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

JUL 14 2017

Refer to NMFS No: WCR-2017-6684

Marie Strassburger, Chief
Fish and Wildlife Service, Pacific Southwest Region
Wildlife and Sport Fish Restoration
2800 Cottage Way, Suite W-1916
Sacramento, California 95825

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Martin Slough Enhancement Project in Eureka, Humboldt County, California

Dear Ms. Strassburger:

Thank you for your letter of March 17, 2017, 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 Martin Slough Enhancement Project. NMFS received your request on March 20, 2017, and determined that there was sufficient information to initiate ESA formal consultation. NMFS received, as part of your request, a copy of the U.S. United States Fish and Wildlife Service's (USFWS) Wildlife and Sport Fish Restoration Program's Biological Assessment/Essential Fish Habitat Assessment for the Martin Slough Enhancement 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 (MSA)(16 U.S.C. 1855(b)) for this action.

This letter transmits NMFS' final biological opinion and EFH consultation pertaining to the USFWS's proposed Project located in Eureka, Humboldt County, California. USFWS is taking the federal lead in the project on behalf of the National Oceanic and Atmospheric Administration's Restoration Center (NOAA RC) and the U.S. Army Corps of Engineers (Corps).

This biological opinion is based on NMFS's review of information provided within USFWS' March 17, 2017 request for formal consultation, associated March 2017 biological assessment, additional submitted information and best available information.

The biological opinion addresses potential adverse effects on the following listed species Evolutionarily Significant Unit (ESU), Distinct Population Segment (DPS), and designated critical habitat:

Southern Oregon/Northern California Coast (SO NCC) ESU of coho salmon (*Oncorhynchus kisutch*)

Threatened (70 FR 37160; June 28, 2005)
Designated critical habitat (64 FR 24049; May 5, 1999);

California Coastal (CC) Chinook salmon ESU (*O. tshawytscha*)

Threatened (64 FR 50394, September 16, 1999)
Designated critical habitat (70 FR 52488, September 2, 2005); and

Northern California (NC) steelhead DPS (*O. mykiss*)

Threatened (71 FR 834, January 5, 2006)
Designated critical habitat (70 FR 52488, September 2, 2005).

Based on the best scientific and commercial information available, in the biological opinion NMFS concluded that the action, as proposed, is not likely to jeopardize the continued existence of the SONCC coho salmon ESU, CC Chinook salmon ESU, or NC steelhead DPS and is not likely to result in the destruction or adverse modification of designated critical habitat for these species. NMFS expects the proposed action will result in incidental take of SONCC coho salmon, CC Chinook salmon, and NC steelhead. An incidental take statement is included with the enclosed biological opinion. The incidental take statement includes non-discretionary, reasonable and prudent measures, and terms and conditions that are expected to further reduce incidental take of SONCC coho salmon, CC Chinook salmon, and NC steelhead anticipated as a result of the proposed action.

The enclosed EFH consultation was prepared pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act. The proposed action includes areas identified as EFH for coho salmon and Chinook salmon, Pacific Salmon species managed under the Pacific Coast Salmon Fishery Management Plan. Based on our analysis, NMFS concludes that the project would adversely affect EFH for Pacific Coast Groundfish and Pacific Coast Salmon temporarily. The proposed action contains measures to minimize adverse effects to EFH.

Please contact Miles Barker at (707) 825-1620, Northern California Office, Arcata, California, or via email at miles.barker@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,
[signature] for
Barry A. Thom
Regional Administrator

Enclosure

cc: Marie Strassburger, USFWS, Sacramento, CA
Kasey Sirkin, Corps of Engineers, San Francisco District, Eureka Field Office, Eureka, CA
Bob Pagliuco, NOAA Office of Habitat Conservation, Restoration Center, Arcata, CA
Copy to file: 151422WCR2017AR00115

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

Martin Slough Enhancement Project in Eureka, Humboldt County, California
NMFS Consultation Number: WCR-2017-6684

Action Agencies: The U.S. Fish and Wildlife Service (USFWS), National Oceanic and Atmospheric Administration's Restoration Center (NOAA RC), and the U.S. Army Corps of Engineers (Corps)

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?
Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch)*	Threatened	Yes	No	No	No
California Coastal (CC) Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Northern California (NC) Steelhead (*O. mykiss*)	Threatened	Yes	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Groundfish	Yes	Yes
Pacific Coast Salmon	Yes	Yes

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

Issued By: [signature], for
Barry A. Thom
Regional Administrator

Date: JUL 1 4 2017

TABLE OF CONTENTS

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS's Public Consultation Tracking System: https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts. A complete record of this consultation is on file at NMFS' West Coast Region, Arcata, California office.

1.2 Consultation History

On March 20, 2017, NMFS received a request from USFWS, NOAA RC, and the Corps for initiation of formal consultation under section 7(a)(2) of the Endangered Species Act (ESA), as amended (16 U.S.C. § 1531 *et seq.*) for the Martin Slough Enhancement Project in Humboldt County, California (Project).

On June 29, 2017, via email, NMFS requested additional information from NOAA RC regarding fish monitoring for the proposed project. On June 30, 2017, NOAA RC responded to NMFS' email request. The additional information included clarification on frequency and duration of monitoring efforts, changes to mortality percentages for Passive Integrated Transponder (PIT) tagged, handled, and released salmonids; and clarification on monitoring techniques and methods to reduce effects on listed species. On July 12, 2017, NOAA RC provided further clarification on the proposed maximum annual number of PIT tagged fish associated with project monitoring. On July 13, 2017, NOAA RC clarified that in the event where complex woody or vegetated habitat is encountered during relocation, an electrofisher will be used to remove fish from construction areas.

The request for consultation concerns the effects of the proposed Project on threatened Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*), California Coastal (CC) Chinook Salmon (*O. tshawytscha*), Northern California (NC) steelhead (*O. mykiss*), and their designated critical habitats.

This biological opinion is based on information provided to NMFS by USFWS with the submittal for formal consultation and additional submitted information. NMFS also considered other sources of scientific and commercial information, including journal articles and technical reports.

1.3 Proposed Federal 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). The USFWS and the NOAA RC propose to provide funding to enhance Martin Slough through the improved operation of new tide gates[1], and construction of new ponds and a modified channel. The Corps will also be permitting the Project under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. The USFWS is taking the federal lead in the project on behalf of NOAA RC, and the Corps. The proposed Project has been designed to restore and enhance tidal and freshwater wetlands and riparian habitat that were characteristic of the historic Martin Slough ecosystem. The overall restoration plan includes re-contouring and restoring approximately 6,000 feet (ft) of tidal channel network in Martin Slough, restoring 4.6 acres (ac) of tidally influenced marsh and ponds, and restoring 3.6 ac of riparian forest.

The activities proposed for the site would restore it to a geomorphic configuration, hydrologic regime and habitat mosaic that would contribute to conservation of sensitive and imperiled plant and animal species; improve water quality, and enhance habitat to benefit fisheries and wildlife. Dewatering, cut, fill, grading, pipeline relocation, and re-planting operations involved in the restoration would result in temporary impacts across the 270-ac project area, which includes 18.9 ac of waters of the United States. Once completed, the Project will provide a matrix of restored landscape features of native salt marsh, fresh and brackish wetland, seasonal wetland, and riparian habitats intended to provide for fish and wildlife habitat.

While the action area is highly disturbed and largely disconnected from tidal influence, it has potential to support a number of federally listed species. Juvenile coho salmon have been present in ponds within the work area, and small numbers of adults could conceivably be present during the early winter spawning period. While steelhead occur in many permanent streams in Humboldt County, repeated sampling of Martin Slough has revealed very few individuals. Chinook salmon have been consistently reported from the Elk River system, but only a single juvenile has been observed in Martin Slough in repeated sampling events since 2007. The Project is comprised of multiple interrelated components as described below. Implementation will be phased over the summers of 2017-2023.

Actions include a new tide gate structure (completed in 2014), enlargement of the Martin Slough channel, relocation and decommissioning of buried PG&E gas lines, installation of scour protection over buried natural gas lines under channels or marsh plains, construction of several tidal ponds, raising of some local low areas on the golf course to elevation 7.0 ft, replacement of multiple agricultural-use and golf course stream crossings (including culverts in the pasture and bridges at the golf course), installation of large wood habitat structures throughout the Project, and extensive planting of wetland and riparian vegetation. Hydraulic, hydrologic, and geomorphic analyses were used to develop the interrelated Project components through an iterative design process.

[1] The new tide gates have already been installed and covered by a previous consultation.

Summary of Project Actions (the locations of the majority of the following restoration actions are shown in Figures 1-3):

- Installation of erosion control measures
- Fish screen installation and fish relocation
- Cofferdam installation
- Stream flow bypass installation
- Construction area stream and pond dewatering
- Staging area access installation (including temporary bridges)
- Interior road hardening (installation of filter fabric, geo-grid, and road base)
- Removal of old culverts and installation of new culverts
- Installation of sheet piles along Martin Slough at the barn on Northcoast Regional Land Trust (NRLT) property
- Replacement of the barn culvert with a bridge (including installation of bridge footings)
- Replacement of golf course bridges, including footings
- Installation of gas line scour protection
- Relocation of 130 ft of 6-inch (in) natural gas line
- Decommission and abandonment of a 4-in natural gas line
- Channel excavation
- New pond excavation
- Existing pond enlargement
- Installation of large wood habitat features in ponds and along channel margins and marsh plains
- Temporary stockpiling of spoils
- Hauling of spoils
- Placement of spoils to repair up to 50 percent of the berm separating Martin and Swain Slough
- Placement of spoils to fill low spots in the pasture and golf course to create positive drainage to prevent ponding on the floodplain and fish stranding during flood events
- Removal of temporary roads and access points and restoration of pasture areas and golf course fairways to pre-Project conditions
- Removal of cofferdams, stream bypass structures, and fish screens
- Installation of cattle exclusion fencing (NRLT property only)
- Installation of wetland & riparian plantings
- Salmonid monitoring with the intent to observe new habitat and monitor fish utilization before introducing full muted tide (which will turn Pond E seasonally brackish)

The purpose of the Project is to improve aquatic and riparian habitat and reduce flooding throughout the action area. Specific goals of the Project include the following:

- Increase the resiliency of the coastal ecosystem by restoring a muted tidal inundation, supporting restored tidal wetlands and aquatic biota
- Decrease the vulnerability of the coastal community to the effects of extreme weather by increasing channel network capacity and floodplain function to reduce flood impacts
- Use fill material from Martin Slough channel enhancement and pond creation for tidal marsh restoration and sea level rise adaptation in the White Slough Unit of the Humboldt

Bay National Wildlife Refuge (HBNWR). The White Slough Project is fully permitted (independent of this Project) to accept clean fill from suitable borrow locations

- Provide habitat and benefits to multiple species by improving and increasing the diversity and amount of fresh and saltwater wetland/estuarine habitat, particularly off-channel and side channel juvenile salmonid rearing and overwintering habitat
- Increase sediment transport capacity from upstream and tidally transported sediment sources
- Improve fish access from Swain Slough into Martin Slough
- Increase the amount and quality of riparian corridor and riparian canopy
- Improve water quality (decrease nutrient impacts, decrease sedimentation, increase salinity)
- Reduce financial losses caused by flooding to the ranching interest and City of Eureka

The proposed action includes improvements to the existing channel and a corresponding larger habitat door to accommodate the larger available tidal prism. The muted tide regulator (MTR) on the new tide gates will be used to create a muted tide cycle and facilitate fish passage. Other Project actions include increasing the size of existing ponds, creating new ponds, making channel modifications, installing fish and wildlife habitat structures (woody debris), and re-vegetation throughout the action area.

The geomorphic stability of enlarging the Martin Slough channel within the action area to increase conveyance area for both flood flows and a diurnal tidal exchange was analyzed using design guidelines developed for tidal channels. This was done because reintroducing a muted tide cycle into the action area would result in large volumes of water flowing up and down the channel with each tide cycle, changing the fluvial processes that maintain the channel with the potential and likelihood of scouring the channel bed and banks, which could cause erosion that could affect existing infrastructure.

The new and expanded ponds would create additional habitat for rearing salmonids, waterfowl, and other aquatic and semi-aquatic species. The ponds would also provide additional storage capacity for storm flows, reducing the amount of time higher ground is inundated. This proposed action would increase the size of three existing ponds on the golf course. Two new ponds would be added, one on the golf course and one on the NRLT property. It is anticipated that this would provide a range of estuarine habitat with varying salinity values. The highest salinity values would be adjacent to the tide gates, and the lowest salinity would be found farther upstream. Salinity values would likely fluctuate from summer to winter months, being higher in the summer when less fresh water is entering the drainage. The golf course would likely need to use the upper irrigation pond as their primary irrigation source or use well water. The additional ponds with varying salinity values would be a large benefit for juvenile salmonids. The ponds would be planted with a variety of wetland and riparian vegetation. The new riparian and marsh vegetation in the pasture would be protected by cattle exclusion fencing.

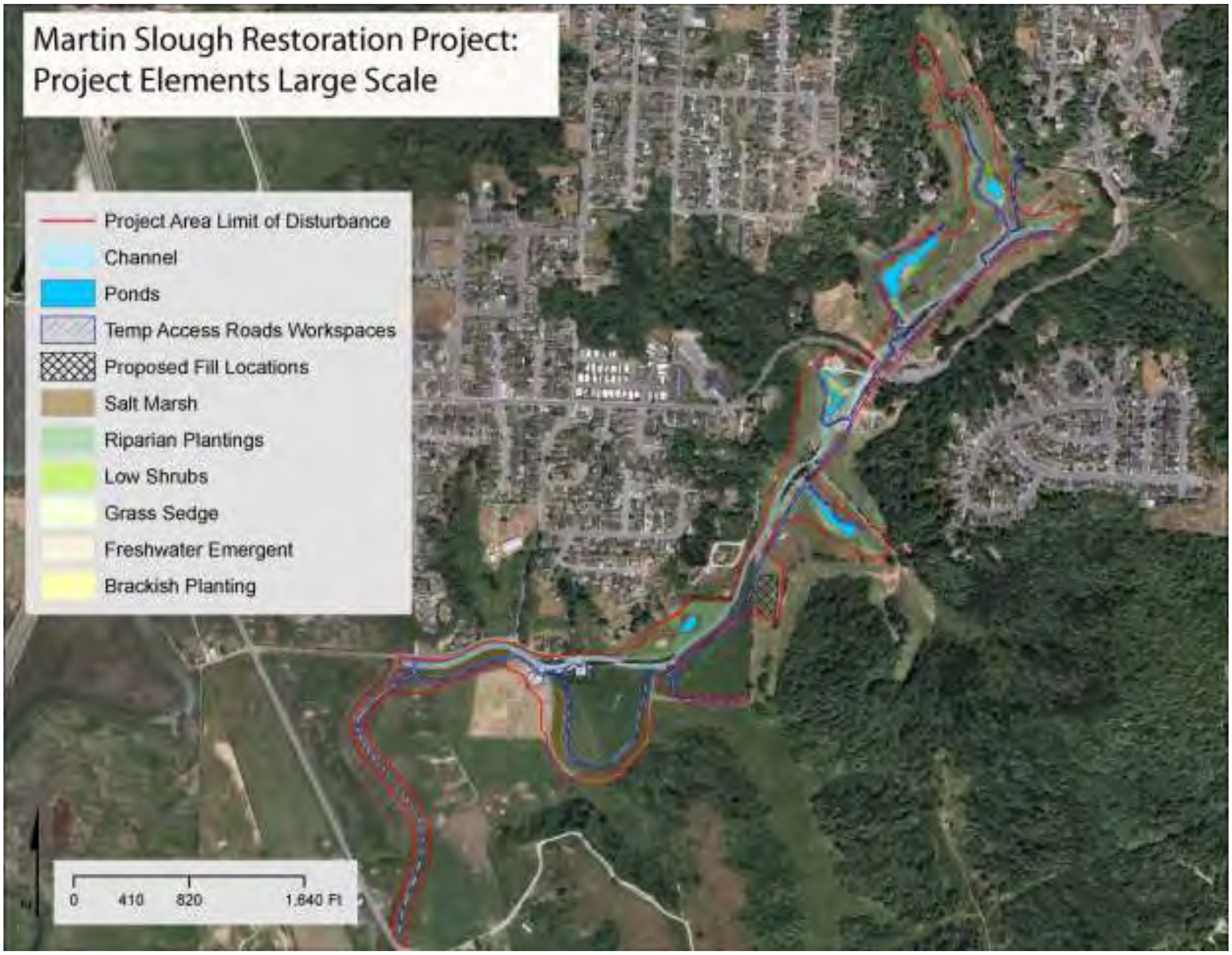

Figure 1. Martin Slough Restoration Project, Project Elements, Large Scale.

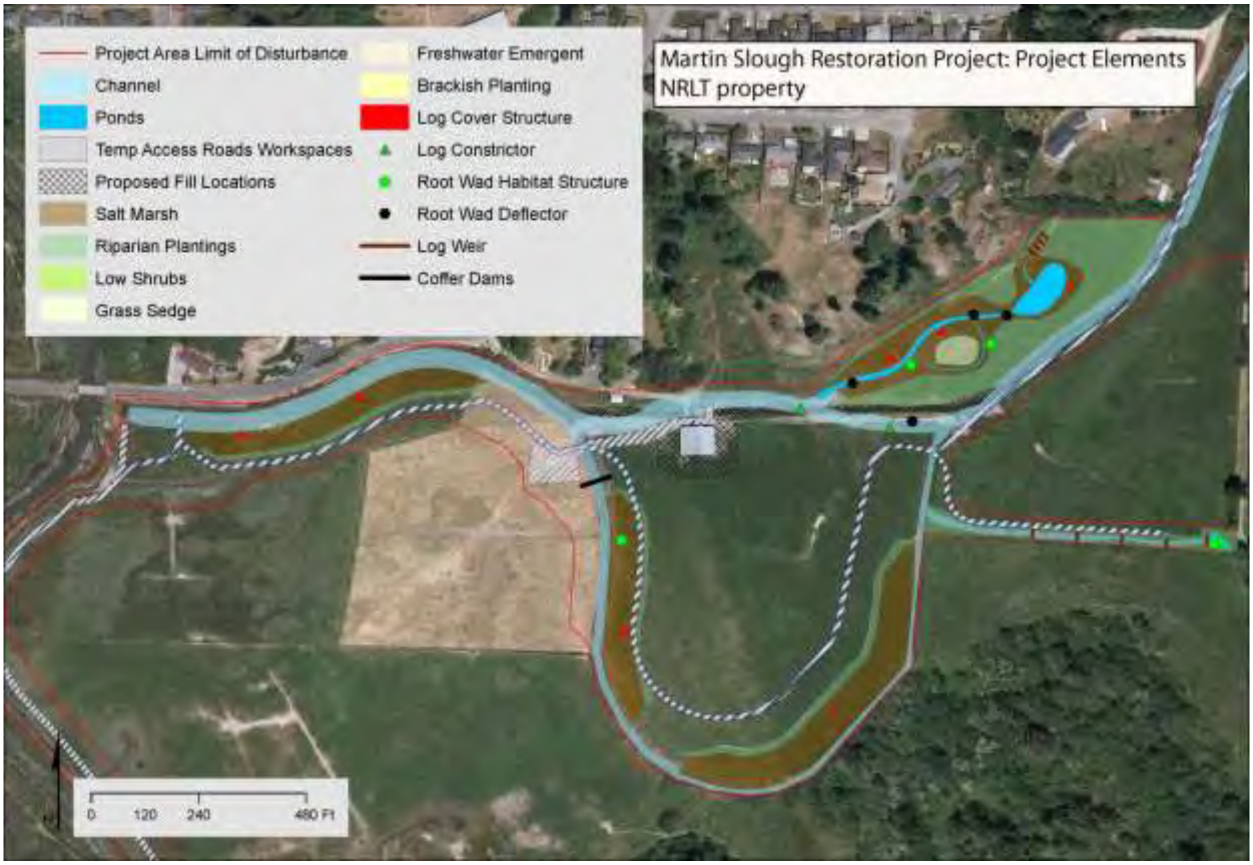

Figure 2. Martin Slough Restoration Project, NRLT Property.

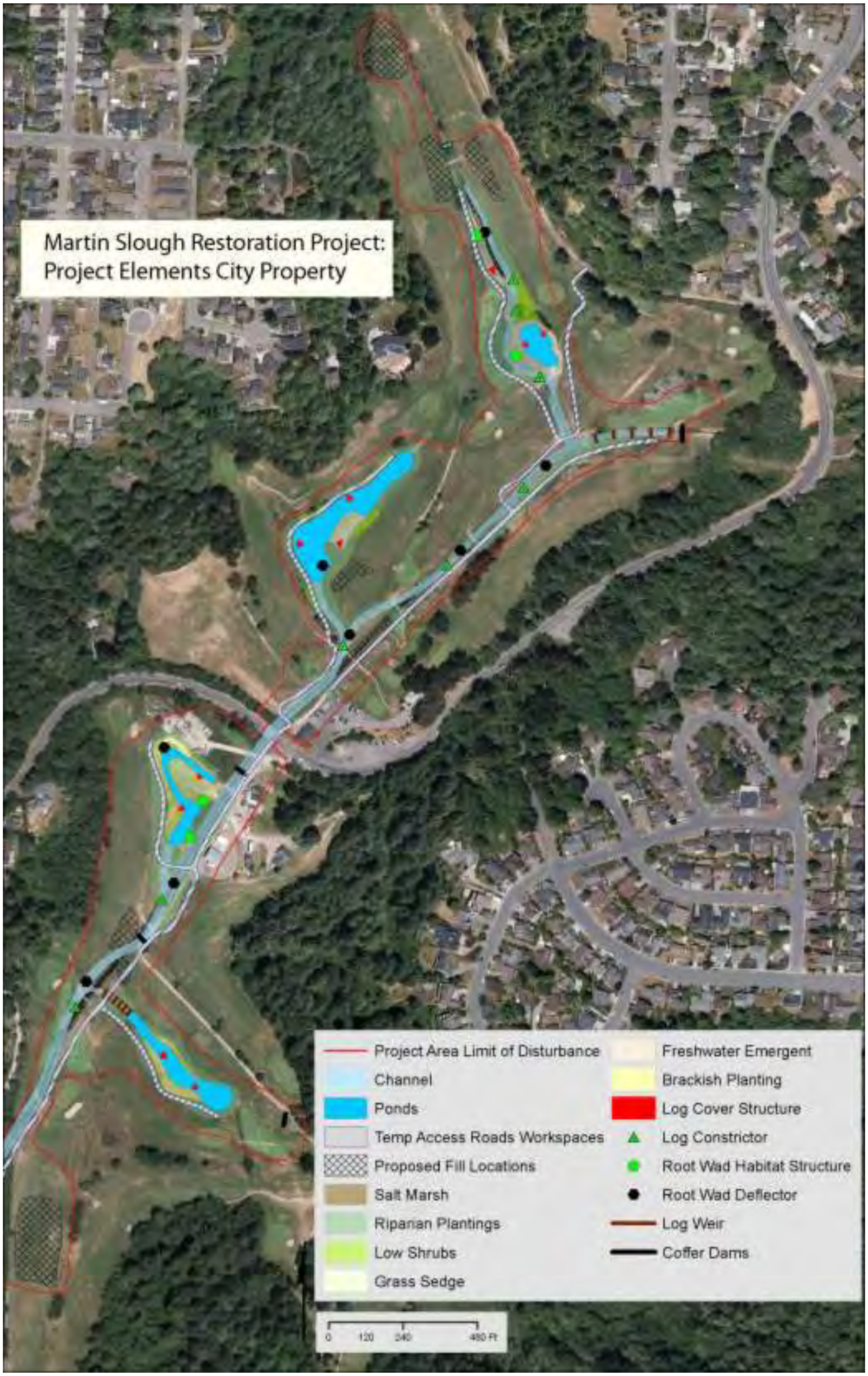

Figure 3. Martin Slough Restoration Project, City of Eureka Property.

1.3.1 Project Phasing

Please refer to Figures 1-4 for the location of all project elements listed below. Project implementation will occur in phases due to three primary factors:

1. The large scale of the Project;
2. Uncertainties around fundraising for phases on the City owned property;
3. State and federal regulators have mandated that USFWS provide replacement habitat for Pond E (see discussion below for more details on the concerns related to Pond E) before performing the pond and channel enhancements around the existing Pond E.

All phases include placement of large wood to enhance habitat, installation and removal of fish screens (locations shown on Figures 1-3), fish capture and relocation, installation and removal of cofferdams (locations shown on Figures 1-3), installation of stream bypass equipment (pumps and/or gravity flow pipes), installation of erosion control measures, and re-vegetation (location shown on Figures 1-3). Existing habitat will be enhanced and fish utilization of this new habitat will be monitored prior to introducing the full muted tide.

Phase 1

Phase 1 was completed in 2014 and involved the replacement of three outdated tide gates at the confluence of Martin Slough and Swain Slough.

Phases 2-4

Phases 2-4 Implementation is proposed for the summer of 2017 (July 2017 – October 15, 2017 or November 15, 2017 if there is no significant rain event) and will likely take approximately two months to complete. These phases include excavating the Martin Slough channel starting from the tide gates moving upstream, including all of the NRLT property and additionally extending approximately 1,400 ft upstream from the boundary between the NRLT and City property (Reaches 1-4 on Figure 4). Additionally, the Marsh Planes A and B (labelled A and B on Figure 4) will be excavated. Pond C (labelled C on Figure 4); a pond fringed by salt marsh and fed by a small freshwater spring, will also be excavated and replanted. The small freshwater pond fed by the southeast tributary (labelled E on Figure 4) and adjoining channel will be excavated in conjunction with excavating the meander bend adjacent to Marsh Plane B. On the lowest downstream portion of the City owned property, Pond D (Labelled as D on Figure 4) will also be enhanced with expanded brackish wetlands containing a variety of depths and an elevated outlet sill that minimizes salinity intrusion.

An existing, undersized culvert crossing leading to the agricultural bridge on the NRLT property will be removed, daylighting the channel for 40 ft. It will be replaced with a 20 ft wide bridge, necessary for agricultural access. Sheet piles or other shoring will be installed on both banks to support this bridge and prevent erosion around the barn. Bridge footings and beams will be installed, with decking and railing on the bridge. Concrete curbs will also be installed around the edge of the bridge and the front of the barn to contain cow manure and prevent it from entering the channel.

Actions on the City property include: installation of three new bridges and their associated footings, removal and disposal of three old bridges.

These phases also include: installation of a variety of different types of large wood habitat structures (locations shown on Figures 1-3), grade control weirs on both the City property and NRLT (locations shown on Figures 1-3), riparian fencing, and re-vegetation (locations shown on Figures 1-3). Additionally, this will include installation of scour protection on the 12-in gas line that crosses the meander bend south of the barn.

Phases 2-4 will also include gas line relocation (6-inch line) and decommissioning of the 4-in line (collectively called the gas line project). The gas line project is being designed and implemented by PG&E in coordination with RCAA and will occur in 2017 and in conjunction with phases 1-3.

Phases 5 and 6
The action agencies anticipate that at most, each phase will take one construction season (June 15 – October 15 or November 15 if there is no significant rain event) with a duration of two to four months. Depending on the amount of secured funding, and the monitoring results of water quality and fish use of Ponds C and D (Figure 4) after implementation in 2017, they may be able to implement Phases 5 and 6 on the City property in conjunction with each other over one construction season in 2018. Alternatively, if there are still concerns over replacement habitat, these phases will be split up with everything except Pond E implemented in 2018, therefore Pond E would be implemented in 2019 (as described above). Implementation may also occur as late as 2023 as long as permits remain viable.

Please refer to Figure 4 for the locations of the following actions:

- Excavation of the remaining Martin Slough channel on City of Eureka property from Pond D to the upstream limit of the project area (Reaches 5-7 on Figure 4).
- Enhancements of Pond E and creation of Pond F and Pond G (Figure 4).
- Excavation of a new channel for the North Fork tributary.
- Fill in portions of the old channel.
- Excavation of Pond G.
- Placing fill to eliminate depressions on the floodplain adjacent to the channel that currently pond during floodplain inundation and present potential fish stranding opportunities.

This will create new freshwater-tidally-influenced habitat (Pond G) that California Department of Fish and Wildlife (CDFW) biologists have observed to provide ideal rearing conditions for juvenile coho salmon. Ponds F and G, as well as the small freshwater pond on the NRLT property, will be considered “replacement ” freshwater habitat for habitat in Pond E that may become seasonally brackish upon implementation of all phases and operation of the muted tide regulator and tidal prism at full design level. Additionally, during these phases USFWS will install a variety of large wood habitat structures; install six new bridges and their associated footings; remove and dispose of six old bridges; install grade control weirs, and re-vegetate (locations shown in Figures 1-3).

Replacement Habitat for Pond E (17th hole pond)
CDFW biologists have observed that juvenile coho salmon have the highest abundance in winter months in tidally influenced reaches and off-channel ponds that have low levels of salinity (less than 5 parts per thousand [ppt]–personal communication Michael Wallace). Currently, Pond E provides this type of habitat and CDFW fish sampling has revealed that the juvenile coho salmon from that pond have the highest growth rates of any of their sampling sites around Humboldt Bay. Because of the current high value of this habitat, USFWS will provide similar replacement habitat before impacting Pond E.

USFWS recently learned from Project engineers (Mike Love, personal communication) that they cannot reintroduce the tidal prism at the full build out level until they complete the channel enhancements to accommodate the additional volume from increased tidal inundation. This is due to concerns about increased channel bed and bank erosion and deposition if larger tides are allowed in the channel before the structure can accommodate it. Consequently, water quality (including salinity) in the ponds (including Pond E) and channel will not change drastically from the current conditions until full Project implementation is complete and USFWS is able to open the tide regulator to the maximum design height.

From a logistical construction standpoint, and to minimize the impacts to the City-owned golf course during construction, USFWS proposes that Pond D and the small freshwater pond connected to the SE Tributary (proposed for construction in 2017), can provide suitable replacement habitat for Pond E. USFWS will monitor fish use and water quality in all new and existing ponds (including Pond E) after phases 2-4 are implemented and USFWS will verify that fish are using the new ponds and that water quality is similar to Pond E. USFWS will share this data with state and federal regulators and, if all agree that these new ponds provide adequate replacement habitat during construction, they then propose to concurrently implement Phases 5 and 6 during the following construction season on the City property (anticipated to take place in 2018). Phases 5 and 6 include the remaining channel enhancements on the City property and enhancements to Ponds E and G with a new pond created, Pond F. If water quality and fish use suggest that Pond E is still the most desirable habitat for endangered coho and that fish use or water quality is not sufficient in Pond D and the small freshwater pond on the SE Tributary, USFWS will conduct the remaining restoration actions on the City property in two phases. Under these circumstances, USFWS will enhance Pond E after all other actions are completed. This would allow for another full season of monitoring the new features before any impacts occur to Pond E.

Phases are shown below in Figure 4 and the anticipated schedule is summarized as follows:

- Phase 1 (NRLT): Funded, constructed in 2014.
- Phase 2-4 (NRLT and lower City): Funded, construction expected summer/fall 2017.
- Phases 5 and 6 (City): Not currently funded, funding sources identified and grant proposals are forthcoming in 2017; anticipated implementation will occur in 2018 and possibly 2019.

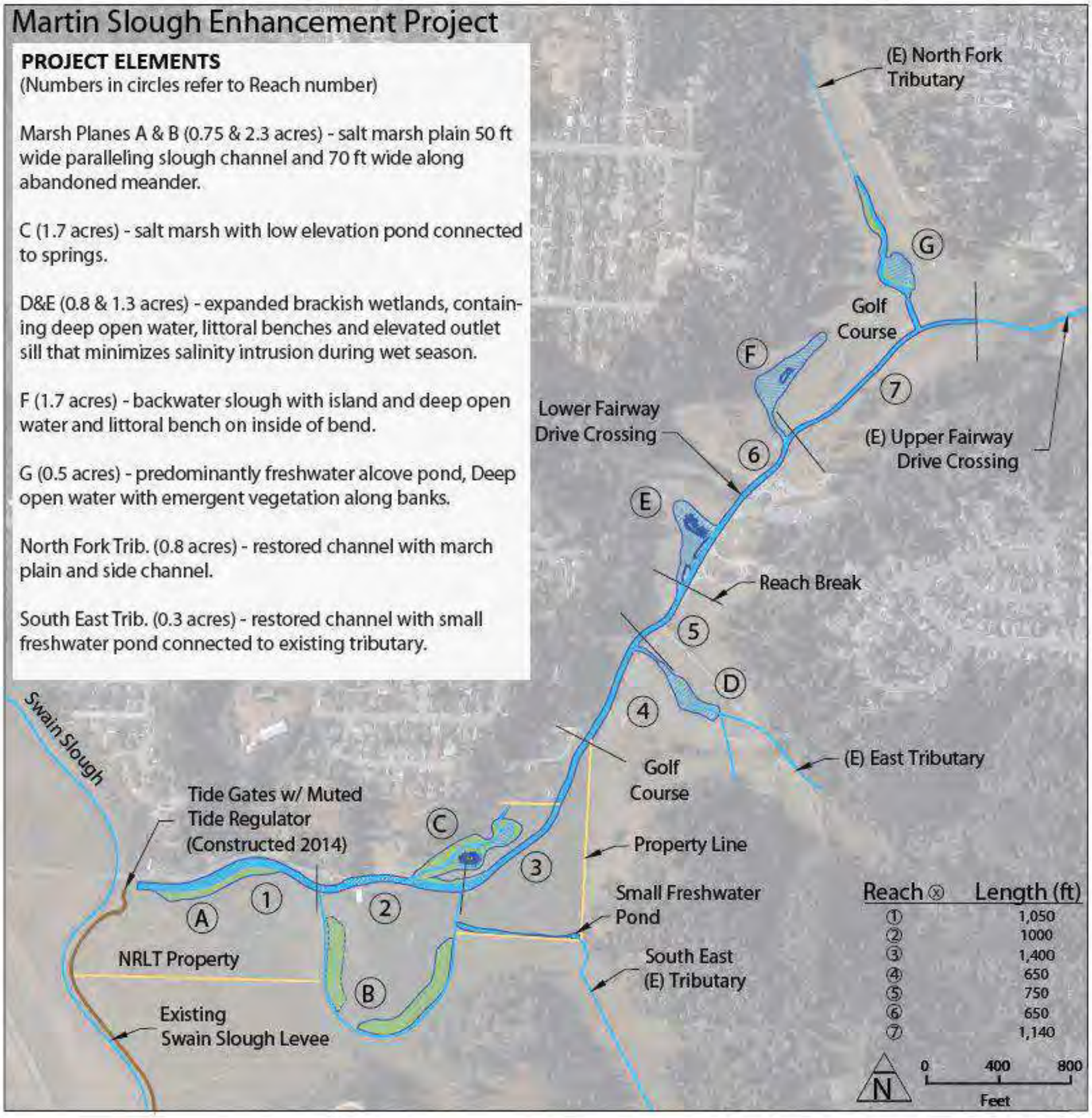

Figure 4. Summary of Martin Slough Enhancement Project Activities

The following sections provide additional detail about the project components summarized above.

1.3.2 Tide Gate Replacement

New tide gates were installed in 2014 to replace the old, undersized tide gates where Martin Slough drains into Swain Slough to improve discharge capacity, improve aquatic organism passage, and introduce estuarine conditions into Martin Slough. The tide gate replacement project is described here because it is an integral part of the Project and without the new tide gates, the rest of the Project as described is not feasible. The replacement tide gates were designed to meet multiple objectives:

- Reduce the duration that floodwaters inundate the golf course and pasture;
- Create a muted tide to enter Martin Slough to provide adequate volume of tidal water for sediment and nutrient flushing and enlargement of estuarine habitat;
- Maintain the tidal water below elevation 6 ft (note: all elevations are in NAVD88) to protect adjacent pasture grasses and turf from salt-burn;
- Mimic the natural variability of the tidal cycle within the muted tide range to support a variety of salt marsh and open water habitats;
- Maximize the amount of time the tide gates are open to provide for upstream and downstream movement of aquatic organisms;
- Maximize the amount of time water velocities through the gate openings meet passage criteria for adult and juvenile salmon and steelhead.

A maximum allowable muted tide elevation of 6 ft within Martin Slough was established to avoid brackish waters in the channel affecting the root-zone of the golf course turf, which will have a minimum elevation of 7 ft after several low areas within the golf course are raised. In general, the muted high tide will only reach 6 ft for brief periods during spring (also called king) tides, which generally occur in late fall/early winter (November-December).

At full build out, once the tide in Martin Slough reaches an elevation of approximately 5.7 ft, (based on the results of water quality monitoring this level can be adjusted as needed) an MTR mechanism will close the auxiliary door, preventing saltwater intrusion into Martin Slough above an elevation of 6 ft. This, in turn, will prevent salt burn of the golf course turf and pasture grasses. The interim operation level of the auxiliary door is 5.0 ft, which will allow sufficient tide water to enter Martin Slough and sustain the salt marsh plants that have established along the channel due to the leakiness of the old tide gates.

1.3.3 Pacific Gas & Electric Gas Line Protection, Relocation, and Decommissioning

Phase 2 will include relocation of 130 ft of a 6-in natural gas line (line L 126A) and de-commissioning of a 4-in gas line (Line L 126B) (the gas line project) to be carried out by PG&E. Phases 4 and 5 will also include installation of scour protection over a 12-in gas line (line L 177) where it crosses the meander on NRLT property and the East Tributary on the Golf Course. The natural gas lines are owned and operated by Pacific Gas & Electric (PG&E).

Scour protection will be installed on the 12-in gas line in three locations where it crosses the stream channel to prevent the loss of soil from channel scour, which would reduce the depth of soil cover over the gas line.

The gas line relocation project is necessary because the enhancement project will result in excavating soil from the channel and adjacent floodplain and thus reducing the soil cover over the gas lines to less than PG&E's required minimum depth of coverage. Prior to installation of the new gas line, the old gas line will be removed from under the channel area proposed for excavation by the enhancement Project. Where the gas line crosses the channel, cofferdams will be installed upstream and downstream of the crossing and the work area will be dewatered by pumping. Stream flow will be routed around the work area by pumping. Energy dissipation will be employed at the stream bypass outlet to prevent an increase in turbidity downstream of the outlet.

Prior to installing the cofferdams, temporary fish screens will be installed upstream and downstream of the cofferdams. A fish biologist will capture fish within the work area by seining. The biologist will be present during the de-watering of the work trench to ensure that any fish that eluded capture during the seining are captured and relocated during the de-watering. Once the site is de-watered and all fish have been captured, they will be released back into the channel at least ¼ mile upstream of the de-watered section where they will have access to suitable habitat areas. Basic water quality measurements (dissolved oxygen, temperature, salinity) will be taken prior to release to verify that conditions are suitable. The intake for the stream bypass will be placed between the upstream fish screen and cofferdam and it will have a screened intake with a mesh size opening no greater that 3/16 in. The outlet of the stream bypass pipe will be discharged into an energy dissipater to prevent scour of the channel and creation of turbidity in excess of background levels.

The 4-in gas line will be decommissioned in place. Based on pot-holing conducted by the Redwood Community Action Agency (RCAA) under the supervision of PG&E, the elevation of the 4-in gas line was determined to be sufficiently deep under the channel that it will not interfere with stream flow, even after the channel is excavated to -1.0 ft as called for in the Project plans.

Phase 3 (Pond G and North Fork Martin Slough enhancement) may proceed prior to the gas line relocation as it involves enhancement of freshwater habitat that will not rely on the muted tide to maintain it. Phases 5 and 6 of the enhancement project will proceed only after the gas line relocation and decommissioning have been implemented.

1.3.4 Tidal Channel

The Project area of Martin Slough will be within the limits of tidal influence after Project implementation, although full tidal variation will not be implemented until all construction is complete. The upper reaches of the Project (North Fork, Pond G, Reach 7 on Figure 4) are expected to remain tidally-influenced-freshwater habitat, meaning the water level will fluctuate with tide levels but the water will remain fresh, even at high tide. Though Martin Slough receives freshwater inflows, the hydraulic geometry of the tidal channel of Martin Slough is assumed to be governed by the daily tidal flux rather than less frequent high flow events from upstream.

The contributing tidal prism is defined as the total tidal flux between mean higher high water (MHHW) and mean lower low water (MLLW) from channel, pond and overbank storage flowing to a channel reach on an ebb tide. The tidal prism in Martin Slough will be controlled by tidal conditions in Swain Slough, tide gate opening geometry, water surface elevations within Martin Slough, and tidal prism storage within Martin Slough.

The Martin Slough tidal channel will be constructed with a trapezoidal shape having side-slopes of 1.5H:1V. The resulting stable channel and marsh plain geometries will have top widths ranging from 60 ft wide at the mouth of Martin Slough (at the tide gates) and upstream along the lower portions of the NRLT property to 20 ft wide at the confluence with the North Fork of Martin Slough. The constructed channel depths, as measured from the top of bank to bottom of channel, will range between 6.3 ft and 3.9 ft.

The new channel profile has a constantly decreasing slope. It matches the existing channel elevation at the upstream end of the Project and slopes downward at an average slope 0.25 percent

(0.0025 ft/ft) until it reaches the confluence with Pond F. Downstream of Pond F, the channel slope averages 0.02 percent (0.0002 ft/ft), ending at the replacement tide gates.

1.3.5 New and Expanded Ponds

The Project will include construction of a new tidal marsh complex (Pond C), enlargement of the existing Pond D into an in-channel tidal pond in a tributary flowing into Martin Slough, enlargement of the existing off-channel Pond E, construction of new Pond F, and enlargement of the existing in-channel Pond G in the North Fork. A new channel will be constructed to route flow from the North Fork around Pond G, making Pond G an off-channel pond. This design feature is intended to route sediment down the North Fork channel around rather than through Pond G to avoid sedimentation of Pond G.

Tidal marshes and pond sizing is an integral process of the equilibrium tidal channel design. Tidally influenced ponds can be a substantial component of the contributing tidal prism in a receiving channel. Some existing vegetation will be removed during the construction of new ponds (Ponds C, F, and the small freshwater pond on the NRLT property and the expansion of existing ponds (Ponds E and G). The existing vegetation that will be impacted is almost exclusively non-native pasture grass on the NRLT property and non-native golf course grasses on the City property.

1.3.6 Tidal Marsh Plains A and B and tidal Marsh Complex C Design

Approximately 1,970 ft of tidal marsh plain in 3 reaches will be constructed along alternating sides of the tidal channel (Marsh Plain A- 750 ft.) and meander reaches (Marsh Plains B1- 500 ft. and B2- 900 ft.) on the NRLT property. The marsh plains will have a top width of 50 to 75 ft with gentle side slopes of 3H:1V transitioning to existing ground. The width of the marsh plain will gently taper to the existing channel width of approximately 20 ft at the 12 in gas line crossings in the meander (*i.e.*, the marsh plain will end at the gas line crossing and stream flow will be carried by the channel only). Similarly, to facilitate flow into the new tide gate, the marsh plain width will taper to the channel width of approximately 35 ft immediately upstream of the tide gates.

The design marsh plain will range in elevation from 4.8 to 6 ft, with varying elevations both in cross section and along the channel length. This range in elevations is expected to support a range of salt marsh plant species. Elevations below 4.5 ft in Martin Slough are not expected to support salt marsh vegetation and will be open channel or mudflat. Elevations between 4.5 and 6 are expected to support a range of marsh communities, including *Sarcocornia* Dominated Marsh and Mixed Marsh.

Marsh Plains A and B and Tidal Marsh Complex C are expected to be brackish to saline most of the year and are expected to support tidal marsh vegetation, thus were designed specifically to support salt marsh plant communities. Ponds D through F are expected to experience brackish to freshwater conditions throughout the year and are expected to support more freshwater marsh species. Pond G is expected to remain fresh year-round but it will be tidally-influenced and pond-water elevations are expected to vary with the tides.

1.3.7 Salinity and Expanded Aquatic Habitats

The salinity modeling indicated that for both current conditions and at full Project completion salinities fluctuate up and down with the tide and with freshwater inflows. Salinities increase in the downstream direction, with rising tides, and with drops in freshwater inflows. Conversely, salinities fall during freshwater inflow events and when the tide is falling. The Project modeled the salinities throughout the action area after project completion with the tidegates operating at the full design level. The Martin Slough Mainstem channel, as well as new and expanded ponds are expected to be more brackish downstream where tidal influence in greater. Conversely, ponds upstream will have a lower salinity closer to the tributary inlet where salinities are approximately 5 ppt. At the highest reaches of the Martin Slough Mainstem, ponds are expected to have salinities less than 1 ppt.

The Project will increase the amount of tidal channel and bordering pond habitats in the Project area. This additional aquatic habitat will also improve hydraulic connectivity. The Project will re-establish a muted tidal prism, which will improve adult salmonid migration and spawning runs to upstream tributaries. Table 1 contains the existing and projected aquatic habitat for the expanded pond areas only. The table does not include the expanded Martin Slough channel width and depth which would also provide increased aquatic habitat.

Table 1. Existing and Projected Habitat for Expanded Pond and Marsh Plain Areas in the Martin Slough Action Area

Expanded Ponds	Existing Habitat (Acres)	Projected Habitat (Acres)
Marsh Plain A	0	0.75
Marsh Plain B	0	2.3
Pond C (brackish)	0	1.7
Pond D (slightly brackish)	0.1	0.8
Pond E (Hole 17) (brackish)	0.2	1.3
Pond F (seasonally brackish)	0	1.7
Pond G (fresh)	0.10	0.5
North Fork (fresh)	0.12	0.8
Southeast tributary	0	0.2
SUBTOTAL	**0.52**	**10.05**
Riparian Habitat	**.50**	**9.23**
TOTAL HABITAT AREA	**1.02**	**19.28**

1.3.8 Golf Course Improvements

Currently, the golf course has numerous low areas on the floodplain that do not drain after storm events. Instead, the water ponds, increasing the potential for stranding of coho salmon as floodwaters recede and leave ponds that become isolated from the creek. As part of the Project design, the low ponding areas within the golf course will be filled to a minimum elevation of 7 ft so they drain towards the channel, reducing the likelihood of fish stranding and improving drainage to minimize flooding of the golf course.

The old tide gates had limited outflow capacity that increased the amount of time necessary for storm events to drain out of Martin Slough. The new tide gates have a much larger outflow capacity, reducing the amount of time it takes for flood flows to drain from Martin Slough. Channel excavation and replacement of the culvert at the barn on the NRLT property will improve conveyance of floodwaters and further reduce the duration of flooding. The added channel capacity and the enlarged ponds will also provide flood water detention, which will reduce the extent of flooding on adjacent pasture and golf course fairways.

1.3.10 Haul Roads

The construction of haul roads may be required to transport excavated materials from the channel corridor to City, County, and State Roads. Haul roads will also provide stable working and staging areas for excavation and loading activities. Haul road construction will depend on subgrade suitability, the size of the transport equipment to be used, the intensity of use, excavation/reuse locations, and identification of sensitive habitats and species.

1.3.11 Construction Dewatering and Stream Diversion Sequencing

During excavation within the channel, management of the stream flow will be required throughout the construction period. Preventing inflow into the active work zones (both tidal and freshwater) will be required to prevent aquatic and non-aquatic organisms from entering the construction site, to reduce the water to be managed in the active work area, and to reduce moisture content in the excavated soils. The MTRs will be taken out of service during construction activities so no tidewater will enter the Martin Slough channel and ponds. This will reduce the amount of water the excavation contractor has to work with when de-watering a work area. Inflow control practices include placement of temporary cofferdams to isolate the active work zone. The cofferdams may be comprised of native material, washed gravel encased with an impermeable geotextile or visqueen liner in combination with ecology blocks, and/ or water bladders. A combination of pumped and gravity diversion pipes will be used to route flow around the active work areas. Fish screens will be installed immediately upstream from the cofferdams to prevent aquatic organisms from being transported into the bypass pipe.

For all construction phases and areas, diversion of freshwater from the upstream cofferdam will be pumped or gravity piped and discharged onto pastures or fairways where it will be allowed to infiltrate into the ground. If needed, to prevent construction site water from returning directly to the stream through overland flow, shallow, temporary holding basins may be excavated in the pasture or fairways. Ponded storm or groundwater in construction areas will not be dewatered by Project contractors directly into adjacent surface waters or to areas where they may flow to surface waters unless authorized by a permit from North Coast Regional Water Quality Control Board (NCRWQCB). In the absence of a discharge permit, ponded water (or other water removed for construction purposes), will be pumped into adjoining fields to infiltrate if suitable, baker tanks, or other receptacles. If determined to be of suitable quality, some of this water may be used on-site for dust control purposes.

Lower Martin Slough Channel (MS 0+00 to MS 46+00), Including Ponds C and D
Cofferdams will be placed at the upstream and downstream end of the restoration area. Diverted flow will be pumped, gravity piped, or ditched and conveyed downstream of the active work zone. Prior to placement of temporary cofferdams, a qualified biologist will utilize seines to corral fish out of the construction limits and into adjoining waters.

Upper Martin Slough Channel Including Pond E and F
Prior to placement of temporary cofferdams, a fish biologist approved by project partners at NOAA and NMFS will utilize seines to corral fish to areas out of the construction limits and into adjoining waters including the newly constructed Ponds C and D. Fish that cannot be corralled to areas outside of the construction limits will be captured and relocated as the water is drawn down during de-watering.

Pond G
During the instream channel excavation, a combination of pumped and/or gravity diversion pipes and or ditches will be used to route flow around the active work areas. Cofferdams will be placed in the Martin Slough channel immediately upstream and downstream from work sites, which will typically be 1,000 ft long or less. The cofferdams will preclude freshwater and tidal inflow into the work zone during construction. Diversion of freshwater from the upstream cofferdam will be pumped or gravity piped through a temporary culvert that will discharge onto pastures or fairways where it will be allowed to infiltrate into the ground.

1.3.12 Revegetation

The goal of the revegetation plan is to create native, forested riparian, wetland, and tidal marsh habitats along the Martin Slough channel and expanded ponds. The excavated reaches of Martin Slough and expanded ponds will be revegetated with low growing brackish and freshwater wetland plants (sedges and rushes) and riparian forest (Sitka spruce, willow, wax myrtle, and alder). All areas disturbed during grading and other construction activities will be treated with erosion control seeding (includes native grasses, forbs, and shrubs). A combination of active planting and passive revegetation with invasive plant control will be used. Active planting will include re-seeding of pasture and golf course fairways and planting of trees and shrubs within the riparian zone. Brackish wetlands will be re-vegetated with a combination of active planting and passive revegetation which will include monitoring and invasive plant removal. Revegetation activities will occur after each construction season during the winter/spring months and will continue until project completion. Active vegetation maintenance will be regularly performed to ensure that the target riparian forest habitat develops along the riparian corridor areas.

1.3.13 Fish Relocation
Before any de-watering activities begin in any creeks or channels within the action area, cofferdams will be erected and all native aquatic vertebrates and larger invertebrates will be relocated out of the construction area into a flowing channel segment by a licensed fisheries biologist approved by project partners with NMFS and NOAA. In deeper or larger areas, water levels shall first be lowered to manageable levels using methods to ensure no impacts to fish and other special status aquatic species. A qualified fisheries biologist or aquatic ecologist will then perform appropriate seining, dip netting, or other trapping procedures to a point at which the biologist is assured that almost all individuals within the construction area have been caught. To minimize take, seining will be the primary method of fish removal where teams of qualified biologists will conduct 2-3 passes throughout the ponds and slough channels for fish removal. In the event where complex

woody or vegetated habitat is encountered, an electrofisher to remove the fish from the construction areas. If electrofishing is necessary, it will be conducted by properly trained personnel following the NMFS guidelines.[2]

Captured individuals will be kept in buckets or insulated coolers equipped with battery operated aerators to ensure survival, and will be relocated to an appropriate flowing channel segment or other appropriate habitat as identified by NMFS, CDFW, and/or the USFWS. Fish loss due to relocation efforts is expected to be very low, no more than 3 percent of those fish captured at any given Project site. Introduced species, particularly Sacramento pikeminnow, shall be documented and reported to CDFW and NMFS. Pikeminnow will be euthanized. Cofferdams will not be removed or tide gates opened until most sediment has settled, which will minimize water quality degradation from suspended sediment and turbidity in the estuary.

1.3.14 Fish Monitoring

As described in the Martin Slough Enhancement Project Monitoring Plan, "the essential purpose of the Project's monitoring activities is to raise a warning flag if the Project's enhancement design components or the current course of management actions are not working so that corrective actions and adaptive management may be applied while cost-effective and time sensitive solutions are still available." Additionally, the monitoring plan will help to gauge the effectiveness of the project once all work phases are fully complete. In developing the monitoring plan, the RCAA attempted to minimize the impact of monitoring efforts on fish species using non-destructive or low-impact sampling techniques. Mortalities of fish that are captured, handled and released is expected to be 1 percent or lower and mortalities of fish that are captured, PIT tagged and released are expected to be 3 percent or lower based on past monitoring conducted by the NOAA RC and CDFW. Monitoring for the Project includes two phases outlined below.

Construction Monitoring
During construction activities, monitoring efforts will be undertaken to avoid or minimize impacts to fish, with particular emphasis on listed species. Species and number of fish will be monitored during relocation prior to channel dewatering.

Post-construction Monitoring
Post-construction monitoring will occur annually beginning in 2017 and will continue for 5 years following project completion, as funding allows, for a total of 8 years. As of July 2017, monitoring funding has been secured for 3 years (Fall 2017 –March 2020) and additional phases of monitoring will be contingent upon additional grant funds. The post-construction monitoring will include CDFW's original 6 sites and add an additional 6 sites for a total of 12 sites. Monitoring will encompass both quantitative and qualitative measures in order to evaluate the Project's annual performance. CDFW or other qualified fisheries biologists will conduct monthly fish monitoring at the Project site, as funding allows, and funding is secure until March 2020. Specifically, the presence/absence of target fish species will be monitored in aquatic habitat re-established or enhanced on the Project site. In addition, native salmonid access to Martin Slough as well as

[2] National Marine Fisheries Service. (2000). Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act. Available at: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/electro2000.pdf.

terminal and off-channel ponds will be monitored. Methods are expected to include seine and minnow trap captures. Water quality samples will also be collected during fish monitoring. Temperature, salinity, water depth, dissolved oxygen, and conductivity will be recorded.

Monitoring Methods and Procedures

Seine

Three consecutive seine hauls will be conducted at each location in the evening using a 20-m x 2-m knotless mesh nylon bag seine. Net construction will consist of 6-millimeter (mm) mesh wing sections 9-m in length and a 3-mm mesh 2-m x 2-m bag section. The seine will be set by 2-3 crew members in a round haul fashion by fixing one end on the beach while the other end is deployed wading upstream and returning to shore in a half circle. Once the lead line approaches the shore it will be withdrawn more than the cork line until fish are corralled in the bag and the lead line is on the beach. Each haul is expected to take approximately 5 minutes. Fish from each haul will be kept separated and placed in aerated 5-gallon buckets prior to processing. Sampling will occur at each site once per month. Sampling will cease if water quality conditions are unfavorable to the health of the fishes or if water temperatures exceed 21°C.

Minnow Traps

Galvanized 5-mm square wire mesh minnow traps will be baited with iodine soaked roe and set. The minnow traps are 430-mm in length with a middle circumference of 760-mm and fyke openings of 25-mm at both ends. The number of traps deployed at sites within reaches will be determined by the probability of detection of Coho Salmon (1-3). Traps will be fished at each site on the bottom of the channel next to habitat structures if possible. Soak time of individual traps will range from 30 to 180 minutes. Sampling will occur at each site once per month. Sampling will cease if water quality conditions are unfavorable to the health of the fishes or if water temperatures exceed 21°C.

Procedures Used

Salmonids captured by seine or minnow traps will be anesthetized using Alka Seltzer Gold in order to safely handle them. All of the fish will be measured for fork length, weighed, and scanned for PIT tags.

Anesthetic

Fish will be closely observed in an anesthetic bath of Alka –Seltzer Gold (aspirin free) brand sodium bicarbonate ($NaHCO_3$) until loss of equilibrium is achieved but operculum movement is still present. The lowest concentration of sodium bicarbonate that will permit safe handling will be used and will range from 1 to 2 tablets per gallon of fresh river water depending on fish size and water temperature. The bicarbonate material will be allowed to completely dissolve before fish are added to the anesthetic bath. Fry and juveniles will be anesthetized in groups of <10 fish and larger parr and smolts will be anesthetized in groups of 2 fish. Salmonids should be able to be handled after 1-2 minutes in the anesthetic bath and will be processed immediately following loss of equilibrium. Fish will be allowed to recover in 5-gallon buckets of aerated fresh river water until normal behavior is observed. Water temperature in the recovery bucket will be monitored and maintained to be within 2°C of the ambient river temperature. Fish will be released to slow water habitat in the location in which they were originally found.

Measure/Weigh

While anesthetized, juveniles are individually placed onto a wetted Plexiglas measuring board and measured to the nearest mm fork length, then transferred to a wetted container on an electronic scale and individually weighed to the nearest 0.01 g.

PIT Tagging

Anesthetized fish greater than or equal to 70-mm fork length may only be implanted with 12-mm tags or smaller, fish 60-mm FL to 69-mm FL may only be implanted with 9-mm tags or smaller, and fish <60-mm cannot be tagged. A full duplex PIT tag that is surgically implanted into the body cavity of the fish will be used as described by Prentice *et al.* (1990). A small incision will be made with a sterile scalpel anterior to the pectoral fin and the tag will be inserted by hand, into the body cavity of the fish.

1.3.15 Construction Erosion/Sediment Control Best Management Practices and Conservation Measures

Best Management Practices (BMPs) that will be implemented as part of the Pollution Prevention and Monitoring Plan will include:

- Cofferdams or other temporary fish screens/water control structures will be placed in the channel during low tide, and will only be removed during low tide (if possible), after work is completed.
- Equipment will not be operated directly within tidal waters or stream channels of flowing streams, until after fish removal efforts have been completed.
- Silt fences and or silt curtains will be deployed in the vicinity of the cofferdams, at excavation sites, and culvert installation and removal areas to prevent any sediment from flowing into the creek or wetted channels.
- Sediment sources will be controlled using fiber rolls, straw, filter fabric, sediment basins, and/or check dams that will be installed prior to or during grading activities and removed once the site has stabilized.
- Erosion control may include seeding, mulching, erosion control blankets, plastic coverings, and geotextiles that will be implemented after completion of construction activities.
- Excess water will be pumped into the surrounding fields to prevent sediment-laden water from entering the stream channel. A maximum 1/16-in opening mesh screen will be used around pump inlets to prevent the potential entrainment of fish species during dewatering.
- Appropriate energy dissipation devices will be utilized to reduce or prevent erosion at discharge end of dewatering activity.
- Turbidity monitoring will be conducted in Martin Slough during the site stabilization period to ensure that water quality is not being degraded. Turbid water will be contained and prevented from being transported in amounts that are deleterious to fish, or in amounts that could violate state pollution laws. Sediment will not travel 500 ft beyond work sites.
- Construction materials, debris, and waste will not be placed or stored where it can enter into or be washed by rainfall into waters of the U.S./State.
- Equipment, when not in use, will be stored outside of the slough channel and above high tide elevations in designated staging areas.

- All construction equipment will be maintained to prevent leaks of fuels, lubricants, or other fluids into the slough. Service and refueling procedures will not be conducted where there is potential for fuel spills to seep or wash into any waterways.
- Extreme caution will be used when handling and/or storing chemicals and hazardous wastes (*e.g.*, fuel and hydraulic fluid) near waterways. Appropriate materials will be on site to prevent and manage spills.

The proposed Project requires dewatering parts of the stream including salmonid habitat. Prior to dewatering, the applicant proposes to implement the following measures to minimize potential Project effects:

1. Construction activities will only occur between June 15 and October 15 (or November 15 if there is no significant rain event) to avoid or minimize adverse impacts to fish to minimize soil compaction and sediment transport.

2. Equipment will not be operated directly within tidal waters or stream channels of flowing streams.

3. To the extent feasible, work will be done during low tide when no water or fish are present, which will temporarily prevent sensitive fish species from gaining access to the vicinity of the work area. If water is present, the work area will be seined 3-mm (1/16-in mesh)) and a fish screen installed (3-mm (1/16-in mesh)) to isolate the work area.

4. All exposed soil surfaces will be mulched and seeded with appropriate native seed, when the work has been completed.

5. Upland areas will be used for equipment refueling. If equipment must be washed, washing will occur where wash water cannot flow into wetlands or waters of the U.S./State.

1.3.16 Mitigation and Avoidance Measures

The Project is expected to be self-mitigating. The components discussed below are included in the Project description.

Establishment of Habitat
The Project will increase the amount of tidal channel and bordering pond and riparian habitats and decrease the amount of agricultural grassland and developed lands in the action area. This will provide additional overwintering and rearing habitat for salmonids and improve hydraulic connectivity and re-establish a muted tidal prism, which will allow for adult salmonid migration and spawning runs to upstream tributaries. Table 2 contains the existing and projected salmonid habitat. The table does not include the expanded Martin Slough channel width and depth which would also provide increased habitat for salmonids.

Table 2. Existing and Projected Salmonid Habitat in the Martin Slough Action Area

Pollution Prevention and Monitoring Plan
As part of the Pollution Prevention and Monitoring Plan (PPMP), BMPs for controlling soil erosion and the discharge of construction-related contaminants will be developed and monitored for successful implementation.

Minimize Potential Pollution Caused by Inundation
Sites will not be inundated (connected to tidal water or upstream freshwater sources) until surface soil conditions have been stabilized, all construction debris removed, and all surface soils have been removed from the site.

Instream Erosion and Water Quality Control Measures during Channel Excavation
In instances where excavation and/or dredging occurs in an effort to widen/deepen the existing channel, in-stream erosion and turbidity control measures will be implemented.

Minimize Removal of and Damage to Native Vegetation

Ponded storm or groundwater in construction areas will not be dewatered by Project contractors directly into adjacent surface waters or to areas where they may flow to surface waters unless authorized by a permit from the NCRWQCB. In the absence of a discharge permit, ponded water (or other water removed for construction purposes), will be pumped into baker tanks or other receptacles, characterized by water quality analysis, and remediated (*e.g.*, filtered) and/or disposed of appropriately based on results of analysis.

1.4 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 includes those areas of land, water and air 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 is determined in part by the proposed project activities, site geography, topography and hydrology, and an understanding of the distribution, habitat requirements, phenology, and vulnerability of special-status species potentially occurring in the action area.

The action area (Figure 5) encompasses the anticipated footprint of the proposed construction activity and construction staging areas as described in Section 1.3. The action area includes the Martin Slough floodplain extending beyond the limits of work slightly to the west and northwest to encompass the tide gates replaced in 2014 and a 500-foot (ft) buffer area around the site to account for any potential temporary increase in turbidity downstream of the work. It also accommodates the potential for noise, vibration, or other temporary disturbance during construction. Because the tide gates will be closed during construction, downstream influence is expected to be minimal.

The action area is located in and adjacent to the southern portion of the City of Eureka and terminates at its confluence with Swain Slough as shown in Figure 6. The mouth of Martin Slough is separated from Swain Slough by a berm and tide gates. The Martin Slough watershed includes both City and County jurisdictions, with the action area owned by the City of Eureka (approximately 120 ac) and two private landowners (approximately 40 ac and 110 ac) whose ownerships are comprised of multiple assessor's parcels. The action area is partially within the coastal zone.

The action area is currently zoned Agriculture Exclusive (60 ac minimum) and Public Facility. Municipal infrastructure directly within the action area includes the City maintained Fairway Drive, three natural gas lines, sewer lines and a pump station, and the Eureka Municipal Golf Course. The Humboldt Community Services District also has existing sewer infrastructure and water lines near Pine Hill Road.

Martin Slough has a watershed area of approximately 5.4 square miles (mi^2) and natural channel length of over 10 mi, with approximately 7.5 mi of potential fish habitat. The lower portion of the watershed flows through low gradient bottomland containing the golf course and pastureland. Many of the stream channels flow from gulches that contain mature second-growth redwood forests. The upper portions of the watershed are either in urban settings, or are recently harvested timber lands slated for future residential and commercial development. The action area consists of the Martin Slough flood plain between Swain Slough and the upper (second) Fairway Drive stream crossing in the lower Martin Slough watershed (Figure 6).

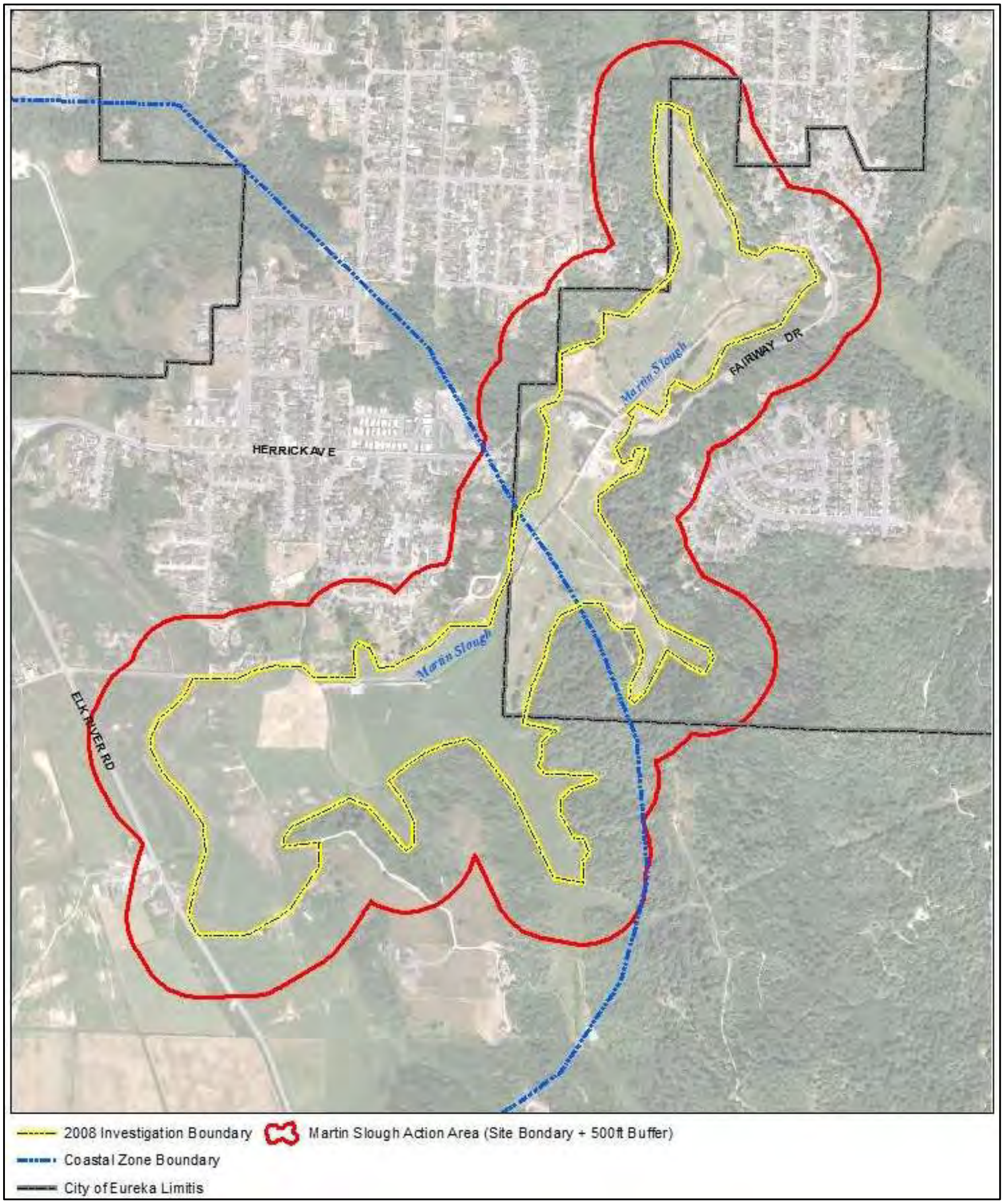

Figure 5. Martin Slough Action Area

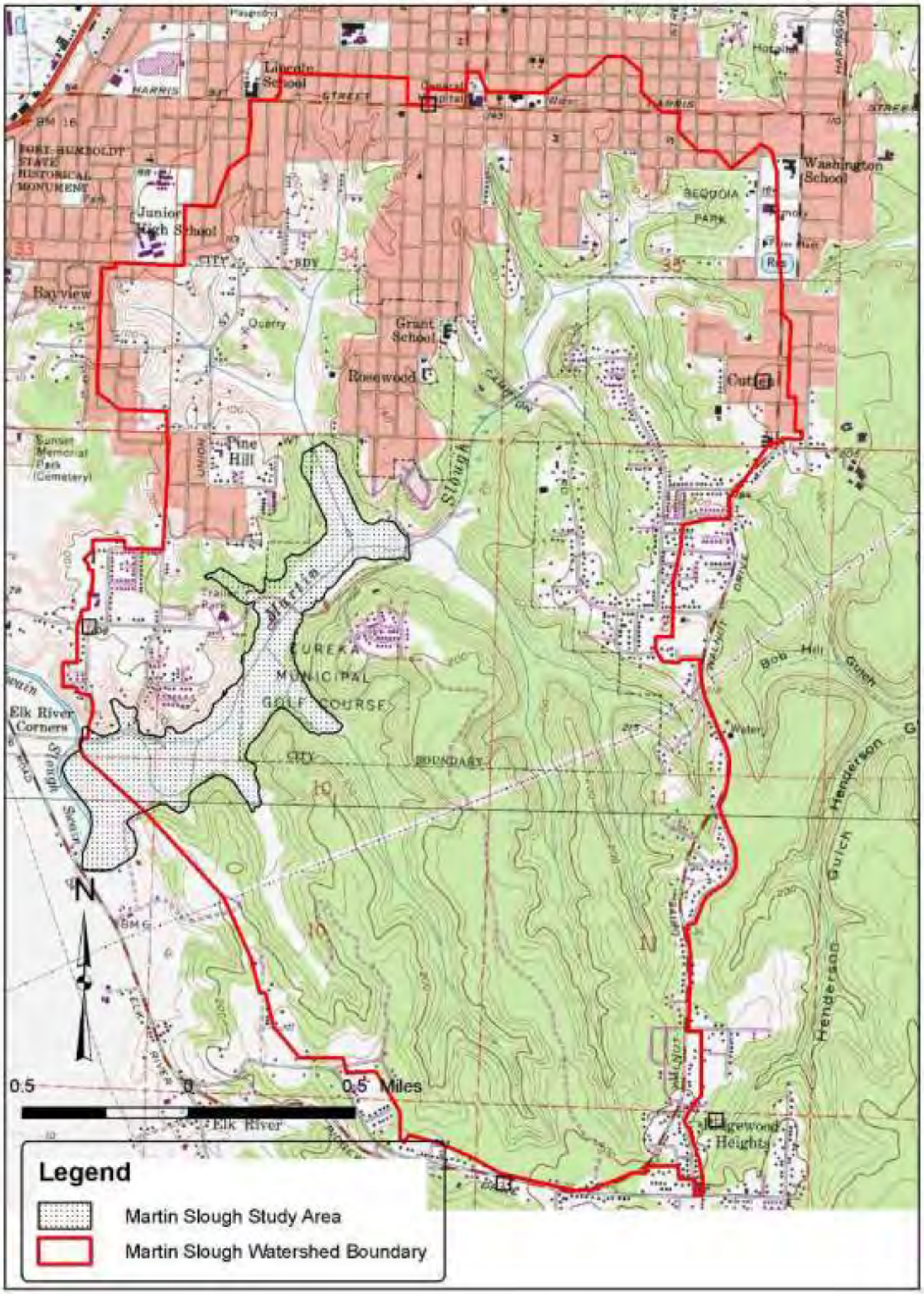

Figure 6. Martin Slough Enhancement Project Site and Watershed Boundary

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides 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 incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or 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).

The designations of critical habitat for species use the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace 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.

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 rangewide status of the species and critical habitat expected 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 by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a RPA to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

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 PBFs that help to form that conservation value.

NMFS has determined that the following species and critical habitat occur within the action area:

Southern Oregon/Northern California Coast (SONCC) coho salmon ESU
(*Oncorhynchus kisutch*)
Threatened (70 FR 37160; June 28, 2005)
Designated critical habitat (64 FR 24049; May 5, 1999);

California Coastal (CC) Chinook Salmon ESU
(*O. tshawytscha*)
Threatened (70 FR 37160; June 28, 2005)
Designated critical habitat (70 FR 52488; September 2, 2005);

Northern California (NC) steelhead DPS
(*O. mykiss*)
Threatened (71 FR 834; January 5, 2006)
Designated critical habitat (70 FR 52488; September 2, 2005).

2.2.1 Climate Change

One factor affecting the rangewide status of SONCC coho salmon, CC Chinook salmon and NC steelhead, and aquatic habitat at large, is climate change. Large reductions in available freshwater habitat due to climate change negatively impacts salmonids throughout the Pacific Northwest (Battin *et al.* 2007). Widespread declines in springtime snow water equivalent (SWE), the amount of water contained in the snowpack, have occurred in much of the North American West since the 1920s, especially since the mid-1900s (Knowles and Cayan 2004, Mote 2006). This decrease in SWE can be largely attributed to a general warming trend in the western United States (Mote *et al.* 2005, Regonda *et al.* 2005, Mote 2006), even though there have been modest upward trends in precipitation in the western United States since the early 1900s (Hamlet *et al.* 2005). The largest decreases in SWE are taking place at low to mid elevations (Mote 2006, Van Kirk and Naman 2008) because the warming trend overshadows the effects of increased precipitation (Hamlet *et al.* 2005, Mote *et al.* 2005, Mote 2006). These climactic changes have resulted in earlier onsets of springtime snowmelt and streamflow across western North America (Hamlet and Lettenmaier 1999, Regonda *et al.* 2005, Stewart *et al.* 2004), as well as lower flows in the summer (Hamlet and Lettenmaier 1999, Stewart *et al.* 2004).

The projected runoff-timing trends over the course of the twenty-first century are most pronounced in the Pacific Northwest, Sierra Nevada, and Rocky Mountain regions, where peak streamflow (temporal centroid of streamflow each year) change has recently amounted to 20 - 40 days at many streams (Stewart *et al.* 2004). Although climate models diverge with respect to future trends in precipitation, there is widespread agreement that the trend toward lower SWE and earlier snowmelt will continue (Zhu *et al.* 2005, Vicuna *et al.* 2007). Thus, availability of water resources under future climate scenarios is expected to be most limited during the late summer (Gleick and Chalecki 1999, Miles *et al.* 2000). A one-month advance in timing centroid of streamflow would also increase the length of the summer drought that characterizes much of western North America, with important consequences for water supply, ecosystems, and wildfire management (Stewart *et al.* 2004). These changes in peak streamflow timing and snowpack will negatively impact salmonid populations due to habitat loss associated with lower water flows, higher stream temperatures, and increased human demand for water resources.

Climate change has potential negative implications for the current and future status of ESA-listed fish in the Pacific Northwest. NMFS reviewed recent studies on the potential effects of climate change in the Columbia River basin and the likely impacts on salmonids. The Independent Scientific Advisory Board (ISAB) described potential impacts of climate change that may result in alterations to the seasonal hydrograph, constrain habitat availability and accessibility, alter precipitation and temperature levels and, in particular, impact the various life-stages of salmon and steelhead (NMFS 2008). Long-term effects of this climatic variation on salmon and steelhead may include, but are not limited to, depletion of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to species migration patterns, accelerated embryo development, premature emergence of fry, and increased competition among species. Global effects of climate change on river systems and anadromous fish are often superimposed upon the local effects of logging, water utilization, harvesting, hatchery interactions, and development within river systems (Bradford and Irvine 2000, Mayer 2008, Van Kirk and Naman 2008).

Climate change is expected to detrimentally affect SONCC coho salmon, CC Chinook salmon, and NC steelhead in freshwater, estuarine, and ocean habitats (Williams *et al.* 2011a, 2011b, 2011c; NMFS 2014). Climate change affects the rangewide status of SONCC coho salmon, CC Chinook salmon, and NC steelhead by altering their aquatic habitat through freshwater temperature regimes which are exacerbated when degraded riparian conditions already support fewer salmon than historical, unaltered conditions. Climate change can play a major role in the life cycle, productivity, and persistence of coho and Chinook salmon, and steelhead populations and can cause extreme conditions that can be catastrophic to salmonid populations (Battin *et al.* 2007, Waples *et al.* 2009, Mantua *et al.* 2010).

The effects of climate change on SONCC coho salmon, CC Chinook salmon, and NC steelhead create the possibility of less-productive ocean conditions and warming of freshwater that increases bio-energetic and disease stresses on anadromous fish. In addition, as climate change reduces the carrying capacity of the habitat within the range of SONCC coho salmon, CC Chinook salmon, and NC steelhead, species viability may be more difficult to achieve (Waples 2002, Wade *et al.* 2013, NMFS 2014). The reduced genetic diversity resulting from depressed population size may limit the ability of individuals to adapt to changing climatic conditions (Beechie *et al.* 2006, McClure *et al.* 2008, Waples *et al.* 2008). For those populations already limited by thermal stress, distribution, migratory alterations, and developmental processes associated with overall population fitness, climate change will likely further alter and/or disrupt those populations (Mantua *et al.* 2010).

2.2.2 SONCC Coho Salmon

On July 19, 1995, NMFS announced its status finding and intent to propose SONCC coho salmon evolutionarily significant unit (ESU), which includes populations spawning from the Elk River (Oregon) in the north to the Mattole River (California) in the south, as threatened under the federal ESA. NMFS published its final decision to list coho salmon as threatened under the federal ESA on May 6, 1997 (62 FR 24588).

On May 5, 1999, NMFS announced designation of critical habitat for coho salmon in the Federal Register (64 FR 24049). Designated critical habitat includes all river reaches accessible to listed coho salmon between Cape Blanco, Oregon and Punta Gorda, California. Accessible reaches are those within the historic range of the ESU that can still support any life stage of coho salmon. Designated critical habitat also includes the adjacent riparian zone, which is defined as the area adjacent to a stream that provides shade, sediment, nutrient or chemical regulation, stream bank stability, and is a source of large woody debris or organic matter (64 FR 24049). The Martin Slough Enhancement site and associated action area are within the designated critical habitat for SONCC coho salmon.

In 2005, NMFS reaffirmed SONCC coho salmon status as a threatened species and also listed three hatchery stocks as part of the ESU (70 FR 37160; June 28, 2005). In 2006, Williams *et al.* described the historical population structure of coho salmon in the SONCC coho salmon ESU based on the location and amount of potential coho salmon habitat, with an assumption that the relative abundance of different populations mirrored the amount of intrinsic potential (IP) habitat in each watershed. In 2008, Williams *et al.* then described the SONCC coho salmon historical population structure as containing 19 functionally independent populations, 12 potentially independent populations, and 17 small dependent populations, and two ephemeral populations. Williams *et al.* (2008) also organized the independent and dependent populations of coho salmon in the SONCC ESU into diversity strata largely based on the geographical arrangement of these populations and basin-scale environmental and ecological characteristics.

NMFS completed a status review of the SONCC coho salmon ESU (Williams *et al.* 2011a) and determined that the ESU, although trending in declining abundance, should remain listed as threatened. The primary factors affecting diversity of SONCC coho salmon appear to be low population abundance, ocean survival conditions, and drought effects (Williams *et al.* 2011a). The most recent status review was completed in 2016, and NMFS determined that drought and ocean conditions seem to be driving recent declines in abundance, however there does not appear to be a change in extinction risk since the 2011 status review (Williams *et al.* 2016).

Life History

Coho salmon are semelparous salmonids, spending the first half of their life cycle rearing in streams and small freshwater tributaries (Table 3). The remainder of the life cycle is spent foraging in estuarine and marine waters of the Pacific Ocean before returning to their stream of origin to spawn and die. Nearly all adult coho salmon returning to spawn in the coastal systems along the northern California coast system enter the estuary in December and January, spawn by mid-winter, and then die. Most spawning adults are three-years old; however, some a small percentage (5–20 percent) of precocious males known as "jacks" return to spawn as two-year olds (Weitkamp *et al.* 1995). Eggs incubate in redds (gravel spawning nests) for 1-3 months, depending on the water temperature, before emerging as alevins (larval life stage that depends upon yolk sacs as its food source). Alevins emerge as fry from February to May and initially congregate in shaded backwaters, side channels, or small streams where the stream velocity is less.

Juvenile rearing usually occurs in tributary streams with a gradient of 3 percent or less, although they may move up to streams of 4 or 5 percent gradient. Juveniles occupy streams as small as 1 to 2-meters (m) wide. They may spend 1 to 2 years rearing in freshwater (Bell and Duffy 2007), or emigrate to lower river and estuary habitat as age 0+ juveniles (Tschaplinski 1988, Koski 2009). Emigration of age 0+ coho salmon is not as common as emigration at age 1 or 2, but represents an important nomadic life history diversity strategy that adds resilience to populations (Koski 2009). Coho salmon juveniles are also known to redistribute into non-natal rearing streams, lakes, or ponds, often following rainstorms, where they continue to rear (Peterson 1982). As small as 38 to 45-mm long, fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Sandercock 1991, Nickelson *et al*. 1992). Emigration from streams to the estuary and ocean generally takes place from March through May. Peak outmigration timing generally occurs in May, with some runs earlier or later, and with most smolts measuring 90 to115-mm fork length.

As fry grow, they migrate to habitats with complex cover such as undercut banks, root wads, large woody debris (LWD) and vegetative overhangs. Instream habitat complexity, including a mixture of pools and riffles, LWD, and well oxygenated cool water (10-15°C/50-59°F) are important habitat components for coho salmon fry (Sandercock 1991, Moyle 2002).

The most productive coho salmon nursery habitats tend to be small streams having a larger ratio of slack water to midstream area (Sandercock 1991). Fry typically rear in freshwater for up to 15 months, migrating to the ocean in the spring as smolts. Coho salmon typically spend two growing seasons in the ocean before returning to their natal stream to spawn. In the estuary, smolts often linger for a period, moving up and down with tidal currents, suggesting that period of estuarine residence is preferred for adjusting their osmoregulatory system to seawater (Nielsen 1994). In Martin Slough, little to no coho salmon spawning occurs. Instead, young of the year (YOY) primarily use the area during the summer and fall, while yearlings use the slough year-round, with the greatest numbers recorded in the winter and spring. Mean residence rearing time for yearlings in the slough varies from a few weeks to nine months (Wallace *et al.* 2015). Adults typically spend the next two years in the ocean before returning to their home streams to spawn (Wallace 2010).

Table 3. Typical Life history of SONCC ESU Coho Salmon in North Coast California Streams

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Migration	■										■	■
Spawning	■	■	■									■
Incubation	■	■	■									■
Rearing (age 0)	■	■	■	■	■	■	■	■	■	■	■	■
Rearing (age 1)	■	■	■									

Source: (CDFG 2002; NMFS 2012)

Survival and distribution of juvenile coho salmon have been associated with available winter habitat (Bustard and Narver 1975, Peterson 1982, Tschaplinski and Hartman 1983, Nickelson *et al.* 1992, Quinn and Peterson 1996). Both instream cover and off-channel habitats that provide slow water are essential to juvenile coho salmon for protection against displacement by high flows and as for cover from predation (Bustard and Narver 1975, Mason 1976, Solazzi *et al.* 2000). Juvenile coho salmon appear to prefer deep (greater than 1.5 ft), slow water (less than 1 ft per second [fps]) habitats within or near cover of roots, large wood, or flooded brush (Bustard and Narver 1975), especially during freshets (Tschaplinski and Hartman 1983, Swales *et al.* 1986, McMahon and Hartman 1989).

During the fall and spring, juvenile coho salmon often make seasonal or temporary shifts to off-channel areas that provide key winter habitat features when temperatures drop and base flow rises (Scarlett and Cederholm 1984, Bell *et al.* 2001). These off-channel habitats provide low velocity rearing areas, often with ample foraging opportunities (Bell *et al.* 2001). Overwintering coho salmon are often found in slower velocity habitats such as floodplains, sloughs, alcoves, backwaters, beaver ponds, and complex or deep in-channel habitats associated with large wood. Off-channel ponds are important winter rearing areas for juvenile coho salmon, and growth rates of juveniles in off-channel habitats were greater than those in the mainstem river (Morley *et al.* 2005, Swales and Levings 1989, Brown and Hartman 1988).

Diversity

Williams *et al.* (2006) classified SONCC coho salmon populations as dependent or independent based on their historic population size. Independent populations are populations that historically would have had a high likelihood of persisting in isolation from neighboring populations for 100 years and are rated as functionally independent (FI) and potentially independent (PI). Core populations are independent populations judged most likely to become viable most quickly. Non-core 1 population types are independent populations judged to have lesser potential for rapid recovery than the core populations. Non-Core 2 populations were identified in response to the requirement that “most” (not all) independent populations should be at moderate risk of extinction, which allows that some independent populations do not need to be either at moderate risk or low risk. For some independent populations, there is little to no documentation of coho salmon presence in the last century, and prospects are low for the population to recover to numbers at least four spawners per IP-km. These populations are categorized as Non-Core 2 populations (NMFS 2014). Dependent populations are populations that historically would not have had a high likelihood of persisting in isolation for 100 years. These populations relied upon periodic immigration from other populations to maintain their abundance. Two ephemeral populations are defined as populations both small enough and isolated enough that they are only intermittently present (McElhany *et al.* 2000, Williams *et al.* 2006, NMFS 2014). The SONCC coho salmon population that overlaps with the Martin Slough Enhancement Action Area is in the Southern Coastal Stratum, Humboldt Bay Tributaries Population, which is a functionally independent, Core population that has a moderate risk of extinction. The key limiting stresses for the Humboldt Bay Tributaries Population include lack of floodplain and channel structure and impaired estuary/mainstem function, and the key limiting threats include roads and channelization/diking (NMFS 2014).

Given the recent trends in abundance across the ESU, the genetic and life history diversity of populations is likely very low and is inadequate to contribute to a viable ESU. Williams *et al.* 2011a indicated that the biological status of the SONCC coho salmon ESU has worsened since 2005, and the primary factors currently affecting diversity of SONCC coho salmon appear to be low population abundance, ocean survival conditions, and drought.

Distribution

The historical population structure (Williams *et al.* 2006), coho salmon status reviews (Good *et al.* 2005, Williams *et al.* 2011a), and the presence and absence update for the northern California portion of the SONCC coho salmon ESU (Brownell *et al.* 1999) summarize historical and current distributions of SONCC coho salmon in northern California.

The distribution of SONCC coho salmon within the ESU is reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which SONCC coho salmon are now absent (NMFS 2001, Good *et al.* 2005, Williams *et al.* 2011a). Scientists at the NMFS Southwest Fisheries Science Center compiled a presence-absence database for the SONCC coho salmon ESU (NMFS 2014) using information for coho salmon streams listed in Brown and Moyle (1991), as well as other streams where NMFS found historical or recent evidence of coho salmon presence. Brown and Moyle (1991) identified 396 streams within the ESU as historic coho salmon streams.

Using the NMFS database, Good *et al.* (2005) compiled information on the presence of coho salmon in streams throughout the SONCC ESU, which closely matched the results of Brown and Moyle (1991). Garwood (2012) compiled coho salmon data through 2004 to generate a historical coho salmon stream list for the California watersheds of the SONCC ESU. Garwood (2012) verified the presence of juvenile coho in 325 of the streams from the Brown and Moyle (1991) study, and identified 217 additional streams. From 2001 to 2003, CDFG conducted 628 surveys in 301 streams across the California portion of the SONCC ESU. Coho salmon were detected in 153 of 245 sampled historic coho salmon streams (Garwood 2012).

The number of streams and rivers currently supporting coho salmon in this ESU has been greatly reduced from historical levels, and watershed-specific extirpations of coho salmon have been documented (Brown *et al.*1994, CDFG 2004, Good *et al.* 2005, Moyle *et al.* 2008, Yoshiyama and Moyle 2010). In summary, information on the SONCC ESU of coho salmon indicates that their distribution within the ESU has been reduced and fragmented, as evidenced by an increasing number of previously occupied streams from which they are now absent (Williams *et al.* 2011a). However, extant populations can still be found in all major river basins within the ESU (70 FR 37160).

Given that all diversity strata are occupied (Williams *et al.* 2011a), the spatial structure of the SONCC coho salmon ESU is broadly distributed throughout its range. However, extirpations, loss of brood years, and sharp declines in abundance (in some cases to zero) of SONCC coho salmon in several streams throughout the ESU indicate that the SONCC coho salmon's spatial structure is more fragmented at the population-level than at the ESU scale.

Abundance
Quantitative population-level estimates of adult spawner abundance spanning more than 9 years are scarce for the SONCC ESU coho salmon. New data since publication of the previous status review (Good *et al.* 2005) consists of continuation of a few time series of adult abundance, expansion of efforts in coastal basins of Oregon to include SONCC ESU coho salmon populations, and continuation and addition of several population scale monitoring efforts in California. Other than the Shasta River and Scott River adult counts, reliable current time series of naturally produced adult spawners are not available for the California portion of the SONCC ESU at the population scale.

Although long-term data on coho salmon abundance are scarce, the available evidence from short-term research and monitoring efforts indicate that spawner abundance has declined since the last status review for populations in this ESU (NMFS 2016). In fact, most of the 30 independent populations in the ESU are at high risk of extinction because they are below or likely below their depensation threshold, which can be thought of as the minimum number of adults needed for survival of a population.

Populations that are under depensation have increased likelihood of being extirpated. To summarize conditions across the ESU, extirpations have already occurred in the Eel River basin and are likely in the interior Klamath River basin for one or all year classes (*e.g.*, Shasta and Scott rivers), Bear River, and Mattole River. Population abundance is uncertain as surveys are few and the results are variable. The Bear River population has a conspicuous absence of coho salmon. Surveyed streams in the Humboldt Bay Tributaries population indicate regular adult abundance greater than depensation (191), while the adult abundance is likely below depensation in the Lower Eel/Van Duzen and Mattole Rivers populations (NMFS 2014). All populations show evidence of decline in all three cohorts, except for Bear River which has no evidence of coho salmon being present.

Coho salmon are found well-distributed throughout the Humboldt Bay tributaries and estuary. However, they are found in less than a quarter of IP habitat in the Mattole River and Lower Eel / Van Duzen River populations – likely as a result of degraded or inaccessible habitat or lack of survey effort. In 2008, coho salmon adult spawners were found in just one Mattole River tributary (NMFS 2014).

Williams *et al.* (2008) determined at least 191 coho salmon must spawn in the Humboldt Bay tributaries each year to avoid effects of extremely low population sizes. The population size of the Humboldt Bay tributaries population is unknown, but the most recent redd abundance estimates for the population were 194 redds in 2009-10 and 2,002 redds in 2010-11 (Ricker, S., personal communication 2011). The trend in Freshwater Creek adult abundance estimates (Figure 7) indicates adult escapement has declined since 2002-03, ranging from a high of 1,807 in 2002-03 to a low of 89 in 2009-10 (Moore and Ricker 2012). However, all three cohorts have experienced slight increases in abundance over the past three years. Published values of marine survival for wild populations of coho salmon range from 29 percent to 0.6 percent and average near 10 percent.

Estimates of coho salmon marine survival from Freshwater Creek for 2007 (2.66 percent) and 2008 (0.85 percent) smolt cohorts are below this average and likely contribute largely to the short term negative trend in adult escapement (Ricker and Anderson 2011). Although the number of juvenile coho salmon emigrating from Freshwater Creek tributaries has remained relatively constant over 8 years, and is estimated at 3,000 individuals (Ricker 2008), there appears to be a large variation in the annual number of juvenile coho salmon rearing in the stream-estuary ecotone. In Freshwater Slough, the catch per unit effort of young-of-the-year coho salmon caught by the California Department of Fish and Game (CDFG) declined between 2005 and 2008.

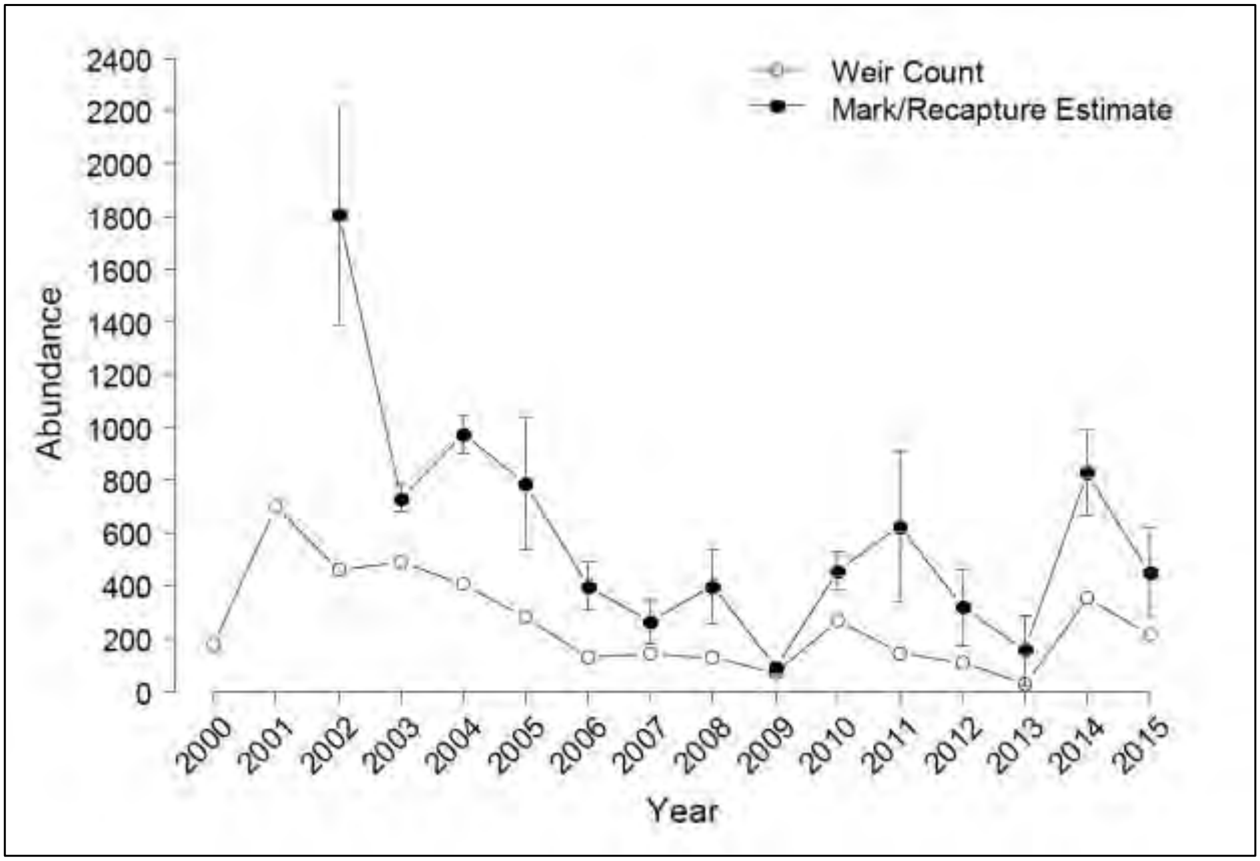

Figure 7. Adult coho salmon weir counts and escapement estimates (± 95% confidence intervals) in Freshwater Creek for survey years 2002 through 2015. (Anderson and Ward 2016).

Although annual spawner escapement in Jacoby Creek is unknown, monitoring in Morrison Gulch following the removal of a fish passage barrier indicates the number of live adult coho salmon (10 individuals) observed in 2008 to 2009 were the lowest since 2001; and the overall eight-year trend in returning adult coho salmon and constructed redds in Morrison Gulch was downward (Taylor and Associates 2009). CDFG spawner and redd surveys of index reaches in Elk River (South Fork, Upper North Fork, and Lower North Fork) varied in number both among years and among locations so no direct comparison among years is possible (Collins 2008). Overall, the trend is a decline in number of live fish observed in Elk River at these locations.

To contribute to stratum and ESU viability, the Humboldt Bay Tributaries core population needs to have at least 5,700 spawners. Sufficient spawner densities are needed to maintain connectivity and diversity within the stratum and continue to represent critical components of the evolutionary legacy of the ESU. Besides its role in achieving demographic goals and objectives for recovery, as a core population the Humboldt Bay Tributaries population fulfills other needs within the Southern Coastal stratum. The Humboldt Bay Tributaries population may serve as a source of spawner strays, including for the extremely depressed Mattole River population to the south and the Mad River to the north.

Juvenile coho salmon are regularly observed in Martin Slough as evidenced by repeated captures during surveys from 2014 to 2016 (Table 4). Yearlings and young of year coho salmon may be present at any season. Adult coho salmon could potentially be present only during the early winter spawning period, and may be present only in small numbers.

Table 4. Number of Juvenile Coho Salmon Captured by Month in Martin Slough, October 2014 to January 2017 (Wallace 2017)

Date	Yearling Coho	YOY Coho
October 2014	0	0
November 2014	0	0
December 2014	1	2
January 2015	13	0
February 2015	9	0
March 2015	16	0
April 2015	37	0
May 2015	37	0
June 2015	1	0
July 2015	0	1
August 2015	0	0
September 2015	0	0
October 2015	0	0
November 2015	0	2
December 2015	0	4
January 2016	13	0
February 2016	113	0
March 2016*	10	0
April 2016	83	0
May 2016	52	0
June 2016	7	0
July 2016	2	1
August 2016	0	0
September 2016**	0	0
October 2016	0	0
November 2016	0	14
December 2016	1	121
January 2017	7	0
Total	***288***	***143***
*high water levels likely reduced catch **no sampling in 17th hole pond due to large amounts of algae		

2.2.3 CC Chinook Salmon

The CC Chinook salmon ESU was listed as a threatened species in 1999 (64 FR 50394) and included all Chinook populations from streams immediately south of the Klamath River in northern California to and including the Russian River. The threatened status of this ESU was reaffirmed in 2005 and seven small artificial propagation programs were also added to the listed ESU (70 FR 37160). NMFS determined that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU. Since 2005, all seven artificial programs have been terminated and all hatchery fish from these programs have returned to spawn. Genetic data from Chinook salmon populations spawning in streams south of the Russian River and in several tributaries to San Francisco Bay suggest that populations spawning between the Russian River and Golden Gate are part of the CC Chinook salmon ESU (Williams *et al.* 2011b) and that the southern boundary of the ESU should be moved southward to the Golden Gate.

Bjorkstedt *et al.* (2005) determined that the CC Chinook salmon ESU historically comprised 15 independent populations (*i.e.*, 10 functionally independent and 5 potentially independent) of fall run Chinook salmon and six independent populations (all functionally independent) of spring-run Chinook salmon. The lack of data on Chinook salmon in smaller watersheds within this ESU, none of which currently support persistent populations of Chinook salmon, confounded efforts to identify dependent populations. The TRT tentatively identified 17 watersheds as possibly supporting dependent populations, but suggested that perhaps only two of these were consistently occupied by Chinook salmon. Populations were assigned to four geographically based strata, with two of these strata further subdivided into fall-run and spring run life history types (Bjorkstedt *et al.* 2005; modified in Spence *et al.* 2008). Based on the limited ancillary data that was available, the TRT concluded that six independent populations of fall Chinook salmon in this ESU were at high risk of extinction or possibly extinct, including the Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala river populations. One population of fall-run Chinook was determined to be at moderate or high risk (Mattole River), and the remaining populations were deemed to be data deficient. All six putative historical populations of spring-run Chinook salmon were believed extinct (Spence *et al.* 2008).

A status review update by the Southwest Fisheries Science Center (SWFSC) concluded that the lack of population-level estimates of abundance for Chinook salmon populations in this ESU continues to hinder assessment of its status (Williams *et al.* 2011b). However, based on a consideration of all new information since the last status review, the SWFSC did not find evidence of a substantial change in the biological status of the ESU (NMF 2016). The updated status review did, however, cite several concerns about the ESU including the apparent loss of populations from one diversity stratum, the loss of the spring-run life history type from two diversity strata, and the diminished connectivity between populations in the northern and southern halves of the ESU. These concerns were generally recognized at the time of the previous status review, but were considered more significant in this review given the recently developed population viability criteria for this ESU. Overall, the SWFSC update concluded that the biological status of this ESU is unchanged from that described by Good *et al.* (2005) who considered it likely to become endangered in the foreseeable future (NMFS 2016).

Life History

Healey (1991) describes two basic life history strategies (races) for Chinook salmon, stream-type and ocean-type, although there is variation within each life history strategy. Like most salmonids, Chinook salmon have evolved variation in juvenile and adult behavior patterns which can help decrease the risk of catastrophically high mortality in a particular year or habitat (Healey 1991). Spring-run Chinook salmon are often stream-type (Healey 1991, Moyle 2002). Adults return to lower-order, headwater, streams in the spring or early summer, before they have reached sexual maturity, and hold in deep pools and coldwater areas until spawning in early fall (Healey 1991, Moyle 2002). This strategy allows spring-run Chinook salmon to take advantage of mid-elevation habitats inaccessible during the summer and fall due to low flows and high temperatures (Moyle 2002). Juveniles emerge from the gravel in the early spring and typically spend one year in freshwater before migrating downstream to estuaries and then the ocean (Moyle 2002).

The California Coastal ESU Chinook salmon (Chinook salmon) are fall-run, ocean-type fish, which are specifically adapted for spawning in lowland reaches of big rivers and their tributaries (Moyle 2002, Quinn 2005). Chinook salmon usually enter rivers from August to January. These fall-run Chinook salmon typically enter freshwater at an advanced, sexually mature stage, move rapidly to their spawning areas on the main stem or lower tributaries of rivers, and spawn within a few days to weeks of freshwater entry and arrival on the spawning grounds (Healey 1991, Moyle 2002). Run timing is, in part, a response to stream flow characteristics, with most spawning occurring in November and December. They typically spawn in the lower reaches of rivers and tributaries at elevations of 200–1,000 ft. (NMFS 2008). Previous sampling in Martin Slough suggests Chinook salmon are infrequently present in most parts of the action area, although the new tide gate has presumably improved access. No spawning habitat exists at the project site due to the brackish nature, agricultural and developed land uses and river characteristics of the site.

In California, ocean-type Chinook salmon tend to use estuaries and coastal areas for rearing more extensively than stream-type Chinook salmon (Thorpe 1994). Juveniles emerge from the gravel in late winter or early spring and generally within a matter of months, migrate downstream to the estuary and the ocean (Moyle 2002, Quinn 2005). A CDFG outmigrant trapping program on the Mad River determined a small proportion of Chinook juveniles will over summer in freshwater (Sparkman 2002). Fresh water residence, including outmigration, usually ranges from two to four months. After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks, and other areas of bank cover. As they grow larger, their habitat preferences change (Everest and Chapman 1972). Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. This life history strategy allows fall-run Chinook salmon to utilize quality spawning and rearing areas in the valley reaches of rivers, which are often too warm to support juvenile salmonid rearing in the summer (Moyle 2002).

After emergence from redd gravels in the spring, most individuals only rear in the reach for a few weeks to a few months prior to outmigration to the ocean in the late winter through early summer (D. Halligan, Stillwater Sciences, personal observation; Moyle 2002). A small percentage of individuals may remain in freshwater for up to a year as observed in the Mad River (D. Halligan, Stillwater Sciences, personal observation). These individuals likely utilize cool water seeps, thermally stratified deep pools, and cool tributaries to escape lethal temperatures as has been documented in juvenile steelhead (Nielsen *et al.* 1994).

Current Distribution and Abundance

Only fall-run Chinook salmon currently occur in the CC Chinook salmon ESU. Spring-run stocks no longer occur in the ESU; however, historical information indicates that spring-run Chinook salmon historically existed in the Mad River and the North and Middle Forks of the Eel River (Keter 1995, Myers *et al.* 1998, Moyle 2002).

California Coastal Chinook salmon are distributed at the southern end of the species' North American range; only Central Valley fall and winter Chinook are found spawning further south. NMFS identified four regions of this portion of the California coast with similar basin-scale environmental and ecological characteristics (Bjorkstedt *et al.* 2005). Sixteen watersheds were identified in these four regions that have minimum amount of habitat available to support independently viable populations. In the North Mountain-Interior Region, the Upper Eel and Middle Fork Eel Rivers contain independent CC Chinook stocks while the Lower Eel and Van Duzen Rivers have the potential to support viable populations. Chinook salmon are annually observed in the Middle Fork Eel River, in Black Butte River, and near Williams Creek. They continue to be observed annually in the Outlet Creek drainage and in the smaller tributaries feeding Little Lake valley. In the North Coastal Region, Redwood Creek and the Mad, Lower Eel, South Fork Eel, Bear and Mattole Rivers all contain sufficient habitat for independently viable CC Chinook salmon populations. NMFS also identified Little River and Humboldt Bay tributaries as containing potentially independent populations. In the North-Central Coastal Region, numerous watersheds in Mendocino County contain (or contained) small runs of CC Chinook salmon that are dependent for persistence upon self-sustaining stocks in Ten Mile, Noyo, and Big Rivers. Along the Central Coastal Region, the Navarro, Garcia and Gualala Rivers historically had independent populations but apparently no longer do. Additionally, the Russian River appears to support a self-sustaining population although the role of hatcheries is uncertain. Seventeen additional watersheds were tentatively identified by the NMFS to contain dependent CC Chinook salmon, but suggested that only two of these watersheds were consistently occupied by Chinook salmon (Williams *et al.* 2011a). While Chinook salmon are also encountered in the San Francisco Bay region, these fish most likely originated from Central Valley populations and are not included in the ESU (Moyle *et al.* 2008).

A common theme in the ESA status determinations for Chinook salmon is the sparseness of spawner abundance data (O'Farrell *et al.* 2012). There is a lack of adult spawner estimates spanning 3-4 generations for any of the populations, which prevents application of the viability criteria developed for this ESU (Spence *et al.* 2008). Additionally, the lack of historical population abundance estimates is a major uncertainty. For example, Chinook salmon are periodically observed in many mid-sized watersheds (*i.e.*, Big River, Ten Mile River, Noyo River, Navarro River, Garcia River, and Gualala River) in the region between Cape Mendocino and the Russian River (Spence *et al.* 2008). However, these watersheds currently do not appear to support persistent populations, and there remains substantial uncertainty about whether they did historically (Bjorkstedt *et al.* 2005). The paucity of historical evidence may reflect in part the fact that substantial modification of habitats due to logging, splash-damming, and other forestry-related activities had already taken place by the late-1800s (Spence *et al.* 2008). In 2007, NMFS assigned a Recovery Priority of 3 to CC Chinook salmon "based on a high degree of threat, a low-to-moderate recovery potential, and anticipated conflict with development projects or other activity." Population trends in the Humboldt Bay tributaries and throughout most of the ESU appear to be negative, and some local populations may have been extirpated. Nehlsen *et al.* (1991) and Higgins *et al.* (1992) considered Chinook in Humboldt Bay tributaries to be at high risk of extinction. Numbers in Freshwater Creek increased in 2000 – 2001 although hatchery fish are thought to have contributed to part of the increase (Good *et al.* 2005). Chinook salmon have been consistently reported from the Elk River system and one sub-yearling was captured in Martin Slough in May of 2011 (Wallace 2017).

The lack of long-term population-level estimates of abundance for Chinook salmon populations continues to hinder assessment of status, though the situation has improved with implementation of the Coastal Monitoring Plan (CMP) in the Mendocino Coast Region and portions of Humboldt County. The available data, a mixture of short-term (6-year or less) population estimates or expanded redd estimates and longer-term partial population estimates and spawner/redd indexes, provide no indication that any of the independent populations (likely to persist in isolation) are approaching viability targets. In addition, there remains high uncertainty regarding key populations, including the Upper and Lower Eel River populations and the Mad River population, due to incomplete monitoring across the spawning habitat of Chinook salmon in these basins (O'Farrell *et al.* 2012). Because of the short duration of most time series for independent populations, little can be concluded from trend information. The longest time series, video counts in the Russian River, indicates the population has remained fairly steady during the 14-year period of record. The longer time series associated with index reaches or partial populations suggest mixed patterns, with some showing significant negative trends (Prairie Creek, Freshwater Creek, Tomki Creek), one showing a significant positive trend (Van Arsdale Station), and the remainder no significant trends. Overall, there is a lack of compelling evidence to suggest that the status of these populations has improved or deteriorated appreciably since the previous status review (Williams *et al.* 2011).

At the ESU level, the loss of the spring-run life history type represents a significant loss of diversity within the ESU, as has been noted in previous status reviews (Good *et al.* 2005, Williams *et al.* 2011). Concern remains about the extremely low numbers of Chinook salmon in most populations of the North-Central Coast and Central Coast strata, which diminishes connectivity across the ESU. However, the fact that Chinook salmon have regularly been reported in the Ten Mile, Noyo, Big, Navarro, and Garcia rivers represents a significant improvement in our understanding of the status of these populations in watersheds where they were thought to have been extirpated. These observations suggest that spatial gaps between extant populations are not as extensive as previously believed. In summary, the new information available since the last status review (Williams *et al.* 2011) does not appear to suggest there has been a change in extinction risk for this ESU (NMFS 2016).

2.2.4 NC Steelhead

The NC steelhead Distinct Population Segment (DPS) comprises winter- and summer-run steelhead populations from Redwood Creek (Humboldt County) southward to, but not including, the Russian River. NC steelhead were originally defined as an ESU that included resident fish, and the anadromous fish were listed as threatened in 2000 (65 FR 36074). In 2006, NMFS redefined the

NC steelhead ESU as a steelhead-only DPS (no resident fish), and reaffirmed that this DPS was a threatened species under the ESA (71 FR 834, January 5, 2006).

Little historical abundance information exists for the naturally spawning portion of the NC steelhead DPS. A Biological Review Team (BRT) established by NMFS conducted a status review for West Coast steelhead and reported their conclusions in 1996 (Busby *et al.*). Although data for the NC steelhead DPS were limited, analysis by the BRT led to the following conclusions: (1) population abundances were low relative to historical estimates; (2) recent trends were downward; and (3) summer-run steelhead abundance was "very low" (Busby *et al.* 1996).

In 2003, another BRT convened to analyze updated biological information for West Coast steelhead and reported their conclusions in 2005 (Good *et al.*). Updated time series of adult abundance data suggested a downward trend in summer-run steelhead in the Middle Fork Eel River, the largest extant population of summer steelhead in the NC steelhead DPS (Good *et al.* 2005). Similarly, analysis of new time series data for adult summer-run steelhead in the Mad River showed a downward trend.

Since publication of the last status review (Good *et al.* 2005), significant new genetic data are available for steelhead populations across much of coastal California and suggest that boundaries changes could be warranted for NC steelhead DPS. A BRT was convened to evaluate these new data and other relevant information related to coastal steelhead DPS boundaries. This review was based on the existing DPS boundaries. As a result of the review, NMFS reaffirmed the NC steelhead DPS as a threatened species again on April 14, 2014 (79 FR 20802).

The NC steelhead DPS includes all naturally spawning winter- and summer-run populations of O. mykiss (steelhead) below natural and manmade impassable barriers in California coastal river basins from Redwood Creek in Humboldt County, to just south of Gualala River in Mendocino County (Spence *et al.* 2008), as well as two artificial propagation programs: the Yager Creek Hatchery and North Fork Gualala River Hatchery (Gualala River Steelhead Project) steelhead hatchery programs. This distribution includes the Eel River, the third largest watershed in California, with its four forks (North, Middle, South, and Van Duzen) and their extensive tributaries. Steelhead in this DPS include what is presently considered to be the southernmost population of summer steelhead in the Middle Fork Eel River. The half-pounder life history also occurs within the range of this DPS, specifically in the Mad and Eel rivers. The TRT identified 29 "functionally independent", 22 "potentially independent", and at least 67 "dependent" populations in the NC steelhead DPS (Bjorkstedt *et al.* 2005; with modifications described in Spence *et al.* 2008). Analysis of genetic data provided support for, and aided in interpretation of population type assignment (NMFS 2007a). The TRT defined five diversity strata in the NC steelhead DPS. Within three of these strata, populations were further subdivided according to life history type, with summer-run and winter-run populations constituting distinct substrata (Bjorkstedt *et al.* 2005, Spence *et al.* 2008, NMFS 2007a).

Extant summer-run steelhead populations are found in Redwood Creek and the Mad, Eel (Middle Fork and Van Duzen) and Mattole Rivers. Spence *et al.* (2008) concluded that adult abundance information for independent populations of steelhead in this DPS were insufficient to rigorously evaluate their viability using criteria developed by the TRT. However, the TRT concluded Bucknell Creek and Soda Creek are at a moderate/high risk of extinction based on low return counts at Van Arsdale Fish Station and the dominance of those counts by hatchery fish. The Upper Eel River was considered to be at a high risk of extinction due to the loss of habitat above Scott Dam and the high proportion of hatchery fish returning to Van Arsdale. Smaller populations including the Noyo River, Hare Creek, Pudding Creek, and Casper Creek were deemed at moderate risk of extinction if fish abundance remained unchanged over time (Spence *et al.* 2008).

The status review update conducted by the SWFSC concluded that the lack of population-level estimates of abundance for steelhead populations in this DPS continues to hinder assessment of its status (Williams *et al.* 2011c). The status review did, however, cite several concerns about the DPS including the continued depressed status of two remaining summer run populations in the DPS (Redwood Creek and Mattole River), the high number of hatchery fish in the Mad River basin, and the uncertainty about the relative abundance of hatchery and wild spawners in the Mad River. The previous status review of Good *et al.* (2005) concluded that the population was likely to become endangered in the foreseeable future. Based on a consideration of all new substantive information on the biological status of the DPS, the SWFSC concluded that its biological status was unchanged (Williams *et al.* 2011c). In summary, the best available updated information on the biological status of the NC steelhead DPS and the threats it faces indicate that it continues to remain a threatened species. In 2016, NMFS (2016) completed another status review and concluded that the collective risk to the persistence of the NC steelhead DPS has not changed significantly since the 2011 review.

Life History

Steelhead possess one of the most complex life history patterns of the Pacific salmonid species. Steelhead typically refers to the anadromous form of rainbow trout. Similar to other Pacific salmon, steelhead adults spawn in freshwater and spend a part of their life history at sea. However, unlike Chinook salmon, steelhead exhibit a variety of life history strategies during their freshwater rearing period, and adults may spawn more than once during their life. The typical life history pattern for steelhead is to rear in freshwater streams for two years, followed by up to two or three years of residency in the marine environment. However, juvenile steelhead may rear in freshwater from one to four years (Moyle 2002).

Steelhead spawn in gravel and small cobble substrates usually associated with riffle and run habitat types. Most YOY fish prefer riffles, while larger (older) fish move into pools. Cover is extremely important in determining distribution; more cover leads to more fish (Meehan and Bjornn 1991). Preferred water temperatures are 13 to 21 °C (55 –70 °F). Most outmigration is during the spring (January to June), but some outmigration may occur during any significant runoff event.

There are two basic steelhead life history patterns, winter-run and summer-run (Quinn 2005, Moyle 2002). Winter-run steelhead enter rivers and streams from December to March in a sexually mature state, migrate to spawning areas and often ascending long distances, and then spawn soon after in tributaries of mainstem rivers (McEwan and Jackson 1996, Moyle 2002). It is likely that Eel River steelhead spawn primarily in tributaries and the upper mainstem (Moyle 2002), but is also probable that a small number of winter steelhead spawn in lower reaches, particularly in low water years (D. Halligan, Stillwater Sciences, personal observation). Old salmonid redds have been observed in the Mainstem Eel River near Dyerville (RM 41) in summer 2000 (D. Halligan, Stillwater Sciences, personal observation as cited in Caltrans 2015), and it is likely that these were late-spawning winter steelhead because Chinook salmon redds are expected to be obscured by high winter flows. Steelhead typically emerge from redd gravels in late spring and early summer, and rear in freshwater for 1–3 years.

Summer steelhead, also known as spring-run steelhead, enter rivers in a sexually immature state during receding flows in the spring and migrate to headwater reaches of tributary streams where they hold in deep pools until spawning the following winter or spring (Moyle 2002). Spawning for all runs generally takes place in the late winter or early spring. Eggs hatch in 3 to 4 weeks and fry emerge from the gravel 2 to 3 weeks later (Moyle 2002). Juveniles spend 1 to 4 years in freshwater before migrating to estuaries and the ocean where they spend 1 to 3 years before returning to freshwater to spawn. Steelhead smolts are usually 15-20 cm total length and migrate to the ocean in the spring (Meehan and Bjornn 1991). Another life history diversity of steelhead is the "half pounder". "Half pounder" steelhead are sexually immature steelhead that spend about 3 months in estuaries or the ocean before returning to lower river reaches on a feeding run (Moyle 2002). Half pounders then return to the ocean where they spend 1 to 3 years before returning to freshwater to spawn. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death. However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Some steelhead "residualize," becoming resident trout and never adopting the anadromous life history.

Upon emerging from the gravel, steelhead fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger; older juveniles establish and defend territories (Humboldt County and Stillwater Sciences 2011). Cover is an important habitat component for juvenile steelhead, both as velocity refuge and as a means of avoiding predation (Shirvell 1990, Meehan and Bjornn 1991). Summer rearing steelhead tend to use riffles and other habitats not strongly associated with cover more than other salmonids (Humboldt County and Stillwater Sciences 2011), but winter rearing juvenile steelhead become inactive and hide in any available cover, including large substrate or woody debris (Humboldt County and Stillwater Sciences 2011). Summer steelhead enter freshwater in the spring through summer, hold in mainstem rivers and large tributaries, and generally spawn in winter though early spring in small, upper-basin tributaries (Moyle 2002).

Diversity

Millions of steelhead from outside the DPS have been stocked in rivers in the NC steelhead DPS since the 1970s. Bjorkstedt *et al.* (2005) documented 39 separate releases of steelhead, many of which occurred over multiple years. Of particular concern is the practice of rearing Eel River-derived steelhead in a hatchery on the Mad River before restocking in the Eel River (Bjorkstedt *et al.* 2005). Over ten years, more than one-half million yearlings were reared and released in this way, and this practice may have reduced the effectiveness of adult homing to the Eel River (Bjorkstedt *et al.* 2005). In addition, abundance of summer-run steelhead was considered "very low" in 1996 (Good *et al.* 2005), indicating that an important component of life history diversity in this DPS may be at risk. NMFS determined in the most recent status review that the potential risks of stochastic processes associated with small population size have increased in the past five years since the previous review (Good *et al.* 2005), likely placing populations of NC steelhead at a higher risk of extinction (Williams *et al.* 2011c).

As described for SONCC coho salmon, Spence *et al.* (2008) classified NC steelhead populations as dependent or independent based on their historic population size and ability to persist in isolation. Given the recent trends in abundance across the ESU, the genetic and life history diversity of populations is likely very low and is inadequate to contribute to a viable ESU. The most recent status review (NMFS 2016) indicated that the biological status of the NC steelhead DPS has not changed since 2011.

Distribution

With few exceptions, NC steelhead are present wherever streams are accessible to anadromous fish and have sufficient flows. Experts consulted during the 2005 status review gave this DPS a mean risk score of 2.2 (out of 5) for the spatial structure and connectivity category (Good *et al.* 2005), indicating it is unlikely that this factor contributes significantly to risk of extinction by itself, but there is some concern that it may, in combination with other factors.

As the 'default' historic spatial processes described by McElhany *et al.* (2000) have likely not been preserved, NMFS (Williams *et al.* 2011c) concluded in the most recent status review that winter steelhead continue to inhabit most of the watersheds in which they historically occurred, thus all diversity strata within the DPS appeared to be represented by extant populations. However, given this information, there is still little information available for assessing whether conditions have improved or worsened over the past 5 years (Williams *et al.* 2011c).

Although large wood features such as debris jams provide winter refuge for steelhead, cover consisting of interstitial spaces in cobble or boulder substrate is considered the key attribute defining winter habitat suitability for juvenile steelhead (Hartman 1965, Chapman and Bjornn 1969, Meyer and Griffith 1997). Hartman (1965) and Bustard and Narver (1975) found that during high winter flows, juvenile steelhead seek refuge in interstitial spaces in cobble and boulder substrates that range in size from 10 to 40+ cm (4 to 16+ in). Initial observations from experiments conducted by Redwood Sciences Laboratory and Stillwater Sciences (unpublished data; cited in Humboldt County and Stillwater Sciences 2011) in artificial stream channels, indicate that juvenile steelhead respond to high flows by seeking cover deep within cobble and boulder substrate, suggesting that steelhead will seek refuge at least 1 to 2 times the depth of the median particle size (d50) in unembedded cobble/boulder substrate.

Abundance

Steelhead abundance has been monitored at three dams in the NC steelhead DPS since the 1930s: Sweasey Dam on the Mad River (annual adult average 3,800 in the 1940s), Cape Horn Dam on the upper Eel River (4,400 annual average in the 1930s), and Benbow Dam on the South Fork Eel River (18,784 annual average in the 1940s; Murphy and Shapovalov 1951, Shapovalov and Taft 1954, Busby *et al.* 1996). These data can be compared to the annual average of 2,000 at Sweasey Dam in the 1960s, annual average at 1,000 at Cape Horn Dam in the 1980s, and annual average of 3,355 at Benbow Dam in the 1970s (McEwan and Jackson 1996, Busby *et al.* 1996). In the mid-1960s, CDFG estimated steelhead spawning in many rivers in this DPS to total about 198,000 (McEwan and Jackson 1996). Currently, the most abundant run is in the Middle Fork Eel River, with about 2,000 fish in 1996 (McEwan and Jackson 1996). Substantial declines from historic levels at major dams indicate a probable decline from historic levels at the DPS scale.

The availability of information on steelhead populations in the NC steelhead DPS has improved considerably in the past 5 years, due to implementation of the CMP across a significant portion of the DPS. Nevertheless, significant gaps in information still remain, particularly in the Lower Interior and North Mountain Interior diversity strata, where there is very little information from which to assess status. Overall, the available data for winter-run populations— predominately in the North Coastal, North-Central Coastal, and Central Coastal strata— indicate that all populations are well below viability targets, most being between 5 percent and 13 percent of these goals. For the two Mendocino Coast populations with the longest time series, Pudding Creek and Noyo River, the 13-year trends have been negative and neutral, respectively (Spence 2016). However, the short-term (6-year) trend has been generally positive for all independent populations in the North-Central Coastal and Central Coastal strata, including the Noyo River and Pudding Creek (Spence 2016). Data from Van Arsdale Station likewise suggests that, although the long-term trend has been negative, run sizes of natural-origin steelhead have stabilized or are increasing (Spence 2016). Thus, we have no strong evidence to indicate conditions for winter-run populations in the DPS have worsened appreciably since the last status review (Williams et al. 2011).

Summer-run populations continue to be of significant concern because of how few populations currently exist. The Middle Fork Eel River population has remained remarkably stable for nearly five decades and is closer to its viability target than any other population in the DPS (Spence 2016). Although the time series is short, the Van Duzen River appears to be supporting a population numbering in the low hundreds. However, the Redwood Creek and Mattole River populations appear small, and little is known about other populations including the Mad River and other tributaries of the Eel River (*i.e.,* Larabee Creek, North Fork Eel, and South Fork Eel).

In summary, the available information for winter-run and summer-run populations of NC steelhead do not suggest an appreciable increase or decrease in extinction risk since publication of the last status reviews (Williams *et al.* 2011). Most populations for which there are population estimates available remain well below viability targets; however, the short-term increases observed for many populations, despite the occurrence of a prolonged drought in northern California, suggests this DPS is not at immediate risk of extinction (NMFS 2016).

Land use activities associated with logging, road construction, urban development, mining, agriculture, ranching, and recreation have resulted in the loss, degradation, simplification, and fragmentation of NC steelhead habitat and caused resulting declines in NC steelhead populations (NMFS 1996). Associated impacts of these activities include: alteration of stream bank and channel morphology, alteration of ambient stream water temperatures, degradation of water quality; elimination of spawning and rearing habitats; fragmentation of available habitats; elimination of downstream recruitment of spawning gravels and LWD; removal of riparian vegetation resulting in increased stream bank erosion; and increased sedimentation input into spawning and rearing areas (NMFS 1996).

Steelhead occur in many permanent streams in Humboldt County, including the Elk River system. Repeated monthly sampling of Martin Slough within the Project area from 2007 to 2011 resulted in the capture of only five juvenile steelhead or rainbow trout. In addition, sampling efforts from July 2015 to May 2016 yielded only three juvenile steelhead trout.

2.2.4 Factors Responsible for Coho Salmon, Chinook Salmon, and Steelhead Decline (ESU and DPS Scale)

SONCC coho salmon ESU

The factors that caused declines in the SONCC ESU of coho salmon include hatchery practices, climate change, ocean conditions, habitat loss due to dam building, degradation of freshwater habitats due to a variety of agricultural and forestry practices, water diversions, urbanization, over-fishing, mining; and severe flood events exacerbated by land use practices (Good *et al.* 2005, NMFS 2014).

Sedimentation and loss of spawning gravels associated with poor forestry practices and roadbuilding are particularly chronic problems that can reduce the productivity of salmonid populations. Non-native Sacramento pikeminnow (*Ptychocheilus grandis*) have been observed in the Eel River basin and could be acting as predators on juvenile steelhead as thermal conditions lead to niche overlap of the two species (Good *et al.* 2005). Droughts and unfavorable ocean conditions during the late 1980s and early 1990s were identified as likely causes of decreased abundance of SONCC coho salmon (Good *et al.* 2005). Reduced flows can cause increases in water temperature, resulting in increased heat stress to fish and thermal barriers to migration. The current drought period (since water year 2012) in California (State of California [http://gov.ca.gov/news.php?id=18379] 2014, NMFS and CDFW 2014, NMFS 2014) has the potential to desiccate rearing and holding areas, creating migration barriers that could eliminate year-classes or entire populations as it continues into water year 2016—*see* http://www.water.ca.gov/waterconditions/ and http://ca.gov/drought/.

MacFarlane *et al.* (2008) compared data on adult returns of returning coho salmon in California for return season 2004/05, compared to subsequent adult returns of their progeny in return year 2007/08. The data indicated a 73 percent decline in returning adults in 2007/08 (offspring from 2004/2005 adults), compared to adult returns in 2004/2005. MacFarlane *et al.* (2008) speculated that because the spatial extent of the decline observed between coho parent and subsequent returning adult offspring, was wide-ranging throughout California and Oregon, ocean conditions were the main causative mechanism for decline. MacFarlane *et al.* (2008) further supported their hypothesis with observations of low adult Chinook returns to California that as juveniles, experienced sub-optimal ocean conditions during the same time as did coho juveniles.

NMFS (2014) describes climate change impacts as detrimental to Pacific salmon through altered runoff patterns causing a precipitation shift from snow to rain, earlier snowmelt, lower summer flows, and more intense storms that will increase peak flows in freshwater. When combined with ocean acidification and large ocean processes (*e.g.* El Nino, Southern Oscillation), climate change is expected to reduce ocean productivity and further alter estuarine habitat as sea level rises. Warmer winter air temperatures will decrease the snowpack in northern California and southern Oregon by up to 75 percent by 2040 and nearly 100 percent by 2080 (Doppelt *et al.* 2008) resulting in earlier and higher high flows, and earlier and lower low flows.

Battin *et al.* (2007) predicted that Chinook salmon spawner capacity throughout the Pacific Northwest was proportional to minimum discharge during the spawning period; reduction trends in flow would result in reductions in spawning capacity due to habitat limitations. Widespread declines in springtime snow water equivalent have occurred in much of the North American West since the 1920s, especially since the mid-twentieth century (Knowles and Cayan 2004, Hamlet *et al.* 2005, Regonda *et al.* 2005, Mote 2006). These trends have resulted in earlier onsets of springtime snowmelt and stream flow across western North America (Regonda *et al.* 2005, Stewart *et al.* 2005), as well as lower flows in the summer (Stewart *et al.* 2005). Low flows are also important for juvenile Coho due to space and food limitations, while low flows may be associated with temperature limitations in other areas (Ebersole *et al.* 2009).

Past forestry practices have harvested canopy-creating trees from stream-side habitat affects cover from predation, water temperature, the watershed's ability to absorb precipitation, water flow timing, erosion, bank stability, retention of in-stream woody debris, recruitment of large woody debris, and habitat complexity. Removal of near-stream vegetation can result in increased water temperature, both short- and long-term (Moring *et al.* 1994, cited by CDFG 2004). The decrease in habitat complexity, loss of stream function, and loss of access to accessible off-channel habitat, and temperature refugia have contributed to reduced summer and rearing capacity for juvenile coho salmon (CDFG 2002).

Hatchery practices as a causative mechanisms of salmonid decline include hatchery straying and mixing with wild spawners where the resulting progeny exhibit lower survival then their wild stock counterparts (McGinnity *et al.* 2003, Kostow 2004), ultimately leading to a reduction in the reproductive success of the wild stock (Reisenbichler and McIntyre 1977, Fleming *et al.* 2000, Chilcote 2003, Araki *et al.* 2007). Flagg *et al.* (2000) found that, except in situations of low wild fish density, increasing releases of hatchery fish can negatively impact naturally produced fish through habitat displacement. Kostow *et al.* (2003) and Kostow and Zhou (2006) found that over the duration of the steelhead hatchery program on the Clackamas River, Oregon, the number of hatchery steelhead in the upper basin regularly caused the total number of steelhead to exceed carrying capacity, triggering density-dependent mechanisms that impacted the natural population. Competition between hatchery and wild salmonids in the ocean can also lead to density-dependent mechanisms that effect wild salmonid populations (Beamish *et al.* 1997; Levin *et al.* 2001, Sweeting *et al.* 2003), especially during periods of poor ocean productivity (Beamish *et al.* 1997, Levin *et al.* 2001, Sweeting *et al.* 2003).

Dam operations disrupt hydrologic signals that salmon use throughout their life history by dampening peak flows and increase low flows—the converse of climate change. Dam construction has limited, or blocked upstream migration access to spawning and rearing habitat and remains one of the single most disruptive anthropogenic factors to decline (NMFS 2014).

CC Chinook salmon ESU

At the time of listing, Chinook salmon and their habitat within the range of this ESU were adversely affected by logging, road construction, urban development, mining activities, agriculture, ranching and recreation (NMFS 1998; 64 FR 50394; 70 FR 37160). These activities resulted in the loss, degradation, simplification, and fragmentation of Chinook salmon habitat. A wide range of impacts resulted from these activities including: alteration of steam banks and channel morphology, alteration of ambient water temperatures, degradation of water quality, elimination of spawning and rearing habitat, elimination of spawning gravels and large woody debris, removal of riparian vegetation and increased stream sedimentation. The effects of periodic flood events exacerbate the adverse effects of these activities. Additionally, the distribution of the Chinook salmon in this ESU has been curtailed by dam construction. The spring-run life history form, which historically spawned and reared in upstream portions of certain watersheds, was heavily impacted by construction of dams and has been completely extirpated from this ESU. Warm Springs and Coyote Dams in the Russian watershed and Scott Dam on the Eel were cited at the time of listing as curtailing or blocking access to spawning and rearing habitat within this ESU. Peters Dam on Lagunitas Creek was also cited as a migration barrier even though the watershed was not included in originally defined ESU.

Overutilization for recreational purposes is considered to be one of the primary reasons for the decline of the CC Chinook salmon ESU. Chinook salmon have supported, and continue to support tribal, commercial, and recreational fisheries, and artificial production, supplementation, and broodstock collection activities. Overfishing in the early days of European settlement depleted many Chinook salmon stocks prior to the impact of more recent habitat degradation (NMFS 1998). Unsustainable harvest rates after extensive habitat degradation likely contributed to further decline of Chinook salmon populations.

Both freshwater and ocean harvest impacts have been reduced over time by active management. Freshwater harvest is managed by CDFG. Ocean harvest is managed by the Pacific Fisheries Management Council (PFMC). Although modern harvest rates have not been estimated directly for the CC Chinook salmon ESU, they may be comparable to rates on Klamath fall-run Chinook salmon (NMFS 1998). Past ocean harvest rate for this population was estimated at 21 percent (PFMC 1996, as cited in NMFS 1998), and freshwater and estuarine harvest rate between 25-30 percent (PFMC 1996, as cited in NMFS 1998).

Artificial propagation of Chinook salmon and other salmonids was also identified as a potential threat to this and other ESUs at the time of their listing. Artificial propagation of salmonids can have a wide range of beneficial or detrimental effects on salmon populations (64 FR 50394, 70 FR 37160). At the time of the last review in 2005, seven artificial propagation programs were considered part of this ESU and eventually listed. Most of these artificial propagation programs were small, cooperative programs authorized by CDFG. In making its 2005 listing finding for this ESU, we considered the effects of these hatchery programs on the viability of the naturally spawning populations of Chinook salmon in this ESU. In general, our assessment concluded that these programs slightly increased the abundance of Chinook salmon in the ESU, but did not have any beneficial (or adverse) impacts on productivity, spatial structure or diversity of Chinook salmon populations, in large part because the programs were very small and broadly distributed over the ESU. Overall, it was concluded that hatchery programs in this ESU did not provide significant benefits to the ESU and could have potential adverse impacts. Since the status review in 2005, all seven artificial propagation programs have been terminated and they no longer have any impacts on naturally spawning Chinook salmon populations within the ESU.

At the time of listing, several natural factors were identified that could adversely affect Chinook salmon populations in this ESU including variability in ocean habitat conditions, drought, flooding, fire, and landslides. Although Chinook salmon and other salmonids clearly survived such natural events over the millennia, there was concern that these types of factors could threaten Chinook populations if coupled with deteriorating freshwater habitat conditions. Cyclic ocean conditions, for example, could affect food supply, predator distribution and abundance, migratory patterns, and overall survival (NMFS 1998). Droughts and floods might reduce Chinook salmon spawning, rearing, and migration habitat, particularly in conjunction with previously described land and water use activities that modify or degrade habitat conditions. Similarly, fire events, particularly if coupled with modified or degraded habitat conditions, could affect woody debris recruitment, shade, and soil stability. Landslides could affect riparian vegetation and sedimentation. These natural factors continue to represent a significant threat, in large part because freshwater habitat conditions have not sufficiently improved since the time of listing and last status review (NMFS 2016).

NC steelhead DPS

Land use activities associated with logging, road construction, urban development, gravel mining, agriculture, ranching, and recreation have resulted in the loss, degradation, simplification, and fragmentation of habitat for steelhead in this DPS which have led to population declines. Impacts associated with these activities include: alteration of stream bank and channel morphology; alteration of ambient stream water temperatures; degradation of water quality; elimination of spawning and rearing habitats; fragmentation of available habitats; elimination of downstream recruitment of spawning gravels and large woody debris; removal of riparian vegetation resulting in increased stream bank erosion; and increased sedimentation input into spawning and rearing areas (NMFS 1996). Land use practices can exacerbate the impact of flooding, and can cause substantial degradation to steelhead habitat (Busby *et al.* 1996). Alteration of the natural hydrology through storage, withdrawal, conveyance, and water diversions for agriculture, flood control, domestic, and hydropower purposes have reduced or eliminated historically accessible habitat for steelhead. The Scott Dam on the Eel River has eliminated access to historical spawning and rearing habitat and has altered the natural flow regime within the basin (NMFS 1996). Modification of natural flow regimes has increased water temperatures, changed fish community structures, and depleted flows. A reduction in flow volume affects fish migration, spawning, and rearing, and reduces the flushing of sediments from spawning gravels, recruitment of gravel and transport of large woody debris (NMFS 1996).

As stated in the NMFS (2015) Multispecies Recovery Plan for the NC steelhead DPS, riparian wetland habitat in California has been reduced by over 90 percent (Dahl and Johnson 1991, Jensen *et al.* 1990, Armour *et al.* 1991, as cited in NMFS 1996). The condition of the remaining riparian, wetland, and estuarine habitats for this DPS is largely degraded and at continued risk of loss or further degradation. The destruction or modification of riparian, wetland, and estuarine areas has resulted in the loss of important rearing and migration fish habitats (Dahl 2011).

Since the original listing of this DPS, in-stream gravel mining practices have improved in Northern California. Mining operations are permitted by the Corps and the permits in place contain numerous impact minimization measures aimed at reducing the effects of gravel extraction on steelhead and their habitat. However, even with minimization measures, gravel extraction reduces overall habitat complexity and reduces the quality and quantity of available pool habitat (Simon and Hupp 1992). Given the sensitivity of channels to disturbance (*i.e.*, current lack of floodplain and channel structure; low levels of instream wood), and the use of gravel extraction reaches by steelhead for rearing, gravel extraction is a threat to rearing juveniles and a moderate threat to adults that require resting habitat in pools during upstream migration (NMFS 2015). Increased focus should be given to addressing the potential threats to this DPS from exposure to common pesticides that may constrain recovery. Lastly, the potential impacts of climate change are now recognized as a moderate threat to this DPS (NMFS 2015).

2.2.5 Critical Habitat

Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation.

The designation(s) of critical habitat for SONCC coho salmon, NC steelhead, and CC Chinook salmon use the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replaces 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 primary constituent elements, physical or biological features, 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.

SONCC Coho Salmon Critical Habitat

Description
Designated critical habitat for SONCC coho salmon encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049). Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding natural impassible barriers (*i.e.*, natural waterfalls); and (3) tribal lands. The area described in the final rule represented the current freshwater and estuarine range of coho salmon. Land ownership patterns within the coho salmon ESU analyzed in this document and spanning southern Oregon and northern California are 53 percent private lands; 36 percent Federal lands; 10 percent State and local lands; and 1 percent Tribal lands.

The designated critical habitat for SONCC coho salmon is separated into five essential habitat types of the species' life cycle. The five essential habitat types include: (1) juvenile summer and winter rearing areas; (2) juvenile migration corridors; (3) areas for growth and development to adulthood; (4) adult migration corridors; and (5) spawning areas. Within these areas, the physical and biological features of SONCC coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (64 FR 24049; May 5, 1999).

Current Condition
The condition of SONCC coho salmon critical habitat at the ESU scale, specifically its ability to provide for the species' conservation, has been degraded from conditions known to support viable salmonid populations that contribute to survival and recovery of the species. NMFS determined that present depressed population conditions are, in part, the result of human-induced factors affecting critical habitat, including: intensive timber harvesting, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals for irrigation. All of these factors were identified when SONCC coho salmon were listed as threatened under the

ESA, and they continue to affect this ESU (NMFS 2014). However, efforts to improve coho salmon critical habitat have been widespread and are expected to benefit the ESU over time (NMFS 2014).

Within the SONCC recovery domain, from 2000 to 2006, the following improvements were completed: 242 stream mi have been treated, 31 stream mi of instream habitat were stabilized, 41 cubic fps of water has been returned for instream flow, and thousands of ac of upland, riparian, and wetland habitat have been treated (NMFS 2007b). Therefore, the condition of SONCC coho salmon critical habitat is likely improved or trending toward improvement compared to when it was designated in 1999.

SONCC coho salmon are dependent upon complex, low gradient habitats for winter rearing, and will express diversity by overwintering in low-gradient, off-channel and estuarine habitats when they are available. The lack of complex aquatic habitat, and much decreased access to floodplains and low gradient tributaries are common features of current critical habitat conditions within the SONCC coho salmon ESU (NMFS 2014). The Recovery Plan also describes that land use activities (*e.g.*, timber harvest, road building, etc.) that occur upstream of low gradient streams, still affect the habitat within low gradient streams by reducing the amount of large wood and shade available and by increasing the amount of sediment that routes through the valley bottom habitats.

CC Chinook Salmon Critical Habitat

Description

Designated critical habitat for CC Chinook salmon steelhead includes the stream channels up to the ordinary high-water line (50 CFR Part 226.211). In areas where the ordinary high-water line has not been defined pursuant to 50 CFR Part 226.211, the lateral extent is defined by the bankfull elevation. Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

Critical habitat for CC Chinook salmon was designated as occupied watersheds from the Redwood Creek watershed, south to and including the Russian River watershed (70 FR 52488, September 2, 2005). Humboldt Bay and the Eel River estuary are designated as critical habitat for the CC Chinook salmon ESU. Some areas within the geographic range were excluded due to economic considerations. Critical habitat was not designated on Indian lands. Designated critical habitat for CC Chinook salmon overlaps the action area. In designating critical habitat for CC Chinook salmon, NMFS focused on areas that are important for the species' overall conservation by protecting quality growth, reproduction, and feeding. The critical habitat designation for these species identifies the known physical and biological features that are necessary to support one or more Chinook salmon life stages, including: (1) freshwater spawning, (2) freshwater rearing, (3) freshwater migration, (4) estuarine areas, (5) nearshore marine areas, and (6) offshore marine areas. Within the PCEs, essential elements of CC Chinook salmon critical habitats include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions (70 FR 52488, September 2, 2005).

Current Condition
The condition of CC Chinook salmon critical habitat, specifically its ability to provide for their conservation, is 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, freshwater and estuarine wetland loss, and water withdrawals for irrigation. All of these factors were identified when CC Chinook salmon were listed as threatened under the ESA, and they all continue to affect this ESU. However, efforts to improve CC Chinook salmon critical habitat have been widespread and are expected to benefit the ESU.

NC Steelhead Critical Habitat

Description
NMFS designated critical habitat for seven of the ESUs/DPSs of Pacific salmon and steelhead, including NC steelhead in September 2005 (70 FR 52488, September 2, 2005). Specific physical and biological features that are essential for the conservation of each species were identified as: freshwater spawning sites; freshwater rearing sites; freshwater migration corridors; estuarine areas; nearshore marine areas; and offshore marine areas. Within the PBFs, essential elements of NC steelhead critical habitats include adequate (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, (10) safe passage conditions, and (11) salinity conditions (70 FR 52488, September 2, 2005).

Habitat areas within the geographic range of the ESU/DPSs having these attributes and occupied by the species were considered for designation. Steelhead critical habitat was designated throughout the watersheds occupied by the ESU/DPSs. In general, the extent of critical habitat conforms to the known distribution of NC steelhead in streams, rivers, lagoons and estuaries (NMFS 2005). In some cases, streams containing NC steelhead were not designated because the economic benefit of exclusion outweighed the benefits of designation, as in the North Fork Eel River. Native American tribal lands and U.S. Department of Defense lands were also excluded. Designated critical habitat for NC steelhead includes the stream channels up to the ordinary high-water line (50 CFR Part 226.211). In areas where the ordinary high-water line has not been defined pursuant to 50 CFR Part 226.211, the lateral extent is defined by the bankfull elevation. Critical habitat in estuaries is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater.

Critical habitat for NC steelhead was designated as occupied watersheds from the Redwood Creek watershed, south to and including the Gualala River watershed. Humboldt Bay and the Eel River estuary are designated as critical habitat for the NC steelhead DPS. Some areas within the geographic range were excluded due to economic considerations. Designated critical habitat for NC steelhead overlaps the action area.

Current Condition
Similar to the current condition of SONCC coho salmon critical habitat, the current condition of NC steelhead critical habitat is degraded throughout most of the range of this species. Estuaries and lower river habitats are greatly reduced, in both area and condition, as the valley bottoms near the mouths of rivers are where most of the agricultural and urban development is concentrated. Levees

constrain most estuaries and lower rivers in this DPS and prevent access to important off-channel rearing habitat. Upstream land uses increase the amount of sediment and warm water that enters low gradient streams and decreases the availability of large wood in these habitats.

The condition of NC steelhead critical habitat, specifically its ability to provide for their conservation, is degraded from conditions known to support viable salmonid populations. NMFS 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, freshwater and estuarine wetland loss, and water withdrawals for irrigation. All of these factors were identified when NC steelhead was listed as threatened under the ESA, and they all continue to affect this DPS. However, efforts to improve NC steelhead critical habitat have been widespread and are expected to benefit the DPS.

Summary of Current Condition of Critical Habitats

Although watershed restoration activities have improved freshwater and estuarine critical habitat conditions in isolated areas, reduced habitat complexity, poor water quality, and reduced habitat availability that resulted from historical and ongoing land management practices persist in many locations, and are limiting the conservation value of designated critical habitat within these freshwater and estuarine habitats at the ESU and DPS scales.

2.3 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).

2.3.1 Status of Listed Species in the Action Area

Coho salmon, Chinook salmon, and steelhead in the action area fall within their respective species' Humboldt Bay Tributaries population. Current estimates of the abundance and distribution of the Humboldt Bay Tributaries coho salmon population are unknown for the watershed as a whole. However, past monitoring efforts have documented adult coho salmon redd abundance in Elk River (CDFW 2013), spawner abundance in Freshwater Creek (Moore and Ricker 2012), and smolt abundance in Ryan Creek (GDRC 2013). From 2009 to 2013 coho salmon redd counts averaged 186 in surveyed reaches Elk River (CDFW 2013). Total spawner counts for coho salmon in Freshwater Creek ranged from a low of 89 in 2010 to a high of 1,810 in 2003. Assuming Freshwater Creek data is representative of the entire Humboldt Bay Tributaries population, the coho salmon population has been in decline since 2003. Smolt abundance estimates from Ryan Creek ranged from a low of 1,390 in 2011 to 6,509 in 2006, with no apparent trend for two of the three cohorts.

Due to a lack of Chinook and steelhead population monitoring data in the Humboldt Bay Tributaries population area, abundance of these populations is inferred from the trends observed in Freshwater Creek. Although Chinook salmon have been counted at the Freshwater Creek weir since 1994, these counts are incomplete as fish can pass over the weir during high flows and smaller jacks may pass through the weir. Counts of Chinook salmon adults at the Freshwater Creek weir from 1994 through 2014 indicate the wild population has declined (Ricker and Anderson 2014). Ricker and Anderson (2014) characterized the decline in Chinook salmon in Freshwater Creek as dramatic, and raised concerns over depensatory population effects. Once the augmentation of hatchery reared Chinook salmon ceased in 2004, weir captures declined rapidly into the single digits, ultimately reaching an all-time low of zero returning adults in 2013 (Ricker and Anderson 2014). Only a few Chinook salmon redds and live adults were observed during Elk River coho salmon surveys from 2009 to 2013 (CDFW 2013), but the surveys typically started following the peak Chinook salmon spawning period.

In Freshwater Creek, adult steelhead returns show no statistically significant trend from 2000 through 2014 (Ricker and Anderson 2014). Return estimates have ranged from a high of 432 adults in 2003-2004 to a low of 51 adults in 2008-2009 (Ricker and Anderson 2014). The adult steelhead escapement in Freshwater Creek the three most recent years was estimated to be 108 ± 35 (95% C.I.) in 2011-12, 149 ± 60 (95% C.I.) in 2012-2013, and 127 ± 54 (955 C.I) in 2013-2014 (Moore *et al.* 2012).

Spatial distribution of juvenile coho salmon, Chinook salmon, and steelhead in Humboldt Bay tributaries is less than the historic extent; however, recent habitat restoration monitoring in the lower portions of tributaries (*e.g.*, Wood Creek, Salmon Creek, Jacoby Creek) has revealed they will distribute to new habitat when made available. Salmonid use of the action area is lowest during the proposed work window.

2.3.2 Status of Salmonid Habitat in the Action Area

The action area within Martin Slough is designated as critical habitat for coho salmon, Chinook salmon, and steelhead. The Martin Slough and Elk River estuary are part of the larger Humboldt Bay ecosystem that accommodates a variety of waterfowl, wading birds, shorebirds, numerous species of fish and other aquatic organisms, passerines, and raptors. Not much is known about the historic composition of the lower portions of Martin Slough. However, it is apparent from its elevation relative to tidewater and its geomorphic features that the lower portions of Martin Slough consisted of estuarine habitat, likely composed of salt marsh and slough channels in the lower action area along with other more brackish water habitats, transitioning to tidally-influenced-freshwater wetlands near the upstream end of the action area.

Although much of the historic estuary has been converted to other land use, some estuarine habitat still exists. That habitat has been severely degraded by the installation of tide gates at the confluence of Martin Slough with Swain Slough and other land management practices. These modifications also have had a pronounced effect on flood routing and sedimentation in the lower channel. Currently, much of Martin Slough within the action area is a relatively small stream flowing through a golf course. The lower portions of the stream are within agricultural areas. There is presently relatively little overhanging vegetation or shade. Upper portions of the watershed, above the action area, include residential neighborhoods within the City of Eureka, and former timberlands.

2.3.3 Factors Affecting Species Environment within the Action Area

Water Quality
Martin Slough within the action area is thought to be at risk, because of seasonally low dissolved oxygen readings and a lack of buffer between the stream and adjacent golf course. Water quality monitoring, in conjunction with monthly fisheries sampling, was conducted by the CDFW from 2007 to 2010. After the replacement of the old tide gate in 2014, these surveys and sampling events were reinitiated and are currently ongoing through 2017.

Habitat Access
In 2007, the existing tide gates at the lower end of the action area had significantly deteriorated and had the potential to block future fish access to Martin Slough. Installation of the new tide gates in 2014 greatly improved fish passage into the action area.

Habitat Elements
Habitat elements are not properly functioning. No information is currently available on substrate type or condition. Since the tide gate mutes (and until recently blocked) tidal scour and sediment outflow, the bottom is assumed to be silt or covered by a layer of silt. No large woody debris was noted in visual inspections. Deep pools and backwaters are uncommon, although golf course ponds provide refugia and rearing habitat for juvenile coho salmon. There is essentially no riparian buffer in much of the action area.

Channel Conditions and Dynamics
Channel condition and dynamics are not properly functioning. Although banks appear to be stable, there is little functioning floodplain and little or no wetland or riparian habitat is present.

Flow/Hydrology
Flow/hydrology is not properly functioning. The historic tidal prism has until recently been eliminated by tide gates at the lower end of the action area. The upper watershed is less affected, but past logging activity and some residential construction have likely increased runoff rates.

Watershed Conditions
The upper watershed is at risk and the lower watershed is not properly functioning. Portions of the watershed are at the edge of urban areas and future growth is expected. Paved roads are present in low to moderate density in the lower watershed and unpaved logging roads are present in the upper watershed. Riparian areas are scarce in parts of the lower watershed.

2.3.4 Previous Section 7 Consultations and Research Permits in the Action

Section 7 consultation on the new tide gate structure and tide gates was implemented under the programmatic consultation on the proposed NOAA RC Funding and Corps Permitting of Restoration Actions from 2012 to 2022, ESA biological opinion, dated March 21, 2012. Within this biological opinion, the NOAA RC proposed to fund restoration projects in Humboldt, Del Norte, Trinity, Siskiyou, and a part of Mendocino counties which are funded and/or permitted from 2012 through 2022. Since the operation of the new tides gates is integral to the proposed action, they are described in the proposed action section.

Mike Wallace of CDFW has conducted fish monitoring within the Action Area annually for over a decade. Wallace's research project titled *Juvenile Salmonid Use of Sloughs and Tidal Portions of Humboldt Bay Tributaries* has been approved annually in the CDFW 4(d) Research Program (2017 4(d) Research Project #20764). Results from Wallace's research is provided in previous sections. The action agencies for this consultation plan to continue and expand Wallace's monitoring as described in the proposed action section.

2.4 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.

SONCC coho salmon, CC Chinook salmon, NC steelhead, and their critical habitats are likely to be exposed to Project-related construction activities. Project activities that may have adverse effects to coho salmon, Chinook salmon, and steelhead include fish capture and relocation, and fish monitoring. The following sections analyze these potential effects.

2.4.1 Fish Relocation

Before any de-watering activities begin in any creeks or channels within the action area, cofferdams will be erected and fish will be relocated out of the construction area into a flowing channel segment by a fisheries biologist approved by project partners with NMFS and NOAA. In deeper or larger areas, water levels shall first be lowered to manageable levels using methods to ensure no impacts to fish. A qualified fisheries biologist or aquatic ecologist will then perform appropriate seining, dip netting, trapping and/or electrofishing to a point at which the biologist is assured that almost all individuals within the work area have been caught. These individuals will be kept in buckets or insulated coolers equipped with battery operated aerators to ensure survival, and will be relocated to an appropriate flowing channel segment or other appropriate habitat as identified by NMFS.

Fish relocation activities pose a risk of death or injury to any salmonids present. Any fish collecting gear has some associated risk to fish, including stress, disease transmission, injury, or death (Hayes *et al.* 1996). Seining, dip netting, and trapping associated with fish relocation activities may result in injury or death to salmonids (see Capture by Seine and Minnow Trap in the fish monitoring section below) including crushing or stranding as these methods may not be able to capture all fish within the area to be dewatered. Fish relocation will occur during the work window beginning in 2017 and is expected to occur annually for three years. Therefore, these activities have the potential to adversely affect juvenile salmonids for up to three construction seasons, with an estimated single dewatering event for phases 2-4 and two dewatering events for phases 5 & 6. The amount of unintentional injury and mortality attributable to fish capture varies widely depending on the method used, the ambient conditions, the number of fish present, and the expertise and experience of the field crew. Because fish relocation activities will be conducted by qualified fisheries biologists, direct effects to and mortality of juvenile coho salmon, Chinook salmon, and steelhead during capture will be minimized. Consequently, small numbers of juvenile coho salmon, Chinook salmon, and steelhead may be injured or killed from crushing or stranding during fish relocation events.

Fish numbers from the mainstem and east tributary slough areas during past fish sampling efforts were reported separately. Because the action area encompasses both of these portions of the slough, NMFS summed the numbers from those sampling events to assist in determining total numbers within the Project site. In addition, NMFS incorporated fish sampling numbers from Martin Slough pikeminnow surveys, which were reported separately from normal CDFW sampling events. This provides the most comprehensive maximum, minimum, and mean fish totals for the entire Martin Slough Project area. Numbers are rounded to the nearest whole digit.

Coho Salmon

Juvenile coho salmon will be captured and then relocated during dewatering to prevent injury or mortality (as described in Section 1.3.13. Other life stages of coho salmon are not likely to occur between July 1st and November 15th in Martin Slough, so they would not be directly affected by in-stream channel activities.

The maximum, minimum, and mean number of yearling coho salmon captured during one sampling event at Martin slough from 2007-2017 was 647, 0, and 38 individuals respectively. The maximum, minimum, and mean number of YOY coho salmon was 121, 0, and 7 respectively. Although 647 yearling coho and 121 YOY coho salmon could be in the slough during the spring/winter, the maximum, minimum, and mean number of yearling and YOY coho salmon during the summer months/construction season (June 15th-November 15th) is significantly lower. Specifically, during this period of time in 2007-2016, a maximum, minimum, and mean of 14, 0, and 2 yearling coho salmon were captured. Similarly, the maximum, minimum, and mean for YOY coho salmon during this same time period was 64, 0, and 8 respectively. Since fish relocation is intended to remove all fish out of the areas to be dewatered, it is possible that the numbers will be higher than the previous sampling especially in years two and three and habitat conditions improve.

Considering a work period spanning from June 15th-October 15 (or November 15 if there is no significant rain event) for up to three construction seasons, with an estimated single dewatering event for phases 2-4 and two dewatering events for phases 5 & 6, a maximum of 100 juvenile coho salmon could be affected by the Project work the first year and up to 600 for the second and third years. There is an estimated 3 percent mortality for salmonids as a result of fish relocation for restoration projects (Collins 2004, NMFS 2012). Based on habitat conditions in the action area and the amount of steelhead identified in previous sampling events, NMFS expects no more than 1,300 juvenile coho salmon individuals will be relocated with a maximum of 39 mortalities from dewatering activities.

Chinook Salmon

Block nets will exclude Chinook salmon during channel construction areas, and if any are present, they would be relocated. Previous sampling suggests the species is infrequently present in most parts of the Project area, although the new tide gate has presumably improved access. Only one juvenile Chinook was captured in Martin Slough in recent sampling events (Ojerholm and Wallace,

2016) and adult Chinook salmon are not expected to be present during the work window. However, post-project monitoring will likely see increased numbers of juvenile Chinook salmon.

Chinook salmon have been recorded in Martin Slough during from June 15th-August 15th (during the construction season work window). Considering a work period spanning from June 15th-October 15 or November 15 if there is no significant rain event for both phases 2-4 and phases 5-6, with an estimated single dewatering event per seasons, a maximum of 20 Chinook salmon could be affected from the Project work per year. There is an estimated 3 percent mortality for salmonids as a result of fish relocation for restoration projects (Collins 2004, NMFS 2012). Based on habitat conditions in the action area, the small number of Chinook salmon identified in previous sampling events, and the expected increase in numbers of Chinook salmon individuals after the first season, NMFS expects no more than 60 Chinook individuals will be relocated with a maximum of 2 mortalities from dewatering activities annually.

Steelhead

Steelhead occur in Martin Slough in small numbers, and it is possible that a few fish will need to be relocated during channel restoration activities. Although no Steelhead were captured during July through October sampling events in 2015, it is expected that the proposed actions associated with the Project will result in a much higher Steelhead presence in Martin Slough after the first season due to improved habitat conditions. Therefore, NMFS assumes that the numbers of steelhead likely to be affected by fish capture and relocation activities will be significantly greater than past monitoring data suggests.

Considering a work period spanning from June 15th-October 15 or November 15 if there is no significant rain event (for up to three construction seasons), with an estimated single dewatering event for phases 2-4 and two dewatering events for phases 5 & 6, a maximum of 15 steelhead could be affected from the Project work per year. There is an estimated 3 percent mortality for salmonids as a result of relocation projects (Collins 2004, NMFS 2012). Based on habitat conditions in the action area and the small number of steelhead identified in previous sampling events, NMFS expects no more than 45 steelhead individuals will be relocated with a maximum of 2 mortalities from dewatering activities.

Coho salmon, Chinook salmon, and Steelhead

Indirect effects associated with capture and relocation activities include predation, competition, and impeded migration. Relocated fish may be exposed to additional predation pressure from birds or other carnivores. However, because salmonids will be relocated to similar habitat adjacent to the work area, predation is expected to be negligible. Relocated fish may have to compete with other fish causing increased competition for available resources such as food and habitat (Keeley 2003). The growth rate of fish can be slowed when density is high. Due to the current low density of salmonids in Martin Slough, increased competition as a result of increased density is not expected to result in a reduction in fitness of individual salmonids.

Block nets will exclude all species from entering in-channel construction areas, and if any are present within the work area, they would be relocated. As previously mentioned, earlier sampling suggests most species are infrequently present in most parts of the action area during the work windows. Therefore, impeded migration resulting from the block nets is not expected to result in a reduction in fitness of individual salmonids.

2.4.2 Fish Monitoring

Capture by Seine and Minnow Trap

Beach seines will be used to capture juvenile ESA-listed salmonids. Beach seines encircle and concentrate fish, and then the seine is brought to shore where fish are removed and placed into buckets or live-cars. The potential adverse effects of capture by seine on juvenile ESA-listed salmonids include entanglement (gilling), scale and mucus abrasion, suffocation, and crushing. Seines and dip-nets with knotless nylon mesh will be utilized to minimize scale and mucus abrasion. Seine tows will be short to prevent suffocation and to ensure that no debris (*e.g.,* rocks, logs, abundant vegetation) are trapped in the seine that may suffocate or crush fish. In the event that debris is trapped within the beach seine, the debris will be removed before fish are centralized in the net to prevent harm. Biologists will use the smallest mesh-size seine-net that is appropriate to achieve sampling objectives while reducing the probability that smaller fish will become gilled in the net. Minnow traps will be used to capture juvenile ESA-listed salmonids. Traps will be fished at each site on the bottom of the channel next to habitat structures if possible, with a short soak time from 30 to 180 minutes.

Any physical handling or psychological disturbance is known to be stressful to fish (Sharpe *et al.* 1998). The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the creek and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18º Celsius or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied regularly. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe *et al.* 1998). The proposed action contain measures that mitigate the factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

PIT Tagging

All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled; therefore any researchers engaged in such activities will follow the conditions listed previously in this opinion to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, and quality control checking. All fish that are subjected to PIT tagging will be thoroughly anesthetized, which will expedite PIT tag insertion and reduce the probability of injury to the fish. Fish will be carefully observed and allowed to recover fully before being released.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987, Jenkins and Smith 1990, Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 kilometers), Hockersmith et al. (2000) concluded that the performance of yearling chinook salmon was not adversely affected by gastrically- or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coho Salmon

Monitoring would begin in 2017 and would be conducted annually for 8 year period, with some resulting handling and harassment of coho salmon. While the risk of monitoring-related mortality is low, it is possible. It is expected that restoration efforts will increase habitat quality in Martin Slough, and therefore more coho salmon are expected to use the action area during the winter/spring and to be captured during sampling events. The pre-project monitoring that has been conducted by CDFW sampled 6 sites throughout Martin Slough. The post-project monitoring will include CDFW's original 6 sites and add an additional 6 sites for a total of 12 sites. According to CDFW's pre-project sampling efforts, the 2009 sampling year had the greatest number of coho yearling captures on Martin Slough with 504 in the winter, 8 in the fall, 23 in the summer and 254 in the spring for a total of 789 handled in 2009. Based on these numbers, the improved habitat conditions and the 6 additional monitoring sites that will be sampled annually, NMFS anticipates that no more than 800 coho 1+ and 135 YOY coho will be captured, handled and released each year. These fish will not be PIT tagged and mortality is expected to be <1 percent or no more than 8 coho 1+ and 2 YOY coho salmon individuals per year. In addition, NMFS anticipates that no more than 800 coho 1+ will be captured, PIT tagged, and released each year. Mortality is expected to be no more than 3 percent or no more than 24 coho 1+ each year. Therefore, NMFS expects no more than 12,800 coho 1+ and 1,080 YOY coho salmon (13,880 total coho salmon) individuals will be handled with a maximum of 272 mortalities from fish monitoring activities over the course of 8 years of monitoring.

Chinook Salmon

Monitoring would begin in 2017 and would be conducted annually for 8 year period, with some resulting handling and harassment of Chinook salmon. While the risk of monitoring-related mortality is low, it is possible. Because restoration efforts should increase habitat quality in Martin Slough, more Chinook salmon are expected to be present in the action area during the winter/spring and captured during sampling events. NMFS anticipates that no more than 50 juvenile Chinook and 300 YOY Chinook salmon will be captured, handled and released each year. These fish will not be PIT tagged and mortality is expected to be <1 percent or no more than 1 juvenile and 3 YOY Chinook salmon individuals per year. In addition, NMFS anticipates up to 50 Chinook age 1+ to be handled and PIT tagged per year with a potential mortality of 3 percent or 2 individuals. Therefore, NMFS expects no more than 800 Chinook salmon 1+ and 2,400 YOY Chinook salmon (3,200 total Chinook salmon) individuals will be handled with a maximum of 48 mortalities from fish monitoring activities over the course of 8 years.

Steelhead
Monitoring would begin in 2017 and would be conducted annually for 8 year period, with some resulting handling, PIT tagging and harassment of steelhead. While the risk of monitoring-related mortality is low, it is possible. Because restoration efforts should increase habitat quality in Martin Slough, more steelhead are expected to be in the action area during the winter/spring and captured during sampling events. NMFS anticipates that no more than 150 steelhead 1+ and 300 steelhead YOY will be captured, handled and released each year. These fish will not be PIT tagged and mortality is expected to be <1 percent or no more than 2 steelhead 1+ and 1 steelhead YOY individuals per year. In addition, NMFS anticipates up to 150 steelhead 1+ to be handled and PIT tagged per year with a potential mortality of 3 percent or 5 individuals. Therefore, NMFS expects no more than 2,400 steelhead 1+ and 800 YOY steelhead (3,200 total steelhead) individuals will be handled with a maximum of 64 mortalities from fish monitoring activities over the course of 8 years of monitoring.

2.4.5 Interdependent and Interrelated Effects

Regulations implementing section 7(a)(2) of the ESA require NMFS to consider the effects of activities that are interrelated or interdependent with the proposed Federal action (50 CFR 402.02). Interrelated actions are those that are part of the larger action and depend upon the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consultation. As mentioned earlier in this Opinion, there are no interdependent or interrelated actions associated with the proposed action other than those already identified and assessed; therefore, there are no additional effects of interrelated or interdependent actions.

2.5 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.3).

The recently constructed Martin Slough Interceptor project consists of a wastewater interceptor system that will improve the water quality of the Martin Slough Watershed and Humboldt Bay by reducing incidents of Sanitary Sewer Overflows. This project is located within the action area and includes the installation of a new buried sewer transmission pipeline that is located outside the aquatic habitat of the action area. The Interceptor Project will benefit water quality in Martin Slough and in combination with the Martin Slough Enhancement Project is not anticipated to have any cumulatively impacts.

The City of Eureka has proposed construction of an irrigation supply pond and associated well within the action area. The pond would be lined and have a two to three-day storage capacity. The well is expected to extend to a depth of 300 ft, with the upper 100 ft grouted to avoid drawing from near-surface groundwater supplies. The Project is currently at 65 percent design. Grant funds for final design have been applied for but not yet allocated.

2.5.1 Hydrological Effects

The Project would improve habitat by widening the channel and increasing complexity. In the longer term, development in the upper watershed would have varying influences on flow depending on the effectiveness of mitigation measures incorporated in those projects.

2.5.2 Water Quality

There could be water quality constituents prevalent in the action area that may be harmful to aquatic life either directly or indirectly. These include excessive nutrients and pathogens from agriculture operations and inputs from landscaping on surrounding developed lands (golf course, residential, commercial, etc.). These pollutants could cause harm to fish if they are found in high enough concentrations. The proposed Project will not increase background existing levels of these constituents although there may be localized short-term release from disturbing the substrate where they have adsorbed to buried soils. Revegetation zones along the riparian area will buffer future input of nutrients and pathogens to the stream channel.

During construction of projects, there could be increased sediment, which should be mitigated through project construction BMPs and the Storm Water Pollution Prevention Plan(s). The Martin Slough project will improve water quality, while the effects of potential longer term development projects in the watershed are unknown at this time. The project will increase the tidal prism and could reduce sediment blockage which might otherwise occur.

Construction of each project could result in short-term impacts to sensitive biological resources that could in turn affect listed species. However, these impacts will be avoided and minimized through BMPs.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) 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 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 diminishes the value of designated or proposed critical habitat for the conservation of the species.

While the action area is highly disturbed and largely disconnected from tidal influence, it has potential to support a number of federally listed species. The Project has been designed to restore and enhance tidal and freshwater wetlands and riparian habitat that were characteristic of the historic Martin Slough ecosystem. The Project is expected to improve habitat conditions for coho salmon, Chinook salmon and steelhead within the action area by providing a matrix of restored landscape features of native salt marsh, fresh and brackish wetland, seasonal wetland, and riparian habitats intended to provide for fish and wildlife habitat. However, construction of the Project may result in some short-term impacts to coho salmon, Chinook salmon and steelhead and their habitat.

In total, the combination of increased turbidity as a result of sediment inputs to the slough channel and degraded water quality as a result chemical contamination is not expected to reduce the fitness, reproductive success, or survival of individual coho salmon, Chinook salmon, or steelhead. Two components of the Project, fish relocation and fish monitoring have the potential to result in death or injury to coho salmon, Chinook salmon, and steelhead juveniles.

Recent surveys demonstrate it is reasonable to estimate that 1,300, 60, and 45 individuals of coho salmon, Chinook salmon, and steelhead respectively, may be captured and relocated. Because mortality resulting from capture and relocation is estimated to be approximately 3 percent, mortalities for coho salmon, Chinook salmon, and steelhead are expected to be up to 39, 2, and 2 individuals respectively (Table 5).

Coho salmon, Chinook salmon, and steelhead individuals may die or be injured from fish monitoring activities. Recent surveys demonstrate it is reasonable to estimate that 12,800, 800, and 2,400 individuals of yearling coho salmon, Chinook salmon +1, and steelhead +1 respectively, may be captured and released or tagged in the 8 year duration. Because mortality resulting from handling and releasing these individuals is estimated to be approximately one percent, mortalities for yearling coho salmon, Chinook salmon, and steelhead +1 are expected to be up to 64, 8, and 16 individuals respectively. Because mortality resulting from capture and tagging is estimated to be approximately 3 percent, mortalities for yearling coho salmon, Chinook salmon +1, and steelhead +1 are expected to be up to 192, 16, and 40 individuals respectively.

Furthermore, YOY coho salmon, YOY Chinook salmon, and YOY steelhead will not be PIT tagged. Recent surveys demonstrate it is reasonable to estimate that 1,080, 2,400, and 800 individuals of YOY coho salmon, YOY Chinook salmon, and YOY steelhead respectively, may be handled during monitoring over the course of three construction seasons and 5 years post project. Because mortality resulting from handling these individuals is estimated to be approximately one percent, mortalities for YOY coho salmon, YOY Chinook salmon, and YOY steelhead are expected to be up to 16, 24, and 8 individuals respectively.

In summary, 13,880, 3,200, and 3,200 individuals of coho salmon, Chinook salmon, and steelhead will be handled with a maximum of 272, 48, and 64 mortalities respectively, from fish monitoring activities during construction annually and five years post construction (Table 6).

The loss of up to 311, 50, and 66 individuals of coho salmon, Chinook salmon, and steelhead respectively, within the action area, which in total constitutes less than one percent of their respective Humboldt Bay Tributaries juvenile populations, represents a measurable, albeit non-appreciable reduction in the abundance of juveniles in each species' respective population during the 8 years exposed to Project activities (Table 7). The loss or injury of these individuals of each species from their respective populations is not expected to affect their likelihood of recovery.

The Project is expected to increase the value of designated critical habitat within the action area. Project features are expected to enhance habitat conditions for salmonid spawning, rearing, and migration in the action area in future years. The Project is expected to appreciably improve the PCEs of coho salmon, Chinook salmon and steelhead designated critical habitat. Improvement to the condition of critical habitat and the condition of listed species is likely to occur based on the restoration and enhancement of tidal and freshwater wetlands, rearing habitat and riparian habitat. These improved habitat conditions will increase success and survival of individual coho salmon, Chinook salmon and steelhead. Further, these improvements will increase the amount of acceptable habitat available within the Martin Slough watershed and will increase the likelihood of recovery of coho salmon, Chinook salmon and steelhead.

2.7 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, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, and NC Steelhead or destroy or adversely modify their designated critical habitats.

2.8 Incidental Take Statement

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

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Take of juvenile coho salmon, Chinook salmon, and steelhead is expected in the form of capture during fish relocation and monitoring. NMFS expects no more than 15,180 juvenile coho salmon, 3,260 juvenile Chinook salmon, and 3,245 juvenile steelhead will be captured, and no more than 311 juvenile coho salmon, 50 juvenile Chinook salmon, and 66 juvenile steelhead will be killed as a result of the proposed action (Table 5-7).

Table 5. Incidental Take Resulting from Fish Relocation

Amount or Extent of Take of Salmonids				
Year	**Action (Type)**	**Coho Salmon**	**Chinook Salmon**	**Steelhead**
1	Relocation	100	20	15
2	Relocation	600	20	15
3	Relocation	600	20	15
Total (3 years)		**1,300**	**60**	**45**
Total Mortality (based on 3% mortality)		**39**	**2**	**2**

Table 6. Incidental Take Resulting from Monitoring

Amount or Extent of Take of Salmonids				
Year	**Action (Type)**	**Coho Salmon**	**Chinook Salmon**	**Steelhead**
1	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
2	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
3	Monitoring (Capture & PIT Tagging)	800	50	150

	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
4	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
5	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
6	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
7	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150
	Monitoring (Handling Only-YOY)	135	300	100
8	Monitoring (Capture & PIT Tagging)	800	50	150
	Monitoring (Capture, Handle & Release)	800	50	150

	Monitoring (Handling Only-YOY)	135	300	100
Total (8 years Capture & PIT tagging)		**6,400**	**400**	**1,200**
Total Mortality (based on 3% capture and PIT tagging mortality)		**192**	**16**	**40**
Total (8 years Capture, Handle & Release)		**6,400**	**400**	**1,200**
Total (based on 1% handling mortality)		**64**	**8**	**16**
Total (8 years Handling Only-YOY)		**1,080**	**2,400**	**800**
Total (based on 1% handling mortality)		**16**	**24**	**8**
Total (8 years)		**13,880**	**3,200**	**3,200**
Total (Handling and PIT tagging mortality)		**272**	**48**	**64**

Table 7. Combined Incidental Take Resulting from Fish Relocation & Monitoring

Amount or Extent of Take of Salmonids			
	Coho Salmon	**Chinook Salmon**	**Steelhead**
Total Amount of Take (Relocation/Monitoring)	**15,180**	**3,260**	**3,245**
Total (Mortality)	**311**	**50**	**66**

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 SONCC coho salmon, CC Chinook salmon, NC Steelhead, or destruction or adverse modification of their critical habitats.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental taking of SONCC coho salmon, CC Chinook salmon, and NC steelhead:

1. USFWS shall take all necessary and appropriate actions within its authorities to minimize injury and mortality to coho salmon, and Chinook salmon, and steelhead resulting from fish relocation, monitoring and dewatering activities.

2. USFWS shall prepare and submit an annual report for fish relocation and fish monitoring activities to document the method of capture, the number of individuals captured by gear type, the location of relocation, and any mortalities or injuries observed.

3. USFWS shall prepare and submit a 3-year report to document fish monitoring and the Project's performance. If funding allows, USFWS will prepare a report documenting the entire extent of pre and post project monitoring.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and USFWS must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). USFWS 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 retain a qualified biologist with expertise in the areas of anadromous salmonid biology, including handling, collecting, and relocating salmonids, salmonid/habitat relationships, and biological monitoring of salmonids. The biologist shall capture fish, by seine or dip nets, from the area to be dewatered and relocate them to suitable habitat outside of the project area.

    B. The biologist shall be present and visually monitor the construction site and offer pertinent advice to persons implementing the activities prior to in-stream channel work to ensure that incidental take to listed salmonids is minimized. The biologist shall be on site during all dewatering events to capture, handle, and safely relocate listed salmonids. The coffer dams and block nets will be checked 3 times each day to ensure that aquatic organisms are not being impinged along the nets, to clear debris, and to ensure that debris accumulation is not jeopardizing the integrity of the block nets. The applicant or USFWS shall notify NMFS biologist Miles Barker at (707) 825-1620 or miles.barker@noaa.gov at least 24 hours prior to relocation activities in order to provide an opportunity for NMFS staff to observe the activities.

    C. Captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish shall not be removed from this water except when released. To avoid predation, the biologist shall have at least two containers to segregate young-of-year fish from larger age-classes and other potential aquatic predators.

D. If any dead or injured listed salmonids are found, the biologist shall contact NMFS biologist Miles Barker by phone immediately at (707) 825-1620. The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. Any and all salmonid mortalities shall 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 shall be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than NMFS Northern California Office without obtaining prior written approval from the Northern California Office. Any such transfer will be subject to such conditions as NMFS deems appropriate.

2. The following term and condition implements reasonable and prudent measure 2:

   The applicant or USFWS shall provide a written annual report to NMFS each year by December 31. The report shall be submitted to NMFS Northern California Office, 1655 Heindon Road, Arcata, California 95521. The report shall contain, at a minimum, the following information:

   Fish Relocation – The report shall 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 listed salmonids, a copy of the logbook, the number of fish relocated by species, the number and species of fish injured or killed, a brief narrative of the circumstances surrounding listed salmonid injuries or mortalities, and a description of any problems which arose during the relocation activities and a statement as to whether or not the activities had any unforeseen effects.

   Fish Monitoring – The report shall summarize annual monitoring activities and will include the number of fish captured by species, the number and species of fish PIT tagged, the number and the number and species of fish injured or killed, a brief narrative of the circumstances surrounding listed salmonid injuries or mortalities, and a description of any problems which arose during monitoring activities and a statement as to whether or not the activities had any unforeseen effects.

3. The following term and condition implements reasonable and prudent measure 3:
   The applicant or USFWS shall provide a written report to NMFS by December 31, 2025. The report shall be submitted to NMFS Northern California Office, 1655 Heindon Road, Arcata, California 95521. The report shall contain, at a minimum, the following information:

Fish Monitoring – The report shall describe the 3 years of post-construction monitoring efforts and contain a summary table for each monitoring season. Additional monitoring reports will be provided depending on funding. The report shall encompass both quantitative and qualitative measures to illustrate the Project's annual performance. The report shall contain copies of monthly fish monitoring data, including: presence/absence of target fish species in re-established or enhanced aquatic habitat, native salmonid access to Martin Slough as well as terminal and off-channel ponds, water quality samples during fish monitoring, and recordings for salinity, water depth, and dissolved oxygen.

2.9 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). The following are conservation measures recommended by NMFS:

1. To minimize harm to relocated fish, NMFS recommends that relocation efforts not take place if air temperatures are greater than 80°F.

2. Any equipment (including boots/waders) and construction equipment should be properly disinfected or cleaned according guidance provided by the State of California Aquatic Invasive Species Management Plan prior to instream work to prevent the spread of aquatic invasive species.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Martin Slough Enhancement 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 ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on 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.

2.11 "Not Likely to Adversely Affect" Determinations

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

The potential impacts to listed fish species and their designated critical habitat that were identified for the proposed action include increased turbidity and suspended sediment, chemical contamination, and increased salinity. The following sections analyze these potential effects.

Effects to Salmon and Steelhead Individuals

Increased Turbidity and Suspended Sediment
Increased turbidity and suspended sediments in Martin Slough may occur as a result of channel excavation after the cofferdams are removed, or as a result of upland restoration activities such as riparian vegetation replanting. Increased turbidity and suspended sediments could cause mortality, illness, or injury of coho salmon, Chinook salmon, and steelhead due to re-suspended contaminants, clogging and abrasion of gill filaments, low-oxygen water, and interference with feeding due to poor visibility (LFR Levine-Fricke 2004). Impacts associated with degraded water quality as a result of increased turbidity will likely be limited to behavioral effects, such as temporarily vacating preferred habitat or temporary reduced feeding efficiency. These behavioral changes are not likely to reduce the fitness of individual salmonids.

Sediment can also smother coho salmon, Chinook salmon, and steelhead eggs, which would affect future fish stocks (Hobbs 1937). However, no suitable spawning gravel has been observed in the Martin Slough Project area and being former tide land, the action area does not contain suitable spawning habitat (*i.e.*, pool-riffle morphology with suitable gravel). Therefore, the project is not anticipated to have any effect on spawning habitat. The introduction of sediments is expected to be short-term and insignificant, and background levels are already high in Martin Slough. In the long-term, turbidity and suspended sediment are expected to be reduced due to upland restoration activities and establishment of a riparian buffer. The proposed minimization measures are expected to effectively minimize the volume of sediment transported to the stream channel in the action area. Therefore, any short-term increases in sediment or turbidity are not expected to reduce the fitness of individual coho salmon, Chinook salmon, or steelhead. Therefore, impacts to listed salmonids due to increased turbidity and suspended sediment are expected to be insignificant.

Chemical Contamination
Equipment refueling, fluid leakage, equipment maintenance near the stream channel, as well as some of the future management and maintenance activities pose some risk of contamination of aquatic habitat within Martin Slough and downstream of the action area. However, upland areas will be used for equipment service and refueling, and all equipment will be washed where wash water cannot flow into wetlands or waters of the U.S./State. Polycyclic aromatic hydrocarbons (PAHs) are chemicals toxic to salmonids that originate from petroleum and combustion products, run-off, asphalt, and automobile emissions. Prolonged exposure to substances such as fuel oils can cause morphological, behavioral, physiological, and biochemical abnormalities (Sindermann *et al.* 1982). The risk of this disturbance would be highest during in-stream channel construction activities and residual effects would be short-term and temporary if they did occur. However, these effects will be avoided through the use of standard BMPs (as described in Section 1.3.15). In addition, all construction equipment will be maintained to prevent leaks of fuels, lubricants, or other

fluids into the slough. Extreme caution will be used when handling and/or storing chemicals and hazardous wastes (*e.g.*, fuel and hydraulic fluid) near waterways, and appropriate materials will be on site to prevent and manage spills. Therefore, no localized water quality degradation is anticipated from toxic chemicals and reduction in fitness of coho salmon, Chinook salmon, or steelhead residing in the action area is not anticipated. Proposed minimization measures (*e.g.*, controlling the discharge of construction-related contaminants through a PPMP) and responses by the applicant to any accidental spill of toxic materials are expected to be sufficient to restrict the effects to the immediate area and not enter the waterway. Therefore, impacts to listed salmonids due to direct or indirect exposure to construction related liquids is extremely unlikely and discountable.

Increased Salinity

Changes in salinity are expected to occur in Martin Slough as a result of the proposed restoration and enhancement activities designed to expand the current channel, ponds, as well as create new ponds. As previously described, the salinity modelling indicated that for both current conditions and at full Project completion salinities fluctuate up and down with the tide and with freshwater inflows. Salinities increase in the downstream direction, with rising tides, and with drops in freshwater inflows whereas salinities fall during freshwater inflow events and when the tide is falling.

As described in section 1.3.7, the completion of the project with the tidegates operating at the full design level, salinities are expected to vary throughout Martin Slough depending on the location and season.

In Martin Slough, increases in salinity are expected to change fish behavior. The ways in which salmonids respond to changes in salinities in the action area will depend mostly on each species' life stage. In some cases, individuals may prefer certain environments based on water quality conditions. Juvenile salmonids are expected to utilize more freshwater habitats such as ponds D, E, and F which will be maintained in the upper layers as the water stratifies, as observed during fish sampling and water quality monitoring conducted between 2006 and 2016. Stratification causes a layering effect with the brackish water being heavier and occupying the bottom of the water column and fresh water being lighter and occupying the upper part of the water column. During the rainy season, salinities greater than 15 ppt will extend upstream in the Martin Slough Mainstem to Pond D. Tidal marsh Complex C (Pond C) will be brackish, but the upstream end of the pond, which receives freshwater input from springs, may have salinities less than 4 ppt. Similarly, Pond D will be brackish at the downstream end, with lower salinity upstream in the pond closer to the tributary inlet where salinities are approximately 5 ppt.

Additionally, Pond E will likely exhibit low salinity due to increased freshwater input from seasonal rains and groundwater inflow during the main time of the year when juvenile coho salmon have been documented using Martin Slough (December to June). Pond E will have varying salinities of 0 ppt to approximately 6 ppt, similar to the mainstem at its outfall location. Pond F is further upstream and it will have very low salinity or be primarily fresh water during the rainy season, with increasing salinity during low flow times of year but maintaining some freshwater habitat due to stratification. Ponds F and G, located in the upper reaches of the Martin Slough Mainstem, are expected to have salinities less than 1 ppt.

At the end of the dry season when stream baseflows are at their lowest, salinities up to 15 ppt are expected to extend from Swain Slough to the upstream head of Pond E. A similar situation may occur for Pond D. Pond E is located where channel salinities drop to a more brackish level. Pond E has salinities of approximately 6 ppt, similar to the mainstem at its outfall location. Ponds F and G are expected to maintain salinities less than 5 ppt. These predicted concentrations are depth averaged. Stratification is expected to occur during these low flow periods, with freshwater dominating the top portion of the water column and high salinities near the bottom.
Although salinities are expected to increase throughout the Project area, freshwater will dominate the top portion of the water column especially during low flow periods in the summertime when some juvenile individuals are known to be present. Pond G is expected to remain fresh throughout the year.

The proposed restoration activities are expected to increase the availability of transition (salt/freshwater) habitat. As a result, this will increase the amount and quality of overwintering and rearing habitat for juvenile coho salmon, which grow larger in estuaries than farther upstream (Wallace and Allen 2009). Similarly, the proposed actions will also improve long-term habitat for steelhead by increasing channel diversity, providing riparian buffer, and expanding off-channel refugia. While very few Chinook salmon are known to be present, it is expected that these activities would benefit individuals from the restoration of in-channel spawning habitat, enhanced riparian buffer, and improved stream flow and habitat complexity. The additional aquatic habitat will improve hydraulic connectivity and increase habitat diversity. The Project will re-establish a muted tidal prism, which will improve adult salmonid migration and spawning runs to upstream tributaries. For these reasons, increases in salinity resulting from restoration and enhancement activities is expected to have a beneficial effect on listed salmonids.

<u>Effects to Salmon and Steelhead Critical Habitat</u>
The designations of critical habitat for SONCC coho salmon, CC Chinook salmon, and NC steelhead use the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). This shift in terminology does not change the approach used in conducting our analysis, whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this consultation, we use the term PBF to mean primary constituent element or essential feature, as appropriate for the specific critical habitat.

Within the range of SONCC coho salmon, CC Chinook salmon, and NC steelhead, the life cycle of these species can be separated into five PBFs or essential habitat types: (1) juvenile year-round rearing areas, (2) juvenile migration corridors, (3) areas for growth and development, (4) adult migration corridors, and (5) spawning areas. Areas 1 and 5 are often located in small headwater streams and side channels, while areas 2 and 4 include these tributaries as well as mainstem reaches and estuarine zones. Growth and development to adulthood (area 3) occurs primarily in near- and off-shore marine waters, although final maturation takes place in freshwater tributaries when the adults return to spawn. Within these areas, essential features of Pacific salmonids' critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions (NMFS 1999). The PBFs of SONCC coho salmon, CC Chinook salmon, and NC steelhead critical habitat associated with this project relate to juvenile year-round rearing areas and juvenile migration corridors. The essential features that may be affected by the proposed action include space for rearing and water quality.

Increased Turbidity and Suspended Sediment
Increased turbidity and suspended sediments in Martin Slough may occur as a result of channel excavation after the cofferdams are removed, channel adjustments after the tidal prism is increased, or as a result of upland restoration activities such as riparian vegetation replanting. Increased turbidity and suspended sediments could cause mortality, illness, or injury of steelhead due to re-suspended contaminants, clogging and abrasion of gill filaments, low-oxygen water, and interference with feeding due to poor visibility (LFR Levine-Fricke 2004). Sediment can also smother steelhead eggs, which would affect future fish stocks (Hobbs 1937). However, no suitable spawning gravel has been observed in the Martin Slough Project area and being former tide land, the Project site does not contain suitable spawning habitat (*i.e.*, pool-riffle morphology with suitable gravel). Therefore the Project is not anticipated to have any effect on spawning habitat. The introduction of sediments is expected to be short-term and insignificant, and background levels are already high in Martin Slough. In the long-term, turbidity and suspended sediment are expected to be reduced due to upland restoration activities and establishment of a riparian buffer.

The proposed minimization measures are expected to effectively minimize the volume of sediment transported to the stream channel in the action area. Impacts to the rearing habitat function of critical habitat for coho salmon, Chinook salmon, and steelhead are expected to result from short-term increases in sediment or turbidity; therefore impacts are expected to be insignificant.

Chemical Contamination
Proposed minimization measures (*e.g.*, controlling the discharge of construction-related contaminants through a PPMP) and responses by the applicant to any accidental spill of toxic materials are expected to be sufficient to restrict the effects to the immediate area and not enter the waterway; therefore, impacts to the water quality function of critical habitat for coho salmon, Chinook salmon, and steelhead are expected to be discountable.

Although localized temporary impacts to critical habitat could occur, the essential features of the essential habitat types of the critical habitat will not be measurably altered, so impacts will be insignificant. Therefore, the aforementioned project impacts "may affect, but are not likely to adversely affect" designated critical habitat for SONCC coho salmon, CC Chinook salmon, and NC steelhead.

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. The MSA (Section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." 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) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by USFWS and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council [PFMC] 2005) and the Pacific Coast Salmon Fishery Management Plan as revised through Amendment 18 (PFMC 2014), (79 FR 75449, NMFS 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

USFWS proposes to enhance Martin Slough through the construction of new tide gates, new ponds and a modified channel in the Elk River watershed, Humboldt County, California. Martin Slough has been designated EFH for Pacific Coast groundfish and Pacific Coast Salmon Fishery Management Plans. A detailed description of the proposed action and affected habitat is provided in the associated biological opinion.

3.2 Adverse Effects on Essential Fish Habitat

Adverse effects of the proposed action on Pacific Coast groundfish EFH and Pacific Coast Salmon are as follows:

1. Temporary habitat degradation from increased suspended sediment and turbidity,
2. Temporary loss of habitat during construction activities.

Lower Martin Slough was historically an estuarine environment. Starry flounder and English sole have been collected from nearby estuaries and eelgrass habitat is widespread in Humboldt Bay and the estuarine regions of Humboldt Bay tributaries (Downie and Lucey 2005, USFWS 2010). These species are likely to use tidal channels, mudflats, and marsh edge habitats of the lowermost reaches of the Elk River Watershed as nursery and foraging habitat, occurring mostly in marine and brackish water habitats. Coho and Chinook salmon are also known to use Martin Slough as rearing habitat. Brackish water habitats, such as Martin Slough, may be used for over-wintering or rearing, and are important transitional habitats for juvenile salmonids undergoing smoltification as they move into marine habitats.

Channel dredging operations can produce a suspended sediment plume that remains for varying durations of time. Resultant reduction in photosynthesis could indirectly affect EFH productivity. The reduced photosynthesis could result in a disruption to food source and feeding habits for fish that utilize the EFH. Project activities may adversely affect EFH for Pacific salmon and Pacific Groundfish by temporarily increasing turbidity and disturbing the benthos during sediment removal. However, given the general low quality of existing habitat in Martin Slough, the adverse effects to EFH would be temporary and minimal. Turbidity issues would be minimized with the BMPs prescribed. No lasting negative impacts to water quality (including temperature), food sources, water depths, or vegetation will occur as a result of the proposed project. No enduring negative effects on fish abundance, health, or long-term sustainability of Pacific Coast Groundfish and Pacific Coast Salmon EFH will result from the proposed project.

After reviewing the effects of the Project, NMFS has determined that the proposed action would adversely affect Pacific Coast groundfish and Pacific Coast Salmon EFH.

Effects to eelgrass from increased sediment, turbidity, and salinity

Two small patches of eelgrass, each approximately one square foot in size, have been observed in Swain Slough approximately 15 ft from the existing tide gates (RCAA 2012). Therefore, there is the potential for construction activities to produce turbidity and sediment-related effects on eelgrass. Construction activities and channel adjustments after construction. Although eelgrass may be exposed to increased turbidity and suspended sediments from construction-related activities, it is expected that these effects would be minor and of short duration. These identified eelgrass patches are not likely to experience a reduction in areal extent and density from increased turbidity and suspended sediment. BMPs (as described in Section 1.3.15 with regard to sediment management and turbidity will be employed to minimize any short duration effects from discharge from the slough. These measures include installation and maintenance of in-stream turbidity curtains and silt-fence along channel banks as specified in project designs, specifications, and erosion control plans.

Upon project completion, the channel enhancements will be able to accommodate the additional volume for increased tidal inundation. The USFWS can reintroduce the tidal prism at the full build out level. As a result, these changes in tidal inundation coupled with increases in salinity throughout Martin Slough and Swain Slough may allow for eelgrass expansion. Therefore, NMFS anticipates that the areal extent of eelgrass may increase in the action area. Determining these anticipated changes to eelgrass will require the completion of quality surveys and mapping prior to construction and post-construction. Although a reduction in the areal extent of eelgrass is not expected, NMFS finds it appropriate to document any potential changes to areal extent and density for the purposes of potential mitigation needed. NMFS believes that the proposed BMPs will adequately address turbidity and sediment-related effects to eelgrass. Additionally, the aforementioned activities have the potential to expand eelgrass in the action area; therefore, NMFS will not require pre-project mitigation.

3.3 Essential Fish Habitat Conservation Recommendations

1. To minimize the effects of temporary habitat degradation and eelgrass disturbance from increased suspended sediment and turbidity, NMFS recommends the BMPs described in Section 1.3.14 are used to the maximum extent practicable.
2. To determine changes in eelgrass areal extent and density, NMFS recommends that eelgrass surveys are conducted 500 feet upstream and downstream of the tidegate. These surveys should include: conducting a pre- and post-construction eelgrass survey, in accordance with the California Eelgrass Mitigation Policy's protocol for mapping (including the un-vegetated area surrounding each). If necessary, the amount of eelgrass mitigation will be determined from pre-construction and post-construction eelgrass survey data.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, USFWS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

USFWS 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 USFWS, NOAA RC, and the Corps. Other interested users could include the permit applicants and persons interested in the conservation of the affected ESU and DPS. Individual copies of this opinion were provided to USFWS, NOAA RC, and the Corps. This opinion will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

5.1 Literature Cited

Anderson, C.W., and D. Ward. 2016. Results of Freshwater Creek Salmonid Life Cycle Monitoring Station 2015-2016.

Battin, J., M. W. Wiley, M. H. Ruckelshaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. PNAS 104(16):6720-6725. doi:10.1073/pnas.0701685104

Beamish, R.J., C. Mahnken, and C.M. Neville. 1997. Hatchery and wild production of Pacific salmon in relation to large-scale, natural shifts in the productivity of the marine environment. ICES Journal of Marine Science 54:1200–1215.

Beechie, T.J., E. Buhle, M.H. Ruckelshaus, A.H. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation 130(4):560-572.

Bell, E., W. G. Duffy, and T. D. Roelofs. 2001. Fidelity and survival of juvenile coho salmon in response to a flood. Transactions of the American Fisheries Society 130:450-458.

Bjorkstedt, E.P., B.C. Spence, J. C. Garza, D.G. Hankin, D. Fuller, W.E. Jones, J. J. Smith, and R. Macedo. 2005. An analysis of historical population structure for Evolutionarily Significant Units of Chinook salmon, coho salmon, and steelhead in the North-Central California Coast Recovery Domain. NOAA Technical Memorandum NMFS-SWFSC- 382: 1-210. US Department of Commerce, La Jolla, California. October.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Publication 19. 83-138.

Bradford, M.J., and J.R. Irvine. 2000. Land use, fishing, climate change, and the decline of Thompson River, British Columbia, coho salmon. Canadian Journal of Fisheries and Aquatic Sciences 57:13-16.

Brown, T.G., and G.F. Hartman. 1988. Contribution of Seasonally Flooded Lands and Minor Tributaries to the Production of Coho Salmon in Carnation Creek, British Columbia. Transactions of the American Fisheries Society. 117:6. 7 p

Brown, L.R., and P.B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service. Department of Wildlife and Fisheries Biology, University of California at Davis.

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. Volume 14, No. 2, p 237-261.

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

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

California Department of Fish and Game (CDFG). 2002. Status review of California coho salmon north of San Francisco. Report to the California Fish and Game Commission. Candidate Species Status Review Report 2002-3.

California Department of Fish and Game (CDFG). 2004. Recovery strategy for California coho salmon. Report to the California Fish and Game Commission. 594 pp. Copies/CDs available upon request from California Department of Fish and Game, Native Anadromous Fish and Watershed Branch, 1416 9th Street, Sacramento, California 95814, or on-line: http://www.dfg.ca.gov/nafwb.cohorecovery

California Department of Fish and Game (CDFG). 2011. 2007-2011 Field Notes – Martin Slough. CDFG Field Office, Eureka, CA, USA.

California Department of Fish and Wildlife (CDFW). 2013. Elk River adult salmonid data for 2009-2013.

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, University of British Columbia, Vancouver.

Collins, B.W. 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 Amery (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, Fortuna, California. March 24.

Conner, W.P., H.L. Burge, and R. Waitt. 2001. Snake River fall Chinook salmon early life history, condition, and growth as affected by dams. Unpublished report prepared by the U.S. Fish and Wildlife Service and University of Idaho, Moscow, ID. 4 p.

Dahl, T.E., and C.E. Johnson. 1991. Status and trends in the conterminous United States, mid-1970s to Mid-1980s U.S. Department of the Interior: Fish and Wildlife Service, Washington, D.C. 28 pp.

Dahl, T.E. 2011. Status and trends of wetlands in the conterminous United States 2004 to 2009. U.S. Department of the Interior; Fish and Wildlife Service, Washington, D.C. 108 pp.

Doppelt, B., R. Hamilton, C.D., Williams, and M. Koopman. 2008. Preparing for Climate Change in the Rogue River Basin of Southwest Oregon: Stressors, risk, resilience and resistance in human, built, economic, and natural systems. University of Oregon Climate Leadership Initiative, University of Oregon Institute for Sustainable Environment, and the National Center for Conservation Science and Policy. 43pp.

Downie, S. T. and K. P. Lucey. 2005. Salt River watershed assessment. Coastal Watershed Planning and Assesment Program. California Department of Fish and Game, Arcata, California, USA.

Ebersole, J.L., M.E. Colvin, P.J. Wigington, S.G. Leibowitz, J.P. Baker, M.R. Church, J.E. Compton, and M.A. Cairns. 2009. Hierarchical modeling of late-summer weight and summer abundance of juvenile coho salmon across a stream network. Transactions of the American Fisheries Society 138:1138-1156.

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

Fleming, I.A., K. Hindar, I.B. Mjölneröd, B. Jonsson, T. Balstad and A. Lamberg. 2000. Lifetime success and interactions of farm salmon invading a native population. Proceedings of the Royal Society of London B-Biological Sciences 267:1517–1523.

Garwood, J. 2012. Historic and Recent Occurrence of Coho Salmon (*Oncorhynchus kisutch*) in California Streams within the Southern Oregon/Northern California Evolutionarily Significant Unit. Unpublished California Department of Fish and Game Report. Fisheries Branch Administrative Report, 2012-03.

Gleick, P.H., and E.L. Chalecki. 1999. The impacts of climatic changes for water resources of the Colorado and Sacramento-San Joaquin river basins. Journal of the American Water Resources Association 35:1429-1441.

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. 598 pp.

Green Diamond Resource Company (GDRC). 2013. Report to NMFS for Permit 1060-Mod 1. Juvenile Salmonid Outmigrant Trapping Program. Ryan Creek.

Halligan, D. Stillwater Sciences, Personal observation.

Hamlet, A.F., P.W. Mote, M.P. Clark, and D.P. Lettenmaier. 2005. Effects of temperature and precipitation variability on snowpack trends in the western United States. Journal of Climate 18:4545-4561.

Hamlet, A.F., and D.P. Lettenmaier. 1999. Columbia River Streamflow Forecasting Based on ENSO and PDO Climate Signals. Journal of Water Resources Planning and Management 125(6):333-341.

Hartman, G. F. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada 22: 1,035–1,081.

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

Healey, M. C. 1991. Life history of Chinook salmon (Oncorhynchus tshawytscha). Pages 311–393 in C. Groot and L. Margolis, editors. Pacific salmon life histories. University of British Columbia Press, Vancouver.

Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Humboldt Chapter, American Fisheries Society.

Hobbs, D. F. 1937. Natural reproduction of quinnat salmon, brown trout in certain New Zealand waters, Fish Bull. N. Z., 6, 1-104.

Hockersmith, E.E., W.D. Muir, and others. 2000. Comparative performance of sham radiotagged and PIT-tagged juvenile salmon. Report to U.S. Army Corps of Engineers, Contract W66Qkz91521282, 25 pp.

Humboldt County Public Works Department (County) and Stillwater Sciences. 2011. Biological Assessment for Levee Maintenance Operations in Lower Redwood Creek, Humboldt County, California. Prepared by Humboldt County Public Works Department, Eureka, California and Stillwater Sciences, Arcata, California. February. 76 p.

Jensen, D.B., M. Torn, and J. Harte. 1990. *In* Our Own Hands: A Strategy for Conserving Biological Diversity in California. California policy seminar research report. University of California, Berkeley, California.

Jenkins, W.E. and T.I.J. Smith. 1990. Use of PIT tags to individually identify striped bass and red drum brood stocks. American Fisheries Society Symposium 7: 341-345.

Keeley, Ernest R. 2003. An experimental analysis of self-thinning in juvenile steelhead trout. Oikos 102.3 (2003): 543-550.

Keter, T. 1995. Environmental history and cultural ecology of the North Fork of the Eel Basin, California. USDA Forest Service, Pacific Southwest Region, R5-EM-TP-002. 116 p.

Knowles, N., and D. R. Cayan. 2004. Elevational dependence of projected hydrologic changes in the San Francisco Estuary and watershed. Climatic Change 62: 319-336.

Kostow, K.E. 2004. Differences in juvenile phenotypes and survival between hatchery stocks and a natural population provide evidence for modified selection due to captive breeding. Canadian Journal of Fisheries and Aquatic Sciences 61:577–589.

Kostow, K.E., A.R. Marshall and S.R. Phelps. 2003. Naturally spawning hatchery steelhead contribute to smolt production but experience low reproductive success. Transactions of the American Fisheries Society 132:780–790.

Kostow, K.E., and S. Zhou. 2006. The effect of an introduced summer steelhead hatchery stock on the productivity of a wild winter steelhead population. Transactions of the American Fisheries Society 135:825–841.

Koski, K.V. 2009. The fate of coho salmon nomads: the story of an estuarine-rearing strategy promoting resilience. Ecology and Society 14(1): 4.

Kramer, S. USFWS, Feb, 2017

Levin, P.S., R.W. Zabel, and J.G. Williams. 2001. The road to extinction is paved with good intentions: negative association of fish hatcheries with threatened salmon. Proceedings of the Royal Society of London B-Biological Sciences 268:1153–1158.

LFR Levine-Fricke. 2004. Draft Framework for Assessment of Potential Effects of Dredging on Sensitive Fish Species in San Francisco Bay. Prepared for U.S. Army Corps of Engineers, San Francisco District, San Francisco, California. 135 pp.

MacFarlane, R.B., S. Hayes, and B. Wells. 2008. Coho and Chinook salmon decline in California during the spawning seasons of 2007/08. National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division. Santa Cruz, CA.

Mantua, M., I. Tohver, and A. Hamlet. 2010. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. Climate Change 102: 187-223.

Mason, J. C. 1976. Some features of coho salmon (*Oncorhynchus kisutch*) fry emerging from simulated redds and concurrent changes in photobehavior. Fishery Bulletin 74: 167–175.

Mayer, T. 2008. Analysis of trends and changes in Upper Klamath Lake hydroclimatology. United States Fish and Wildlife Service. Water Resources Branch. Portland, Oregon. 31 pp.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-42. Seattle. 156 pp.

McEwan, D., and T.A. Jackson. 1996. Steelhead restoration and management plan for California. California Department of Fish and Game, Inland Fisheries Division. 244 pp.

McGinnity, P., P. Prodo, A. Ferguson, R. Hynes, N. O´ Maoile´idigh, N. Baker, D. Cotter, B. O'Hea, D. Cooke, G. Rogan, J. Taggart and T. Cross. 2003. Fitness reduction and potential extinction of wild populations of Atlantic salmon, *Salmo salar*, as a result of

McMahon, T. E., and G. F. Hartman. 1989. Influence of cover complexity and existing velocity on winter habitat use by juvenile coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 46: 1,551–1,557.

Meehan, W. R., and T. C. Bjornn. 1991. Salmonid distributions and life histories. American Fisheries Society Special Publication 19: 47–82.

Meyer, K. A., and J. S. Griffith. 1997. Effects of cobble-boulder substrate configuration on winter residency of juvenile rainbow trout. North American Journal of Fisheries Management 17: 77-84.

Miles, E.L., A.K. Snover, A.F. Hamlet, B. Callahan, and D. Fluharty. 2000. Pacific Northwest regional assessment: the impacts of climate variability and climate change on the water resources of the Columbia River basin. Journal of the American Water Resources Association 36:99-420.

Moring, J.R., G.C. Garman, and D.M. Mullen. 1994. Effects of logging practices on fishes in streams and techniques for protection: a review of four studies in the United States. *In* Rehabilitation of Freshwater Fishes, I.G. Cowx, editor. Hull International Fisheries Institute, University of Hull, U.K.

Moore, T. 2013. Personal communication. Environmental Scientist. California Department of Fish and Wildlife. September 27.

Moore, T.L. and S.J. Ricker. 2012. Escapement, spawning distribution and migration patterns of adult salmonids in Freshwater Creek, 2011-2012. Anadromous Fisheries Resource Assessment and Monitoring Program, California Department of Fish and Game, Northern California – North Coast Region. December. 22 p.

Morley, S. A., P. S. Garcia, T. R. Bennett, and P. Roni. 2005. Juvenile salmonid (*Oncorhynchus* spp.) use of constructed and natural side channels in Pacific Northwest rivers. Canadian Journal of Fisheries and Aquatic Sciences 62(12):2811–2821.

Mote, P. W. 2006. Climate-Driven Variability and Trends in Mountain Snowpack in Western North America. Journal of Climate 19: 6209-6220.

Mote, P. W., A. F. Hamlet, M. P. Clark, and D. P. Lettenmaier. 2005. Declining mountain snowpack in western North America. Bulletin of the American Meteorological Society 86:39-49.

Moyle, P.B. 2002. Inland Fishes of California. Second Edition. University of California Press. Berkeley, California.

Moyle, P.B., J.A. Israel, and S.E. Purdy. 2008. Salmon, steelhead, and trout in California: status of an emblematic fauna. University of California, Davis. Available: www. caltrout.org/SOS-Californias-Native-Fish-Crisis-Final-Report.pdf.

Murphy, G.I. and L. Shapovalov. 1951. A preliminary analysis of northern California salmon and steelhead runs. Calif. Fish. Game, 37 (4): 497-507.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration. 443 pages.

National Marine Fisheries Service (NMFS). 1996. Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Watershed Scale. National Marine Fisheries Service, Environmental and Technical Services Division, Habitat Conservation Branch.

National Marine Fisheries Service (NMFS). 1998. Factors contributing to the decline of Chinook salmon: an addendum to the 1996 West Coast Steelhead Factors for Decline report. National Marine Fisheries Service, Portland, Oregon. 71 pp.

National Marine Fisheries Service (NMFS). 2001. Status review update for coho salmon (Oncorhynchus kisutch) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coast evolutionarily significant units. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California. April 12. 43 pp.

National Marine Fisheries Service (NMFS). 2007a. Recovery outline for the Distinct Population Segment of Northern California Steelhead (issued August 16, 2007). Available at: http://www.westcoast.fisheries.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/southern_oregon_northern_california/nc_steelhead_recovery_outline_final_may_2007.pdf

National Marine Fisheries Service (NMFS). 2007b. Magnuson-Stevens Reauthorization Act Klamath River Coho Salmon Recovery Plan. Prepared by Rogers, F. R., I. V. Lagomarsino and J. A. Simondet for the National Marine Fisheries Service, Long Beach, CA. 48 pp.

National Marine Fisheries Service (NMFS). 2008. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation: Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10 (a)(1)(A) Permit for Juvenile Fish Transportation Program (Revised and reissued pursuant to court order, NWF v. NMFS, Civ. No. CV 01-640-RE (D. Oregon)). NOAA's National Marine Fisheries Service Northwest Region.

National Marine Fisheries Service (NMFS). 2014. Final recovery plan for the Southern Oregon/Northern California Coast evolutionarily significant unit of coho salmon. September 2014. Arcata, California.

National Marine Fisheries Service (NMFS). 2015. Public Draft Coastal Multispecies Recovery Plan. National Marine Fisheries Service, West Coast Region, Santa Rosa, California.

National Marine Fisheries Service (NMFS). 2016. 2015 5-Year Review: Summary and Evaluation of California Coastal Chinook Salmon and Northern California Steelhead. NMFS West Coast Region. April 2016.

National Marine Fisheries Service (NMFS) and California Department of Fish and Wildlife (CDFW). 2014. NMFS, West Coast Region and CDFW's California Voluntary Drought Initiative—Goals of the Voluntary Drought Initiative http://www.westcoast.fisheries. noaa.gov/publications/protected_species/salmon_steelhead/drought_2014/voluntary_drou ght_initiative_051414.pdf.

National Oceanic and Atmospheric Administration (NOAA) Restoration Center. 2012. NOAA's National Marine Fisheries Service's final programmatic biological opinion of NOAA Restoration Center's proposed funding and the U.S. Army Corps of Engineers' proposed permitting of restoration projects within the National Marine Fisheries Service's Northern California Office jurisdictional area. March 21, 2012. Arcata, California 95521.

Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16:4-21.

Nickelson, T.E., J.W. Nicholas, A. M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Unpublished manuscript. Oregon Department of Fish and Wildlife, Research and Development Section, Corvallis, and Ocean Salmon Management, Newport. 83 pp.

Nielsen, J. L. 1994. Invasive cohorts: impact of hatchery-reared coho salmon on the trophic, developmental, and genetic ecology of wild stocks. In Theory and application in fish feeding ecology, edited by D. L. Strouder, K. L. Fresh and R. J. Feller. Columbia, South Carolina: University of South Carolina Press.

O'Farrell, M. R., W. H. Satterthwaite, and B. C. Spence. 2012. California Coastal Chinook Salmon: Status, data, and feasibility of alternative fishery management strategies. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: NOAA-TMNMFSSWFSC-494. December 2012.

Ojerholm, E. and M. Wallace. 2016. Field note-Martin Slough, thence Swain Slough, thence Elk River, thence Humboldt Bay-July 2015 to May 2016. Pacific States Fisheries Commission and California Department of Fish and Wildlife, Eureka, California, USA.

Pagliuco, B. NOAA, May 23, 2014.

Peterson, N.P. 1982. Immigration of juvenile coho salmon (*Oncorhynchus kisutch*) into riverine ponds. Canadian Journal of Fisheries and Aquatic Sciences 39:1308-1310.

Pacific Fishery Management Council (PFMC). 1996. Preseason report I: Stock abundance analysis for 1996 ocean salmon fisheries. Pacific Fishery Management Council, 50 p. + app. (Available from Pacific Fishery Management Council, 2130 SW Fifth Avenue, Suite 224, Portland, OR 97201).

PFMC (Pacific Fishery Management Council). 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. 2007. U.S. West Coast highly migratory species: Life history accounts and essential fish habitat descriptions. Appendix F to the Fishery Management Plan for the U.S. West Coast Fisheries for Highly Migratory Species. Pacific Fishery Management Council, Portland, Oregon. January.

PFMC. 2005. Amendment 18 (bycatch mitigation program), Amendment 19 (essential fish habitat) to the Pacific Coast Groundfish Fishery Management Plan for the California, Oregon, and Washington groundfish fishery. Pacific Fishery Management Council, Portland, Oregon. November.

PFMC. 2008. Management of krill as an essential component of the California Current ecosystem. Amendment 12 to the Coastal Pelagic Species Fishery Management Plan. Environmental assessment, regulatory impact review & regulatory flexibility analysis. Pacific Fishery Management Council, Portland, Oregon. February.]

Prentice, E.F. and D.L. Park. 1984. A study to determine the biological feasibility of a new fish tagging system. Annual Report of Research, 1983-1984. Project 83-19, Contract DEA179-83BP11982.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system, 1986-1987. Bonneville Power Administration, Portland, Oregon.

Prentice, E.F., T.A. Flagg, and C.S. McCutcheon. 1990. Feasibility of using implantable passive integrated transponder (PIT) tags in salmonids. American Fisheries Society Symposium 7: 317-322.

Quinn, T.P. 2005. The behavior and ecology of Pacific salmon and trout. UBC Press, Vancouver.

Regonda, S.K., B. Rajagoplan, M. Clark, and J. Pitlick. 2005. Seasonal shifts in hydroclimatology over the western United States. Journal of Climate 18:372-384.

Reisenbichler, R.R., and J.D. McIntyre. 1977. Genetic differences in growth and survival of juvenile hatchery and wild steelhead trout, *Salmo gairdneri*. Journal of the Fisheries Research Board Canada 34:123–128.

Ricker, S. 2008. Escapement and spawning distribution of adult salmonids in Freshwater Creek, 2007-08. Scientific report prepared in partial fulfillment of fisheries Restoration Grant Grantee Agreement No. P0510533. Anadromous Fisheries Resource Assessment and Monitoring Program, California Department of Fish and Game, Northern CaliforniaNorth Coast Region, Arcata, California. 12p.

Ricker, S. 2011. Personal communication. Associate Biologist. California Department of Fish and Game, Northern California, Anadromous Fisheries Resource Assessment and Monitoring Program, Arcata.

Ricker, S.J. and C.W. Anderson. 2011. Freshwater Creek salmonid life cycle monitoring station. Annual Report. California Department of Fish and Game, Anadromous Fisheries Resource Assessment and Monitoring Program, Arcata 59 p. plus appendices.

Ricker, S.J. and C.W. Anderson. 2014. Results of Freshwater Creek Salmonid Life Cycle Monitoring Station 2013-2014. Prepared by: Humboldt State Sponsored Programs Foundation *In* Partnership with California Department of Fish and Wildlife

Rondorf, D.W. and W.H. Miller. 1994. Identification of the spawning, rearing and migratory requirements of fall Chinook salmon in the Columbia River Basin. Prepared for the U.S. Dept. of Energy, Portland, OR. 219 p.

Sandercock, F.K. 1991. Life history of coho salmon. Pages 397-445 in C. Groot and L. Morgolis, editors. Pacific Salmon Life Histories. UBC Press. Vancouver, British Columbia, Canada.

Scarlett, W. J., and C. J. Cederholm. 1984. Juvenile coho salmon fall-winter utilization of two small tributaries of the Clearwater River, Jefferson County, Washington. Pages 227–242 in J. M. Walton and D. B. Houston, editors. Proceedings of the Olympic Wild Fish Conference, 23–25 March 1983. Fish Technology Program, Peninsula College, Port Angeles, Washington.

Shapovalov, Leo and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (Sahno gairdneri gairdneri) and Silver Salmon (Oncorhynchus kisutch). California Department of Fish and Game, Fish Bulletin No. 98.

Sharpe, C.S., D.A. Thompson, H.L. Blankenship, C.B. Schreck. 1998. Effects of Routine Handling and Tagging Procedures on Physiological Stress Responses in Juvenile Chinook Salmon. The Progressive Fish-Culturist. 60(2):81-87.

Simon, A., and C.R. Hupp. 1992. Geomorphic and vegetative recovery processes along modified stream channels of West Tennessee. USGS Open File Report 91-502.

Sindermann, C. J., S. C. Esser, E. Gould, B. B. McCain, J. L. McHugh, R. P. Morgan II, R. A. Murchelano, M. J. Sherwood, and P. R. Spitzer. 1982. Effects of pollutants of fishes. Pages in G. M. Mayer, Ed. Ecological stress and the New York Bight: science and management. Estuarine Research Federation Press, Columbia, South Carolina, USA.

Solazzi, M. F., T.E. Nickelson, S.L. Johnson, and J.D. Rogers. 2000. Effects of increasing winter rearing habitat on abundance of salmonids in two coastal Oregon streams. Canadian Journal of Fisheries and Aquatic Sciences 57(5): 906-914.

Sparkman, M.D. 2002. Annual Report: Upper Redwood Creek Juvenile Salmonid Downstream Migration Study, 2000-01. Project 2a5.

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. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center: NOAA-TM-NMFS-SWFSC-423.

Spence, B.C. 2016. North-Central California Coast Recovery Domain. Pages 26 – 47 in T.H. Williams, 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.

State of California. 2014. Governor Brown Declare Drought State of Emergency. https://www.gov.ca.gov/news.php?id=18379

Stewart, I.T., D.R. Cayan, and M.D. Dettinger. 2004. Changes toward earlier streamflow timing across western North America. Journal of Climate 18:1136-1155.

Swales, S., R. B. Lauzier, and C. D. Levings. 1986. Winter habitat preferences of juvenile salmonids in two interior rivers in British Columbia. Canadian Journal of Zoology 64: 1,506–1,514

Sweeting, R.M., R.J. Beamish, D.J. Noakes, and C.M. Neville. 2003. Replacement of wild coho salmon by hatchery-reared coho salmon in the Strait of Georgia over the past three decades. Transactions of the American Fisheries Society 23:492–502. Taylor, R.N. and Associates. 2009. Summary of Morrison Gulch spawner surveys for 2008- 2009. 2p.

Tschaplinski, P.J. 1988. The use of estuaries as rearing habitats by juvenile coho salmon. In T.W. Chamberlain (ed.), Proceedings of a workshop: Applying 15 years of Carnation Creek results. (pp. 123-142). Nanaimo, BC: British Columbia Ministry of Environment, Lands, and Parks.

Tschaplinski, P. J., and G. F. Hartman. 1983. Winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Canadian Journal of Fisheries and Aquatic Sciences 40: 452–461.

USFWS. 2010. Listed/Proposed Threatened and Endangered Species for the Ferndale (Document number: 574896433-124420) and Fortuna (Document number: 574896433-124958) Quads. Accessed May 13, 2010 (expires November 13, 2010). http://www.fws.gov/arcata/specieslist/search.asp.

Van Kirk, R. W., and S. W. Naman. 2008. Relative effects of climate and water use on baseflow trends in the Lower Klamath basin. Journal of American Water Resources Association 44(4): 1035-1052.

Vicuna, S., E. P. Maurer, B. Joyce, J. A. Dracup, and D. Purkey. 2007. The sensitivity of California water resources to climate change scenarios. Journal of American Water Resources 43:482-498.

Wade, A., T.J. Beechie, E. Fleishman, H. Wu, N.J. Mantua, J.S. Kimball, D.M. Stoms, and J.A. Stanford. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology 50(5):1093-1104.

Wallace, M., 2010. Juvenile coho salmon use of the tidal portions of Humboldt Bay tributaries. Presented at the Humboldt Bay Symposium, April 23, 2010. Eureka, California, USA.

Wallace, M. 2014. Field Note: Martin Slough, thence Swain slough, thence Elk River, thence Humboldt Bay August and September 2014. Arcata, California: California Department of Fish and Wildlife.

Wallace, M., S. Ricker, J. Garwood, A. Frimodig, and S. Allen. 2015. Importance of the stream-esturay ecotone to juvenile coho salmon (Oncorhynchus kisutch) in Humboldt Bay, California. California Fish and Game 101:241-266.

Wallace, M. 2017. Field note-Martin Slough, thence Swain Slough, thence Elk River, thence Humboldt Bay-June 2016 to January 2017. California Department of Fish and Wildlife, Eureka, California, USA.

Wallace, M. 2017. Personal communication. California Department of Fish and Wildlife, Eureka, California, USA.

Wallace, M. and S. Allen. 2009. Juvenile salmonid use of the tidal portions of selected tributaries to Humboldt Bay, California. Final Report for contract P0610522. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=17971.

Waples, R.S. 2002. Effective size of fluctuating salmon populations. Genetics 161: 783-791.

Waples, R.S., G.R. Pess, and T. Beechie. 2008. Evolutionary history of Pacific salmon in dynamic environments. Evolutionary Applications 1(2):189-206.

Waples, R., T. Beechie, and G. Pess. 2009. Evolutionary history, habitat disturbance regimes, and anthropogenic changes: What do these mean for resilience of Pacific salmon populations? Ecology and Society 14(1): 3. [online] URL: http:// www.ecologyandsociety.org/vol14/iss1/art3.

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. NOAA Technical Memorandum NMFS-NWFSC-24. U.S. Department of Commerce, NOAA, Northwest Fisheries Science Center, Seattle, WA. 258 pp.

Williams, T.H., E.P. Bjorkstedt, W.G. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, M. Rode, R.G. Szerlong, R.S. Schick, M.N. Goslin, A. Agrawal. 2006. Historical population structure of coho salmon in the Southern Oregon/Northern California Coasts evolutionarily significant unit. NOAA-TM-NMFS-SWFSC-390. U.S. Department of Commerce, NOAA, NMFS, Southwest Fisheries Science Center, Santa Cruz, California. 85 pp.

Williams, T.H., B. Spence, W. Duffy, D. Hillemeier, G. Kautsky, T.E. Lisle, M. McCain, T. Nickelson, E. Mora, and T. Pearson. 2008. Framework for assessing viability of threatened coho salmon in the Southern Oregon/Northern California Coasts evolutionarily significant unit. NOAA Technical Memorandum NMFS-SWFSC-432. U.S. Department of Commerce, NOAA, NMFS, Southwest Fisheries Science Center Santa Cruz, California. 113 pp.

Williams, T.H., D.A. Boughton, S.T. Lindley, and B.C. Spence. 2011a. Southern Oregon/Northern California Coast Recovery Domain 5-Year Review: Summary and Evaluation of Southern Oregon/Northern California Coast Coho Salmon ESU. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Ecological Division, Southwest Fisheries Science Center, Santa Cruz, California.

Williams, T.H., D.A. Boughton, S.T. Lindley, and B.C. Spence. 2011b. North-Central California Coast Recovery Domain 5-Year Review: Summary and Evaluation of California Coastal Chinook Salmon ESU and Central California Coast Coho Salmon ESU. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Ecological Division, Southwest Fisheries Science Center, Santa Cruz, CA.

Williams, T.H., B.C. Spence, S.T. Lindley, and D.A. Boughton. 2011c. North-Central California Coast Recovery Domain 5-Year Review: Summary and Evaluation of Central California Coastal Steelhead DPS and Northern California Steelhead DPS. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Fisheries Ecological Division, 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. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, CA

Winzler & Kelly, Michael Love & Associates, and Coastal Analysis. 2006. Martin Slough enhancement feasibility study.

Yoshiyama, R.M., and P.B. Moyle. 2010. Historical review of Eel River anadromous salmonids, with emphasis on Chinook salmon, coho salmon and steelhead. University of California at Davis. Center for Watershed Sciences working paper; a report commissioned by California Trout. Davis, CA. February 1.

Zhu, T., M.W. Jenkins, and J.R. Lund. 2005. Estimated impacts of climate warming on California water availability under twelve future climate scenarios. J. Am. Water Res. Assoc. 41:1027-1038.

5.2 Federal Register Notices Cited

60 FR 38011. 1995. National Marine Fisheries Service. Endangered and Threatened Species; Proposed Threatened Status for Three Contiguous ESUs of Coho Salmon Ranging from Oregon through Central California. Federal Register 60(142). July 25, 1995.

62 FR 24588. 1997. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species; Threatened Status for Southern Oregon/Northern California Coast Evoltionarily Significant Unit (ESU) of Coho Salmon. Federal Register 62(87). May 6, 1997.

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

64 FR 50394. 1999. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California. September 16, 1999.

65 FR 36074. 2000. National Marine Fisheries Service. Endangered and Threatened Species; Threatened Status for One Steelhead Evolutionarily Significant Unit (ESU) in California. Federal Register, 65: 36074-36094. June 7, 2000.

70 FR 52488. 2005. National Marine Fisheries Service. Final Rule. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. September 2, 2005.

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

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

79 FR 20802. 2014. National Marine Fisheries Service. Final Rule. Endangered and Threatened Wildlife; Final Rule to Revise the Code of Federal Regulations for Species under the Jurisdiction of the National Marine Fisheries Service. Federal Register79 (71):20802-20817. April 14, 2014.