order to place the rip-rap armoring onto the streambank, heavy machinery will dig within the streambank for access to the site and disrupt the streambed to excavate a toe trench for placing rip-rap and LWD. The proposed disturbance of the site is likely dislodging previously armored and sequestered inter-gravel fine sediment and allowing it to be mobilized and transported downstream when the action area re-waters the following fall.

Studies of sediment effects from culvert construction determined that the level of sediment accumulation within the streambed returned to control levels between 358 to 1,442 meters downstream of the culvert (LaChance et al. 2008). Compared to the sediment impact of a culvert

[5] See page 6 for a detailed listing of steelhead PBFs and essential habitat types.

replacement, which often involve disturbing a significant volume of road fill, the excavation of the area of mixed grain size substrate[6] at the toe of the stabilized slope (1,200 feet long by 20 feet deep) proposed by this project will likely result in a moderate turbidity response. Thus, sediment effects from the proposed bank stabilization are expected to extend downstream within the action area for a distance downstream approximately 1,700 feet (518 meters) within the range presented by LaChance et al. (2008), but likely no further than 1,700 feet below the project site. Turbidity pulses during the first fall rains may slightly degrade the value of critical habitat in the action area, but only temporarily. Based on the size of the area disturbed and stream and bank substrate conditions, NMFS expects turbidity during the first fall rains to last for only a few hours, given the proposed measures by the applicant to minimize sediment delivery from the site. Minimization measures are expected to reduce the duration, and quantity of sediment deposited downstream, and is unlikely to have a substantial impact on rearing, spawning, or migration habitat in the action area.

Of greater concern than ephemeral turbidity pulses is the long-term preclusion of natural fluvial and geomorphic processes that will likely result from the Project. Streams transport water and sediment from upland sources to the ocean and, generally speaking, the faster the streamflow, the greater the erosive force. Natural processes constrain and moderate these erosive forces, such as when complex structure both within (*e.g.*, boulders or woody debris) and adjacent (*e.g.*, riparian vegetation) to the stream channel slows the water velocity and, by extension, its erosive force (Knighton 1998). Where existing geology and geomorphology allow, such as within the action area[7], a stream channel will also 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 LWD, and allows floodplain engagement during appropriate winter flows (Spence *et al.* 1996).

By design, streambank stabilization projects prevent lateral channel migration, effectively forcing streams into a simplified linear configuration that, without the ability to move laterally, instead erode and deepen vertically (Leopold *et al.* 1968; Dunn 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

[6] Streambed substrate consists of a mixture of different size classes (e.g., cobble, gravel, sand, and fines), of which only the fines component and smaller will likely entrain into to the water column and produce turbidity. Conversely, most material used for filling the void between the road and stream elevations is plain soil composed primarily of small easily entrainable particles.

[7] Hulbert Creek within the action area was classified by CDFG (2006) as an F4 channel, which are characterized as "entrenched meandering riffle/pool channels on low gradients (<2%) with a high width/depth ratio and a predominantly gravel substrate.

floodplain and riparian habitat function. The resulting simplified stream reach typically produces limited macroinvertebrate prey and poor functional habitat for rearing juvenile salmonids (Florsheim *et al*. 2008). Because bank stabilization utilizing rip-rap is typically designed to withstand high streamflow caused by large storm events, the rip-rap structure, and by extension the impacts to instream habitat, are in effect everlasting, harming future fish generations well into the future. Moreover, streambank stabilization impacts not only extend temporally; altered geomorphic and hydraulic processes can propagate spatially both upstream and downstream of hardened bank structures, dependent upon site- and structure-specific characteristics (Henderson 1986 and Arnaud-Fassetta *et al.* 2005, as cited in Florsheim *et al.* 2008), meaning that "bank stabilization often begets more bank stabilization." Finally, rip-rap as a stabilization material immediately and permanently replaces a natural earthen streambank, which can provide complex fish habitat (*e.g.*, undercut banks, submerged rootwads, *etc.*) (Fischenich and Copeland 2001), with a relatively simple, homogenous streambank structure less suitable for juvenile salmon and steelhead (Schmetterling *et al.* 2001; Fischenich 2003).

The Applicant proposes to install complex LWD within the structure below the ordinary high water level in order to improve habitat complexity and thwart future channel incision. Nevertheless, by stabilizing a 170-foot length of the streambank with rock rip-rap is expected to increase in-channel velocities. Therefore, the Project will likely compromise the value of available critical habitat in the action area for spawning, migrating, and rearing, by precluding natural fluvial and geomorphic processes within the action area for the foreseeable future.

Impacts to Steelhead

Juvenile salmonids residing within the project area are not expected to be directly affected by construction activities, but are expected to be indirectly affected by post project impacts to habitat conditions. Construction activities associated with the proposed project are not expected to affect steelhead because those activities will be conducted when the project area is dry and no fish are present. Any fish residing within the stream reach the following fall and affected by the turbidity will likely experience short-lived, sub-lethal behavioral impacts (*e.g.*, reduced feeding efficiency). These ephemeral turbidity impacts, likely lasting a couple to several hours, are not expected to reduce fish growth as feeding behaviors will quickly resume after the short pulse of turbidity. Fish migrating, spawning, or rearing within the action area along the proposed stabilization site will experience degraded aquatic habitat caused by the Project for varying durations. The time period during which adult and/or juvenile fish are exposed to elevated turbidity resulting from instream construction will likely be short, approximately several hours. Moreover, the level of turbidity will likely be slightly above background levels and well below levels found to injure or kill salmonids; impacted fish will more likely experience short-term behavioral effects, such as being forced to relocate to avoid the elevated turbidity, or experiencing reduced feeding efficiency if remaining in the turbid area. Fish that relocate away from the turbid area will likely experience greater feeding efficiency than those fish that remain, but this greater efficiency will likely be tempered by increased competition, as fish densities rise

within refugia areas. Whether relocating or remaining within the action area, the turbidity impacts experienced by affected fish will likely be discountable, given the expected low turbidity levels and short impact duration resulting from the Project.

By comparison, fish response to impacts resulting from the proposed bank stabilization will be much longer in duration. The rip-rap structure, and its resulting effect on natural channel-evolution processes and instream habitat, are expected to last well into the future -- at least several decades. These effects will be somewhat offset by the addition of large woody debris, however, the long-term impacts from bank stabilization may lead to decreased productivity and abundance of juvenile salmon in the action area over successive generations. In effect, the proposed bank stabilization will perpetuate the diminished carrying capacity that already exists within 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). 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. NMFS does not anticipate any cumulative effects in the action area other than those from ongoing actions already described in the Environmental Baseline above.

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 versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a whole that resulted from implementing the action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), 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 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) reduce the value of designated or proposed critical habitat for the conservation of the species.

Sausal Creek is a "dependent population" in the Interior Diversity Stratum, and serves an essential role in CCC steelhead recovery efforts (NMFS 2016). A small number of steelhead inhabiting the action area will experience a higher likelihood of perishing prior to reaching adulthood and spawning, primarily due to reduced fitness and growth brought about by the

proposed bank stabilization project construction and its negative impact on instream habitat. However, the anticipated small loss of juvenile steelhead is unlikely to appreciably impact the future survival and recovery at the ESU and DPS scale, since adequate quantities of habitat remain within the reaches of Sausal Creek and its tributaries from which the lost production can be regained.

Global climate change presents another real threat to the long-term persistence CCC steelhead, especially when combined with the current depressed population status and human caused impacts. Regional (*i.e.*, North America) climate projections for the mid to late 21st Century expect more variable and extreme inter-annual weather patterns, with a gradual warming pattern in general across California and the Pacific Northwest. However, extrapolating these general forecasts to our smaller action area is difficult, given local nuances in geography and other weather-influencing factors. Water temperatures may rise somewhat in the action area due to climate change over the next several decades, reinforcing the likelihood of reduced carrying capacity in the action area due to bank stabilization as described above.

The proposed action will degrade PBFs and essential habitat types in the action area, namely those related to juvenile rearing. Yet, the effects of the proposed action, 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 CCC steelhead DPS, given the small area being degraded compared to the quality and quantity of habitat within the Sausal Creek and Russian River watersheds. Thus, the proposed action will not impair the ability of critical habitat to play its intended conservation role of supporting populations CCC steelhead at the ESU and DPS level.

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 action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the action is unlikely to jeopardize the continued existence of CCC steelhead or destroy or adversely modify its designated critical habitat for CCC steelhead.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to Section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and Section 7(o)(2)

provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

Amount or Extent of Take

NMFS expects the proposed project will result in incidental take of CCC steelhead during two construction seasons. Take in the form of reduced fitness of some individual fish within the action area is expected. However, quantifying the number of fish impacted is difficult, given the complex and variable components at play. Individual fish behavior, and how that behavior adapts to evolving habitat conditions, will primarily influence how many fish will be impacted by the Project, and to what degree. In this circumstance, NMFS cannot provide an amount of take that would be caused by the proposed action. In instances such as this, NMFS designates the expected level of take in terms of the extent of take anticipated. Here, the best available indicator for the extent of take is related to the area of habitat lost due to streambank rip-rap armoring at the Project site. This variable is directly proportional to extent and nature of harm attributable to this project.

Therefore, for harm associated with permanent placement of rock armor along the Sausal Creek, the linear length of streambank covered by rip-rap rock armor will serve as an effective take indicator. Specifically, the anticipated take will be exceeded if the total distance of rip-rap rock armor placement is longer than 170 feet, or the spatial area exceeds 0.06 acres. Likewise, anticipated take will be exceeded if the amount, size and type of LWD and willow cuttings as proposed within the final project design, are not incorporated into the constructed Project. This take indicator operates as an effective reinitiation trigger because the Corps has authority to conduct compliance inspections and to take actions to address noncompliance, including post-construction (33 CFR 326.4).

Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of incidental take, coupled with other effects of the proposed action, is not likely to jeopardize CCC steelhead, or destroy or adversely modify their critical habitat designated for CCC steelhead.

Reasonable and Prudent Measures

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

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

1. Measures shall be taken to ensure construction activities

2. Minimize incidental take caused by the rip-rap streambank stabilization by ensuring riparian plantings survive and successfully revegetate the streambank.

3. Ensure completion of a monitoring and reporting program to confirm that the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are effective in minimizing incidental take.

Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (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. The applicant shall implement erosion control measures and cease construction related activities 24 hours before a daily weather forecast of a 0.25 inch or greater precipitation event.

2. The following Terms and Conditions implement Reasonable and Prudent Measure 2:
    a. The applicant prepares a vegetation monitoring plan to ensure establishment of streambank vegetation so that the streambank area functions at its maximum potential. Vegetation monitoring plan shall be submitted within 60 days of Project conclusion.
    b. Prepare a vegetation monitoring report and submit to NMFS annually by April 1. Report is required for the first three years following the Project. The vegetation monitoring report should include the following:
        i. Project identification
            1. Permittee name, permit number, and project name.
            2. Corps contact person.
            3. Starting and ending dates of monitoring survey completed.
        ii. Vegetation condition.
            1. Photos of streambank vegetation area conditions at the project site before, during, and after project completion. Include general views and close-ups showing details of the project and project area.
            2. Label each photo with date, time, project name, photographer's name, and a comment about the subject.
        iii. Vegetation monitoring data:
            1. Dead or dying trees identified during vegetation monitoring survey will be removed and replanted to ensure at least 80% survival of vegetation plantings (including willow planting). Identify the

number of dead or dying plants removed and replaced to ensure 80% survival.

2. Brief discussion about height and condition of the planted vegetation and contribution to replacement of lost functions (improved forage and natural cover) at the site.

c. Send plans and reports to:

National Marine Fisheries Service
Attn: North Coast Branch Supervisor
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

3. The following Terms and Conditions implement Reasonable and Prudent Measure 3:
   a. Implementation Monitoring Report Required. The permittee shall submit an implementation monitoring report to NMFS, at the address above, within 30 days of completing all construction work for each construction season. The implementation monitoring report will describe the permittee's success meeting his or her permit conditions.
      i. Implementation Monitoring Report Contents. The monitoring report will include the following information:
         1. Project Identification.
            a. Permittee name, permit number, and project name.
            b. Project location by sixth-field HUC or by latitude and longitude as determined from the appropriate United States Geological Survey 7-minute quadrangle map.
            c. Corps contact person.
         2. Habitat Conditions. Photos of habitat conditions at the project site before, during, and after project completion.
            a. Include general views and close-ups showing details of the project and project area.
            b. Include photos of the streambank contouring operations for the rip-rap construction. Label each photo with date, time, project name, photographer's name, and a comment about the subject.
         3. Project data. Include the following specific project data in the monitoring report.
            a. Number of days it takes to complete the revetment construction.
            b. Total linear length of the new revetment.
            c. Width of rock placement.
            d. The number and type of any rootwads placed in the revetment, or any other structures designed to minimize habitat degradation.

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 the Corps implement the following conservation recommendation.

1. NMFS recommends the Corps purchase conservation bank credits at a NMFS-approved conservation bank for the following: (1) permanent loss of natural streambank and channel processes; and (2) temporary loss of cover and forage habitat due to rip-rap armoring.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Project. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3 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.

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 Applicant. Individual copies of this opinion were provided to the Corps. The format and naming adheres to conventional standards for style.

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.

Objectivity

Information Product Category: Natural Resource Plan

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

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion 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 reviewed in accordance with West Coast Region ESA quality control and assurance processes.

4 REFERENCES

Scientific Literature, Government Reports, and Similar Documents

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

Benkert, R. 2002. SCWA Fishery Biologist, personal communication.

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.

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

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

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. 1965. California Fish and Wildlife Plan, Vol. I: Summary. 110p; Vol. II: Fish and Wildlife Plans, 216p.; Vol. III: Supporting Data, 180p.

California Department of Fish and Game (CDFG). 2002. Russian River Basin Fisheries Restoration Plan - July 2002 Draft. Robert Coey (CDFG), Sarah Nossaman-Pearce (UCCE), and Colin Brooks and Zeb Young (HREC-IHRMP), Healdsburg, CA. 331pp.

California Department of Forestry and Fire Protection (CalFire). 2017. Redwood Fire Mendocino Lake Complex Watershed Emergency Response Team, Final Report. CA-MEU-012169. California Natural Resources Agency. November 15, 2017. 28p.

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

Cloern, J. E., N. Knowles, L. R. Brown, D. Cayan, M. D. Dettinger, T. L.Morgan, D. H. Schoellhamer, M. T. Stacey, M. van der Wegen, R. W. Wagner, and A. D. Jassby. 2011. Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change. PLoS ONE 6(9):13.

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

Doney, S. C, M. Ruckelshaus, J. E. Duffy, J. P. Barry, F. Chan, C. A. English, H. M. Galindo, J. M. Grebmeier, A. B. Hollowed, N. Knowlton, J. Polovina, N. N. Rabalais, W. J. Sydeman, and L. D. Talley. 2012. Climate Change Impacts on Marine Ecosystems. Annual Review of Marine Science 4:11-37.

Dunne, T., and L. B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Company, New York.

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.

Fischenich, J. C., and R. R. Copeland. 2001. Environmental considerations for vegetation in flood control channels. ERDC TR-01-16. U.S. Army Corps of Engineers, Flood Damage Reduction Research Program, Engineer Research and Development Center, Vicksburg, MS. December.

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

Florsheim, J.L., Mount, J.F., and Chin, A. 2008. Bank erosion as a desirable attribute of rivers. BioScience, 58: 519–529. DOI:10.1641/B580608.

Garcia & Associates. 2017. Section 404 Permitting Materials for West Fork Russian River bank Stabilization and Restoration at Coyote Valley Reservation. Submitted to the U.S. Army Corps of Engineers, San Francisco District, Regulatory Branch, San Francisco, CA. Prepared for the Coyote Band of Pomo Indians, Redwood Valley CA. Prepared by: Garcia and Associates, Auburn, CA.

Good, T. P., R. S. Waples, and P. B. Adams. 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-66.

Hayes, M.L. 1983. Active Capture Techniques. Pages 123-146 *in* L.A. Nielsen and D.L. Johnson, eds. Fisheries Techniques. American Fisheries Society. Bethesda, Maryland. 468 pages.

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. National Marine Fisheries Service, West Coast Region. April 2016. 55 p.

Jahn, J. 2010. National Marine Fisheries Service fisheries biologist. Personal communication.

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.

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

LaChance, S., M. Dube, R. Dostie, and P. Berube. 2008. Temporal and spatial quantification of fine-sediment accumulation downstream of culverts in brook trout habitat. Transactions of the American Fisheries Society 137:1826-1838

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

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

Momenier B. 2002. NMFS Natural Resources Specialist. Personal Communication.

Mendocino County Resource Conservation District (MCRCD). 2016. West Fork Russian River and Forsythe Creek 2016 Salmonid Spawner Surveys Final Report. Prepared for Coyote Valley Band of Pomo Indians Environmental Protection Department. Ukiah, California. Dated June 2016.

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.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NMFS-NWFSC-35.

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

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

National Marine Fisheries Service (NMFS). 1997. Status review update for West Coast steelhead from Washington, Idaho, Oregon and California. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 68 p.

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

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

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

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

PFMC (Pacific Fishery Management Council). 2014. Pacific Coast Fishery Management Plan for the California, Oregon, and Washington Groundfish Fishery. Pacific Fishery Management Council, Portland, Oregon 97220, May 2014.

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

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.

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.

Scriven, J. 2018. Fishery Biologist. Mendocino County resource Conservation District.

Sonoma County Water Agency (SCWA). 2002. Upper Russian River steelhead distribution study. Prepared by D. Cook for SCWA. Santa Rosa, CA. 71 p.

Steiner Environmental Consulting. 1996. History of the salmonid decline in the Russian River. Sonoma County Water Agency, California State Coastal Conservancy, & Steiner Environmental Consulting. Prepared by: Steiner Environmental Consulting, Potter Valley, CA. 1996.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services, Inc. Corvallis, Oregon. December. Report. National Marine Fisheries Service, Portland, Oregon.

Spence, B. C., E. P. Bjorkstedt, J. C. Garza, J. J. Smith, D. G. Hankin, D. Fuller, W. E. Jones, R. Macedo, T. H. Williams, and E. Mora. 2008. A framework for assessing the viability of threatened and endangered salmon and steelhead in the North-Central California Coast recovery domain. NOAA-TM-NMFS-SWFSC-423. NOAA Technical Memorandum NMFS. 194 pp.

Spence, B. C., E. P. Bjorkstedt, S. Paddock, and L. Nanus. 2012. Updates to biological viability 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.

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

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, and S. R. Shrestha. 2011. Climate change and growth scenarios for California wildfire. Climate Change 109(1):445-463.

Williams, T. H., S. T. Lindley, B. C. Spence, and D. A. Boughton. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest 17 May 2011 – Update to 5 January 2011 report. National Marine Fisheries Service Southwest Fisheries Science Center. Santa Cruz. CA.

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

Federal Register Notices

62 FR 43937: National Marine Fisheries Service. Final Rule: Listing of Several Evolutionary Significant Units of West Coast Steelhead. Federal Register 62:43937-43954. August 18, 1997.

64 FR 24049: National Marine Fisheries Service. Final Rule and Correction: Designated Critical Habitat for Central California Coast Coho and Southern Oregon/Northern California Coast Coho Salmon. Federal Register 64:24049-24062. May 5, 1999.

70 FR 37160: National Marine Fisheries Service. Final Rule: Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. Federal Register 70:37160-37204. June 28, 2005.

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

71 FR 834: National Marine Fisheries Service. Final rule: Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. Federal Register 71:834-862. January 5, 2006.

81 FR 7214: National Marine Fisheries Service. Interagency Cooperation-Endangered Species Act of 1973, as Amended; Definition of Destruction or Adverse Modification of Critical Habitat. Federal Register Volume 81: 7214-7226. February 16, 2011.