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

August 5, 2021 **Refer to NMFS No:** WCRO-2021-01006

Kasey Sirkin
Lead Biologist, Eureka Field Office
U.S. Army Corps of Engineers
450 Golden Gate Avenue
San Francisco, California 94102

David White
California Supervisor
NOAA Restoration Center
777 Sonoma Ave, Suite 325
Santa Rosa, California 95404

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response on the Redwood National and State Parks' Visitor Center and Restoration Project, near Orick, California

Dear Ms. Sirkin and Mr. White:

Thank you for your letter of April 19, 2021, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Redwood National and State Parks' Visitor Center and Restoration (Project). This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

The enclosed biological opinion describes NMFS' analysis of potential effects 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 habitat in accordance with section 7 of the ESA. Based on the best scientific and commercial information available, NMFS concludes that the action, as proposed, is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, and NC steelhead or destroy, or adversely modify designated critical habitat for these species. NMFS expects the proposed action would result in incidental take of SONCC coho salmon, CC Chinook salmon, and NC steelhead. An incidental take statement, with terms and conditions, is included with the enclosed biological opinion.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action. Based on our analysis, NMFS concluded that the Project would adversely affect EFH of Pacific salmon. Therefore, we have included the results of that

review in Section 3 of this document. At this time, NMFS has no EFH conservation recommendations to provide.

Please contact Leslie Wolff in Arcata, California at (707) 601-5455, or via email at Leslie.Wolff@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Enclosure

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ARN 151422WCR2021SR00083

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

Redwood National and State Parks' Visitor Center and Restoration Project

NMFS Consultation Number: WCRO-2021-01006
Action Agencies: U.S. Army Corps of Engineers and NOAA Restoration Center

Table 1. 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	Yes	No
Northern California (NC) steelhead steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
California Coastal Chinook (CC) salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No

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

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

Issued By:

Alecia Van Atta
Assistant Regional Administrator
California Coastal Office

Date: August 5, 2021

TABLE OF CONTENTS

1. INTRODUCTION

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

1.1. Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), and implementing regulations at 50 CFR 402, as amended. 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.

Save the Redwoods League (the League), a non-profit conservation organization, seeks to restore and develop their 125 acre parcel at the most downstream end of Prairie Creek, Humboldt County, California (Figure 1). The League is working in partnership with Redwood National and State Parks (RNSP), and many other project partners to design and build restored aquatic habitat and to provide new visitor services, including a new RNSP Visitors Center, at the site (restoration and visitor services together are referred to as the Project).

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

1.2. Consultation History

As part of the League's commitment to collaboration and early involvement, beginning in 2015 numerous meetings and site visits were hosted to discuss aquatic restoration and visitor service opportunities at the site. NMFS has been a Project partner since 2015, other partners include: RNSP, California State Coastal Conservancy, NOAA Restoration Center (NOAA RC), Yurok Tribe, California Trout, U.S Fish and Wildlife Service, and the California Department of Fish and Wildlife.

As Project proponent, the League has applied for a U.S. Army Corps of Engineers (Corps) permit under section 404 of the Clean Water Act, and has received project funding from the NOAA RC. The League provided drafts of the Project BA for NMFS review during December, 2020, February, 2021, and March, 2021. On April 14, 2021, NMFS, the Corps, NOAA RC and the League agreed on the final version of the BA (GHD 2021), and on April 19, 2021, NMFS received the Corps' and the NOAA RC's request to initiate formal ESA and EFH consultation on the Project.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The League, as applicant for a Corps 404 permit (lead action agency), and recipient of NOAA RC grant funding (additional action agency), proposes to restore approximately 89 acres of the lower Prairie Creek watershed (major tributary to Redwood Creek) and enhance aquatic habitat in approximately three-quarter mile of mainstem Prairie Creek. Prairie Creek enters Redwood Creek close to its mouth, at river mile 3.5, near the town of Orick, California. The restoration component of the Project includes stream, floodplain and wetland restoration to enhance Prairie, Skunk Cabbage, and Libby creeks (Figure 1). The Project will improve stream connectivity with the adjacent floodplain and create a diversity of habitats (primary channel, backwater channels, installation of large wood, wetlands) to improve salmonid habitat. The restoration also includes removing non-native vegetation and planting native vegetation across the site, removing 21 acres of asphalt, and restoring old mill roads (Figure 2). The NMFS (2014, 2016) recovery plans for SONCC coho salmon, CC Chinook salmon and NC steelhead describe that improving habitat in Prairie Creek and its floodplain is a high priority recovery action that will anchor Prairie Creek as a salmon stronghold, and cool water refuge in a changing climate.

In addition, the League proposes to develop visitor services onsite, including a new RNSP visitor center and onsite interpretive elements, establishment of a Yurok Tribal site to conduct ceremonies and to use for other tribal community events and interpretive purposes, and construction of a new segment of the California Coastal Trail (CCT) and other local trails. The trails hub includes visitor access, parking, interpretive elements, a trailhead and information on the regional trails (Figure 2). The Project will begin in early fall 2021, and will take approximately 10 years to implement. Habitat restoration activities will likely be completed by 2025 when the land is scheduled to be transferred from the League to the National Park Service, while the visitor center may take longer to implement, as funding is acquired.

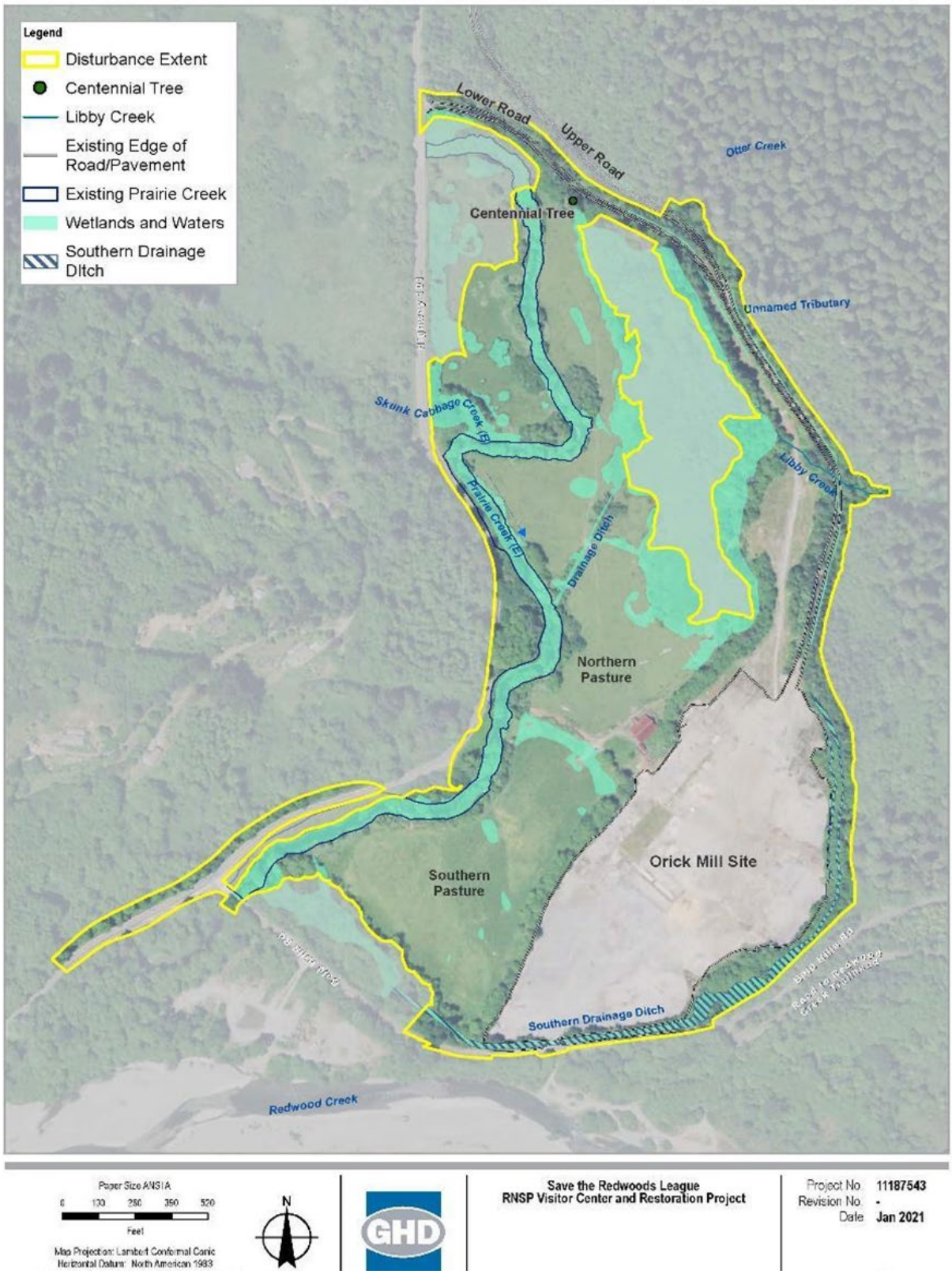

Figure 1. Project location and site map (GHD 2021).

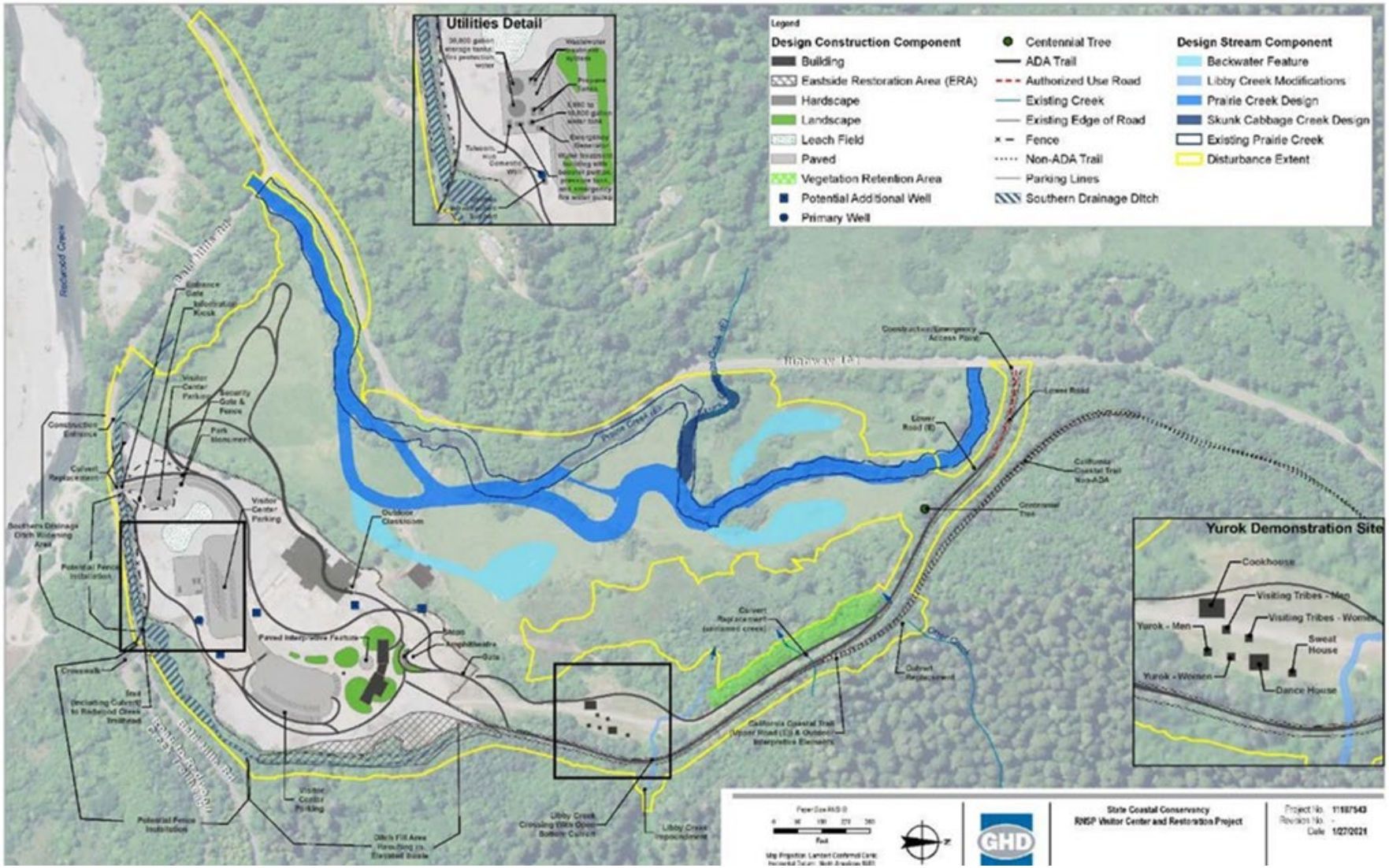

Figure 2. Project components (GHD 2021).

1.3.1. Project Schedule

The normal operating season (NOS) is defined as June 15 through October 15 for ground disturbing activities unless dry weather permits the extension of the NOS beyond October 15, and until the Redwood Creek estuary breaches and adult salmonids have the potential to be entering the watershed (to be determined in coordination with NMFS). Activities that are not ground disturbing include: the asphalt removal at the former mill site, visitor center structural construction (including construction of building, amenities, fencing), Yurok Tribal site structural construction (buildings) and revegetation. The NOS extension process includes review of the NOAA/National Weather Service Low Flow and Transition Season data and communication with the Corps, the NOAA RC, and NMFS to determine if an NOS extension is possible, and if so, the daily construction procedures to be used during the NOS extension.

Construction of the Project will be sequenced to make the best use of the site's materials and staging locations, and to make use of available public and philanthropic funding sources, many of which become available in annual cycles. This will also limit the total acreage of ground disturbance in any specific construction season, compared to full project construction. Sequencing of the Project is as follows:

- Prairie Creek restoration: five construction seasons, 2021-2025.
- Phase 1 (2021): Early Implementation Project, includes construction of a northeastern backwater pond in the Prairie Creek floodplain, removal of approximately two acres of asphalt, and construction of a coastal trails approach at the northern end of the current extent of the asphalt.
- Phase 2 (likely 2022 and 2023): Construction of upper section of Prairie Creek, northwestern backwater channel, and middle section of Prairie Creek, including the confluence with lower Skunk Cabbage Creek.
- Phase 3 (likely 2024): Construction of lower section of Prairie Creek and southeast backwater channel.
- Site grading includes removal of asphalt, concrete foundation, potential remnant utilities and barn foundation, likely 2022 and 2023.
- Libby Creek Enhancement, including culvert replacement: one construction season, likely 2022-2024.
- California Coastal Trail and other trails, including culvert replacements at Otter Creek and an unnamed tributary; one construction season, 2022-2025.
- Yurok Tribal Site: one construction season, likely 2025.
- Interim Trails Hub: one construction season, likely 2023-2025,
- Visitor Center (and amenities): one construction season, to occur by 2031, as funding is secured.

1.3.2. Visitor Center and Services

The visitor center will be located atop the historic mill site, situated in the southeastern portion of the Project area above the 100-year floodplain return interval (Figure 2). Two old mill roads, the Upper and Lower roads that extend to the north from the old mill site, will be improved or restored and converted to trails. The visitor center will consist of two main buildings connected by an outdoor covered walkway totaling approximately 5,347 square feet. A 2,518 square foot

screened-in eating and picnicking area, covered by a rooftop, will be located in the northern extent of the visitor center building resulting in a total development footprint of 7,865 square feet.

The 21-acre existing asphalt foundation will be removed in sections and filled by sourcing material from the restoration to complete construction of the visitor center, utilities and stormwater retention basins. All asphalt and concrete will be disposed of offsite in an appropriate upland location. Approximately 1.6 acres of walkways, trails and pedestrian plazas will be associated with the visitor center, in addition to numerous outdoor interpretive exhibits, including a watershed display, and an approximate 0.5-mile loop trail to overlook Prairie Creek.

The entrance gate is located along Bald Hills Road, approximately 0.25 mile from the Highway 101 intersection. Existing southern drainage ditch culverts will be replaced with at least 36-inch diameter culverts in the same location and at approximately the same slope. Three parking lots totaling approximately 3.1 acres will be constructed near the visitor center. The Project will result in a net decrease of impervious surfaces (i.e., removal of existing concrete foundations and 21 acres of asphalt, and use of permeable pavers in the new construction).

Stormwater Management

The Project will improve stormwater infiltration across the visitor center footprint and mimic natural drainage conditions. To treat and manage stormwater that originates from impervious surfaces, the Project will include stormwater bioretention basins designed and appropriately sized to retain the runoff sourced from the 95th percentile of a rainfall event (approximately 2 inches) over a 24-hour period. Bioretention basins are distributed throughout the site based on hydrology (natural flow paths) and soils with greater infiltrative capacity (SHN 2020a).

Water Sources

Potable water will be required for drinking and sanitary uses at the visitor center and Yurok Tribal site, and for sprinkler systems and firefighting at the site. Although the existing well is able to provide ample water to meet the anticipated potable drinking water demand, up to four other wells may be developed on site to meet overall water demand. Water will be stored in two 40,000-gallon "raw water" storage tanks in the visitor center utilities area. Peak daily drinking water use for the visitor center and Yurok site is anticipated to be up to 6,130 gallons per day (gpd) (SHN 2020b). In addition, up to ten restoration irrigation storage tanks (each at 10,500 gallon capacity) could potentially be placed within the visitor center area to store water for the establishment of native vegetation following construction. The restoration irrigation storage tanks would be filled during the winter.

Groundwater monitoring indicates the site consists of at least two distinct aquifers: a shallow zone of perched groundwater which is interpreted to represent an open, unconfined water table aquifer, and a deeper, partially to fully confined aquifer separated by a thick layer of clay material (LACO 2011a, LACO 2011b). The proposed wells will be drilled to the approximate depth of the existing well (118 feet) in order to access groundwater from the deeper, confined aquifer (LACO 2011b). Well diameters are expected to be six to eight inches; water sourced from the well(s) will be pumped to the raw water storage tanks located onsite in the utility area.

The raw water storage tanks will be filled during the winter and a large draw of groundwater is initially expected. Following the initial filling of the tanks, a large draw down is not expected because structure fires are not anticipated to take place frequently, if at all, due to regular maintenance of the utilities onsite, sprinklers within the visitor center, and proper staff training. Should a wildfire or other emergency occur and fire protection water is needed, the tanks will be emptied and then refilled following use, which may occur in the dry season. NMFS would be contacted if this situation arises. The raw water tanks will be filled/topped up daily throughout the year (including during the dry season) to account for use of potable water, which is anticipated to peak at 6,130 gpd (SHN 2020b) [which corresponds to 0.01 cubic feet per second (cfs) in Prairie Creek].

Wastewater

An onsite wastewater treatment system will be installed and will include a leach field located along the southern portion of the visitor center area (Figure 2). There will be a 100 percent reserve leach field area adjacent to the primary leach field site. Wastewater will be pumped through a series of tanks for treatment prior to pumping wastewater to the leach field. The onsite wastewater treatment system will be located approximately 1,000 feet east of Prairie Creek, and 350 feet north of the southern drainage ditch.

Electrical

Pacific Gas & Electric service will be delivered by removing existing overhead lines which cross Prairie Creek and installing new overhead service lines south along Highway 101 and east along Bald Hills Road, to the entrance gate and into the visitor center site. Power lines within the Project area will likely be overhead, however may be buried, and will predominantly be located within the visitor center footprint. No power lines are proposed in Prairie Creek or its floodplain.

Earthwork

The approximately 105,000 cubic yards (cy) of river run gravel that the former Orick Mill was built on will be left in-place or used as fill material for other Project components. Up to approximately 108,200 cy of fill, comprised of up to approximately 89,000 cy of fill from the Prairie Creek Restoration area, will be used at the visitor center site to raise the current elevation.

Operations and Maintenance

Utility operations and maintenance for the visitor center will include routine drinking water treatment and testing, periodic testing of fire suppression water levels, periodic testing of the emergency fire pump and generator, and routine refueling of propane storage tanks. The septic tank will be pumped every three to five years and the pump screen in the septic tank will be cleaned annually. The stormwater bioretention basins, parking lots, and culverts will be managed and cleared of debris as needed. Vegetation maintenance to promote the establishment of native flora and to limit the establishment of non-native plants may be implemented through mechanical and chemical means during the full 10 year project duration. A description of proposed herbicide use for the entire site is discussed in the Herbicide section under 1.3.3 Prairie Creek Restoration.

California Coastal Trail (CCT), Other Trails and Trails Hub

The CCT is a network of public trails for walkers, bicyclists, equestrians, wheelchairs, and other non- motorized users along the 1,200 mile California coastline. The Project will create a new approximately 1.3 mile section of the CCT along the Upper Road from the Project entrance gate at Bald Hills Road to the trail terminus at the intersection with the existing Berry Glen footpath. Hiking, bicycling, and equestrian use are anticipated on the Project's portion of the CCT.

The CCT will have an American Disabilities Act (ADA)-accessible segment between the entrance gate to the intersection with the Lower Road trail, located approximately 1,750 feet north of the visitor center. The Lower Road trail will be a new trail (using the existing Lower Road alignment), which will run from the visitor center north to the Yurok Tribal site, and will parallel and intersect with the CCT (creating a loop trail back to the visitor center). The visitor center footprint will be used to provide interim public access as a trails hub, until full funding for the visitor center can be realized.

Planned improvements along the Upper and Lower roads include culvert replacements (from north to south) at Otter Creek, the Unnamed Tributary, and at Libby Creek (Figure 2). Surface water will not be present in Otter Creek, the Unnamed Tributary, or Libby Creek (which drain into the easterly wetlands) during the NOS, due to lack of surface connectivity with Prairie Creek and dry late spring and summer conditions. The culverts would be replaced with the same size culverts and at the same slope (note that the hillslope steepens just above the Upper Road, and is unpassable by listed salmonids). All construction work will use best management practices (BMPs) to minimize or prevent sediment transport outside of the construction work area, such as straw wattles around the construction area, and areas of disturbance will be mulched following earthwork with straw, redwood bark and/or coir.

The CCT, Lower Road Trail, interim Trails Hub and all trails within the Project area will be maintained regularly to provide a safe and visible pathway between each trail's starting point and terminus. Routine operations and maintenance may include clearing and maintaining ditches and culverts along trails, clearing seasonal debris (if it poses an imminent threat to the functionality of the Upper or Lower Road, or nearby culvert), trimming back vegetation along trails, maintaining safe public access, repairing or replacing equipment and interpretive displays as needed, vegetation management to control non-native plants, cleaning signage, and remedying potential vandalism to signage. Maintenance work in waterways, including but not limited to clearing ditches and culverts, will be conducted during dry weather when possible but may be implemented during wet weather if built up debris poses an imminent threat to a culvert, nearby road or other critical infrastructure. Vegetation management will consist of manual methods including hand pulling and use of power equipment, and chemical treatments when necessary, including the use of herbicides (described in more detail in section 1.3.3 below).

Yurok Tribal Site

The Redwood Creek watershed, of which Prairie Creek is an integral component, is within ancestral lands of the Yurok Tribe. The installation of a Yurok Tribal Site will provide opportunities for the Yurok Tribe to conduct dances and ceremonies on Yurok ancestral land. The Yurok Tribal site will include a sweat house, dance house, cook house, houses for men and

women of the Yurok Tribe and visiting Tribes and a bathroom (used during programs and events only).

Utilities, including domestic water, fire water, sewage treatment (with pumping), and electricity may be installed to the site from the visitor center. Wastewater and sewage would be pumped to the leach field near the visitor center; the leach field has the capacity to service use at the Yurok Site during special events (GHD 2021).

1.3.3. Prairie Creek Restoration

The League proposes to restore almost one mile of aquatic habitat in Prairie Creek and its floodplain by transitioning it from an incised channel and frequently disconnected floodplain, to a connected system of wetlands, riparian habitat, spruce-dominated upland vegetation, backwater braided channels, an interconnected floodplain with tributary and off-channel habitats, plentiful large wood, riffles and pools.

Construction

As shown on Figure 2, the Prairie Creek channel will be realigned and high-elevation ground lowered to improve floodplain connectivity, instream habitat for salmonids and other aquatic species, and to restore geomorphic and future habitat forming function. The new channel alignment will be located further away from Highway 101 to allow for floodplain and aquatic habitat creation with reduced risk to the Highway 101 road prism (NHE 2018a, NHE 2018b). The Prairie Creek alignment will remain in its current location from the downstream property boundary to approximately 850 feet upstream, where the channel will be constructed to split into two braided channels.

The abandoned Prairie Creek channel (which runs immediately adjacent to Highway 101) would be filled with compacted material, large rock and/or a vinyl or PVC sheet pile wall that will be installed by vibratory driving or by heavy equipment. This work would take place while the work area is dewatered. Immediately upstream of the portion of channel to be abandoned is the confluence with Skunk Cabbage Creek, where up to 500 feet of lower Skunk Cabbage Creek would be shifted north, which would include excavation and filling, to improve hydrologic exchange. A portion of the existing Prairie Creek (upstream of the existing confluence with Skunk Cabbage Creek) would become the lower extent of Skunk Cabbage Creek (Figure 2). At the confluence with Skunk Cabbage Creek and upstream, the surrounding floodplain would be lowered and graded. However, Prairie Creek would remain in the same footprint as it currently is.

Approximately 200 feet upstream of the confluence with Skunk Cabbage Creek, two backwater channels with backwater pond features are proposed for the first phase of restoration. Construction of these backwater features will not require dewatering of any stream channel (Figure 2), and will be implemented in 2021. These pond features are expected to stay inundated year-round; however, the backwater channels are expected to disconnect from Prairie Creek at approximately 4 cfs and below. The construction of the backwater channel and deep pond features will offer greater habitat complexity and improved connectivity between Prairie Creek and the floodplain over a broad range of flows.

In addition, existing higher-elevated ground within the Prairie Creek floodplain will be lowered to improve habitat connectivity to Libby Creek (via the floodplain and easterly wetlands) during the wet winter months and high flow events when the entire floodplain may be connected via surface water (Figure 2).

Grade control structures will be installed in the lower portion of the channel near Bald Hills Road. The channel beds of constructed stream channels and existing channels that will remain (totaling approximately 6.5 acres) will be lined with existing or imported sand, gravel and/or cobble material (the backwater channel and pond features are not proposed to receive imported gravel). LWD will be installed throughout the channels and floodplain to promote geomorphic evolution and improve habitat complexity/cover. LWD is planned for the backwater channels, floodplain and at every meander bend; LWD will be installed at a minimum rate of 85 pieces per mile and will interact with the base flow water surface elevation to bankfull water surface elevation. LWD will be installed with a vibratory driver and/or heavy equipment from channel banks or the adjacent floodplain. The non-native pasture grasses and topsoil will be scraped from the adjacent grassy floodplain prior to construction. This material will be used onsite in the development footprint, composted onsite or buried. Floodplain grasses may also be managed with pre-construction treatment, such as mowing, disking and herbicide application to reduce the local seed bank and to prevent grasses from re-invading disturbed sites.

Biotechnical bank and floodplain protection will be used within the new channel and habitat features to minimize erosion and enhance re-vegetation, which is particularly important in the southern/downstream portion of the site due to the erodible soils (Figure 3). The biotechnical materials will be biodegradable and will provide temporary stability while vegetation becomes established. Biotechnical bank and floodplain protection methods include use of three types of treatment. Type 1 (green in Figure 3) includes two tiers of woven fabric, the lower fabric woven tighter to restrict movement of fine sediment, and the top fabric woven loser to maintain coarse sediment in place. Type 2 (pink in Figure 3) includes mulch (likely redwood bark) followed by placement of coir (coconut fiber) fabric, and Type 3 (yellow in Figure 3) includes mulch. Type 1 would be installed along the channel banks and up to 20 feet beyond top of bank, Type 2 would be installed along the floodplain, and Type 3 either in the floodplain and/or areas of disturbance.

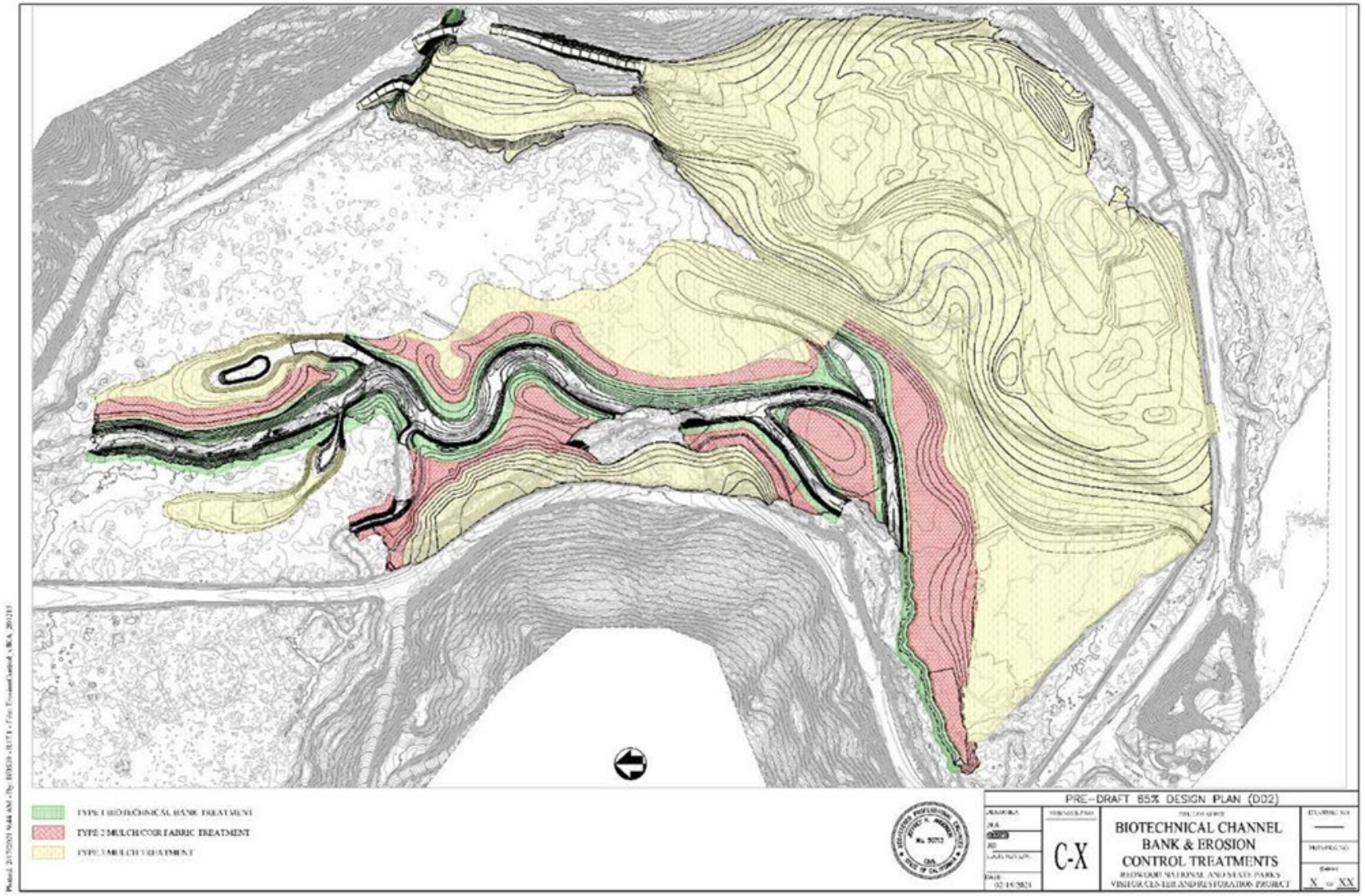

Figure 3. Biotechnical channel bank and floodplain erosion control treatments (GHD 2021).

Dewatering and Fish Relocation during Construction

During habitat restoration the Prairie Creek channel will be temporarily disconnected from its upper and lower reaches and dewatered in sections not to exceed 2,000 feet per year, for a total of four construction seasons from 2022 to 2025 (not including the first construction season in 2021). There is approximately 11,175 square meters of instream habitat per dewatering event within Prairie Creek and lower Skunk Cabbage Creek during each of the four dewatering years. Figure 3 shows that the middle sections of Prairie Creek within the Project will be moved away from Highway 101, and require dewatering, which will occur from an upstream to downstream direction over the four years. Earthen sediment plugs or similar barriers, such as coffer dams, will be constructed to separate the work area from the stream channel. Upstream flow will be bypassed around the construction area via a pipe or similar conduit in a "clear water diversion".

To avoid potential impingement or entrainment of fish at the upstream point of the bypass hose piping, screened fittings and filters compliant with NMFS (2001) and CDFW mesh requirements (including at least 27 percent porosity with openings no more than 2.38 mm maximum width to exclude juvenile salmonids [CDFW 2002]) will be installed and maintained over hose ends. Block nets will be installed at least ten feet upstream of the bypass piping to prevent entrainment or impingement of fish against intake hosing. The upstream intake end of the clear water diversion piping shall be located between the cofferdam and the upstream block net in the gravels of the channel bed in lower velocity areas. Additional shallow wells with intake hosing may be installed within the dewatered channel bed to capture groundwater seepage. The isolated creek will then be dewatered, and all aquatic species within the dewatered section will be relocated as described below.

Dewatering equipment including pumps will remain onsite and used as needed to keep the construction zone dry. Dewatering will occur during the NOS, and will not occur in more than one section at a time, and will occur once per season (for a total of up to 2,000 feet per season), for up to four construction seasons. Dewatering equipment includes cofferdams, sand bags, fish screens, pumps, and sediment curtains. All diversion equipment, such as diversion screens and block nets, will be checked twice daily (including weekends) for as long as the diversion is running. Areas planned for excavation that don't require dewatering (e.g., construction of a new off-channel pond) will have sediment plugs installed to minimize sediment transport from the newly excavated feature into Prairie Creek.

After the stream banks have been stabilized and the construction area washed over to allow fine sediment to settle, the work area will be reconnected with the creek. Water that appears dirty will be pumped out of the construction area at the downstream end and discharged into a construction infiltration area. This process will continue until water washed over the construction area appears to be "running clear". At that point the constructed area can be reconnected with the receiving waterway via removal of the coffer dam or sediment plug. When possible, the sediment plug will be removed following a small rain event when there will naturally be some turbidity in the waterway. A sediment curtain will be installed at the downstream portion of the receiving water to minimize the amount of sediment entrainment during removal of coffer dams and/or sediment plugs.

Dewatering will require that fish be relocated from up to 2000 feet of Prairie Creek per year, as described above, during four construction seasons from 2022 to 2025. During one year of fish relocation, the lower 280 feet of Skunk Cabbage Creek may also be dewatered in tandem with Prairie Creek. Fish will be relocated into either Little Lost Man or Lost Man creeks. The following measures will be implemented during fish relocation:

- Perform initial fish relocation 3-5 days prior to the start of dewatering. A second attempt, the morning following the initial endeavor, shall be made to capture any remaining fish.
- Exclude fish from re-entering work area by blocking the stream channel above and below the work area with fine-meshed net or screens. Mesh size should be no greater than 1/8". Completely secure bottom edge of the net or screen to channel bed to prevent fish from re-entering work area. Block nets should be placed in areas of low water velocity to minimize impingement of fish.
- A qualified fish biologist shall perform seining, dip netting, trapping and/or electrofishing to a point at which the biologist is assured that all aquatic species within the construction area that can be caught with a net, have been caught.
- Cease activities when water temperatures exceed 68 degrees Fahrenheit (20°C).
- Minimize handling of salmonids. When handling is necessary, always wet hands or nets prior to touching fish.
- Electrofishing shall be conducted after seining, dip netting and trapping has occurred as a means to ensure that all fish of all species are captured from within the dewatering area and that no fish remain to be desiccated during dewatering or crushed by equipment. To minimize injuries, low-frequency pulsed direct current less than 30 hertz (<30Hz) shall be used when electrofishing.
- Place captured fish in cool, shaded, aerated, dark colored containers filled with cool, clear water. Provide aeration with a battery powered external bubbler. Protect fish from jostling and noise and do not remove fish from this container until time of release. Release fish when the container reaches capacity or within one and a half hours after capture.
- Place a thermometer in the holding container, and periodically conduct partial water exchanges, if water temperature gets too warm (>68°F [20°C]) or there is more than an hour of delay between when the holding container exceeds maximum capacity and the time of release.
- Avoid overcrowding in containers.
- Cease capture, and release listed salmonids when containers are filled to capacity.
- The ultimate relocation site will be approved by NMFS prior to relocation.
- If fish mortalities occur, these individuals shall be recorded, collected and frozen for delivery to NMFS.

Earthwork

Up to approximately 135,500 cy of material will be excavated from the Prairie Creek restoration area, and up to approximately 50,700 cy of this material will be used as fill and graded within the restoration area. The remaining fill material will be used at the visitor center site or for CCT construction, or other Project components. Earthen fill will be stored and processed in upland areas, and protected with erosion control. Invasive plants will be removed and buried or composted onsite, or hauled off site to a proper disposal facility.

Post Construction Revegetation

The Prairie Creek restoration area will be revegetated with native species including woody riparian species such as willow, alder, and black cottonwood (*Populus trichocarpa*), conifers such as Sitka spruce and coast redwood, shrubs such as oceanspray (*Holodiscus discolor*), and numerous wetland species such as rushes (*Juncus* spp.), sedges (*Carex* spp.), native grasses, and hardstem bulrush (*Schoenoplectus acutus*) (McBain Associates 2020). The floodplain, channels and wetlands will be planted in high densities of native species to be integrated with the biotechnical erosion treatments. Plant cages or exclusion fencing may be installed around native vegetation plantings to limit browsing.

Water Quality Monitoring

A small structure may be built near the stream to house stream gauging equipment and water quality monitoring instruments. Staff plates and piping (stilling wells) will likely be installed between the structure and the creek channel in order to house equipment sensors in the creek, or to provide continuous creek samples for the water quality instruments within the structure (if deemed feasible). A cableway will also be constructed over the creek channel to obtain discharge and other water quality samples during high flows when wading is not possible. The cableway will consist of two small A-frames sitting on or in concrete footings on the top of bank on each side of the creek channel and anchored by concrete blocks if needed. A cable will be suspended between both A-frames and sampling equipment will be deployed from the cable.

Operations & Maintenance

To ensure the long-term viability of the reconstructed stretch of Prairie Creek and adjacent floodplain, operations and maintenance measures will be implemented. Operations and maintenance (including monitoring) will be conducted by a task force comprised of agency representatives, landowner staff, non-profit organizations, and volunteers over a duration of up to ten years. The property is anticipated to transfer from the League to the NPS in 2025, who will assume Project operations and maintenance responsibilities at that time.

Vegetation management will be implemented to limit the establishment of non-native vegetation and to promote the establishment of native flora species. Non-native vegetation control will include hand pulling, mowers, weed eaters, a small backhoe, and/or herbicides. Heavy equipment will not be used instream to remove invasive plants. Manual invasive plant removal would occur June 15 to October 15 and would not require dewatering of the channel.

A small amount of surface water (a maximum diversion of 0.2 cfs per day) from Prairie Creek is proposed for mobile irrigation units during implementation irrigation. Use of the existing well (or one of the proposed wells) is proposed for post-implementation irrigation. Irrigation sourced from Prairie Creek will adhere to the following restrictions from the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 2010) and the Water Drafting Specifications (NMFS 2001a):

- A maximum approach velocity and the intake of 0.8 feet/second (Flosi et al. 2010);
- A sweeping velocity that is greater than the approach velocity (Flosi et al. 2010);
- Screen openings not to exceed 3/32 inch (NMFS 2001a);

- Pumping operation limited to one hour before sunrise and one hour after sunset (NMFS 2001a);
- Pumping rate not to exceed 350 GPM (NMFS 2001a);
- Pumping not to exceed 10 percent of stream flow (NMFS 2001a);
- Screen surface area at least 2.5 square feet (NMFS 2001a); and
- Intake locations where water is deep and flowing (Flosi et al. 2010).

A permanent irrigation system will be built and used if plantings need irrigation in dry seasons following the implementation year. Water for the permanent irrigation system would be sourced from the existing onsite well and would rely on the use of storage tanks, which would be filled in the winter wet season. Stored water would be used to irrigate through the dry season, and only re-filled with groundwater in the dry season if tanks run out of water and irrigation is necessary for the survival of the plants.

Herbicide

Proposed herbicide treatment conforms to existing invasive vegetation management by Redwood National Park as described in the following documents:

- Biological Assessment of Impacts on Aquatic and Terrestrial Endangered and Threatened Species from Invasive Plant Management in Redwood National Park (RNP 2017);
- ESA Section 7 Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Redwood national Park's Invasive Management Program (NMFS 2017);
- Invasive Plant Management Plan and Environmental Assessment for Redwood National Park and Santa Monica Mountains National Recreation Area (NPS 2017b).

Herbicide will not be applied directly to or over water, or saturated soils (which is considered to include the presence of the water table within 12 inches of the soil surface). Only aquatically approved herbicides may be applied over dry wetlands (with non-saturated soils), within riparian habitats with dry soils, up to the water's edge, or within 300 feet of perennial streams or 150 feet of intermittent streams, via direct injection (such as use of an injector gun, drill and fill, and/or cut and paint) or by spot application targeting individual plants. Existing spot application treatment of herbicide within riparian areas within RNP utilizes the backpack sprayer method with targeted application typically within 12 inches of the plant (GHD 2021).

Proposed herbicide treatment within dry riparian areas, 150-300 feet from waterways, or over dry wetlands includes the use of aquatically approved herbicides (imazamox, imazapyr, and specific formulations of glyphosate and triclopyr TEA) and two adjuvants (Agri-Dex and Hasten® Modified Vegetable Oil). Adjuvants are substances that may be added to herbicide formulations to enhance the uptake of the herbicide by a plant, making it more accessible to the active herbicide ingredient. Descriptions of these herbicides and adjuvants are sourced from RNP (2017) and described in detail in the BA (GHD 2021).

Application will occur in summer or fall when there is less than ten percent chance of rain in the forecast for 48 hours. Species targeted for herbicide treatment include (but are not limited to) Himalayan blackberry and pampas grass (GHD 2021). Should conditions align (absence of

standing water, and saturated soils in wetlands), the aquatically approved herbicide can also be used to opportunistically treat reed canary grass in dry areas.

1.3.4. Libby Creek Enhancement

Libby Creek is a perennial stream that originates east of the Project area (Figure 1). A concrete impoundment within Libby Creek exists approximately 100 feet east of the Upper Road. The portion of Libby Creek upstream of the Lower Road consists of a steep (approx. 12 percent grade) boulder bedded channel that is believed to be too steep for salmonids to access (NHE 2017). Thus, the goal of the Libby Creek project is to enhance natural processes in the drainage, and not fish passage.

Up to 700 feet of the Libby Creek channel will be enhanced through culvert replacements and channel enhancements. The existing impoundment will remain in place, and no work is proposed from approximately 25 feet upstream of the Upper Road. The culverts under Upper and Lower roads will be replaced with narrower open bottom culverts to daylight more of Libby Creek, allow for greater flow and to allow natural creek bed formation. From approximately the Lower Road and 50 feet downstream, fill will be excavated from the banks to Libby Creek to provide a smoother gradient towards the easterly wetlands, where Libby Creek can be seasonally connected to overbank flow. Dewatering and rewatering will be necessary and will be done as described earlier for Prairie Creek, as will erosion control and placement of gravel in excavated stream bed. Routine maintenance will include vegetation management and culvert storm-proofing as previously described.

1.3.5. Monitoring

The BA (GHD 2021) describes that: 1) wetland vegetation success monitoring, including measurements of native plant species total cover in the wetland monitoring area with success criteria spread out over five years, 2) reporting mortality during fish relocation during construction, 3) riparian revegetation success rates will be measured, with re-planting as needed to meet full cover criteria, and 4) water quality grab samples and photo points are the monitoring components currently funded and proposed by the League.

If fish mortalities occur, these individuals shall be recorded, collected and frozen for delivery to NMFS, and NMFS will be contacted in real time, i.e. immediately after a dead salmonid is observed. Monitoring of habitat quality along Prairie Creek will be conducted via photo points, visual observations and random water quality samples. Water quality samples will be randomly collected upstream and downstream of the Project area during and after large storm events, described in the BA (GHD 2021) as precipitation events that cause Prairie Creek to overtop its banks, throughout the fall and winter following construction to monitor turbidity. Prairie Creek overtops its banks occasionally, usually a few times a year. Because water quality samples will be representative of what is flowing downstream at the watershed scale, and not just of potential sediment input sourced from within the Project area, a visual assessment of instream turbidity conditions in conjunction with the quantitative turbidity readings from grab samples will determine whether BMP modifications are needed.

At least six photo points will be established along Prairie Creek with photos collected twice annually in June and November for five years following construction of restoration activities.

Photos will face upstream and downstream. Visual observations of vegetation and water quality would be noted at each photo point. Photographs from each photo point, notes on visual observations of vegetation and water quality, and turbidity data will be compiled and included in the annual monitoring report, which will be sent to agencies by December 31 of each year.

1.3.6. Potential Effectiveness Monitoring

If funding is available, the Prairie Creek restoration would be monitored for up to ten years, including:

- As-built surveys would be conducted following Project implementation. Channels created in Prairie Creek and Libby Creek would be inventoried through a series of cross sections and profiles.
- Topographical surveys would be conducted annually from valley wall to valley wall.
- Surface water level loggers would be installed within Prairie Creek, and discharge estimates would be determined at the upstream of the Project area.
- Piezometers would be installed in the Prairie Creek floodplain and wetlands to monitor groundwater movement.
- Fish habitat typing of instream features and assessment of LWD additions for habitat value.

In addition, fish monitoring would be focused within the newly-constructed main channel and off channel habitat features in Prairie Creek. The purpose of the monitoring is to gauge the effectiveness of the restoration actions on fish, and to investigate residence time, immigration, and emigration timing, growth, presence/absence, and habitat utilization of salmonids within the improved creek and floodplain areas. The final monitoring plan would be developed in conjunction with NMFS. There will be 8 to 13 sampling locations throughout the Project reach. Captured fish (using seine and other nets) would be placed in an aerated five-gallon bucket following each haul and returned to the habitat where they were found. Sampling will cease if water quality conditions are unfavorable to fish health or if temperatures exceed 69.8°F (21°Celsius (C)). After weighed and measured for length, a portion of captured juvenile salmonids will be implanted with a Passive Integrated Transponder (PIT) tag to track the movement of the fish. A series of PIT antennas may be installed within the Project footprint to assess residency time, utilization and apparent survival. To determine an overall presence/absence and habitat utilization, snorkel surveys would occur pre- and post- restoration in the main and side channels each month during winter and summer.

During the 10 years of effectiveness monitoring, the League proposes to handle:

- No more than 1,000 coho salmon yearlings (age 1+) each year, through net and minnow trap capture methods. Out of those 1,000 coho salmon age 1+ juveniles, no more than 400 would be PIT tagged each year to obtain residency times and growth rates.
- Up to 1,000 age 0+ coho salmon each year, through net and minnow trap capture methods. The age 0+ coho salmon will not be PIT tagged.
- No more than 1,700 age 0+ Chinook salmon per year, through net and minnow trap capture methods. Out of those 1,700 age 0+ Chinook salmon, no more than 50 will be

PIT tagged each year.
- No more than 600 age 1+ and 2+ steelhead each year, through net and minnow trap capture methods. Out of those 600 age 1+ and age 2+ steelhead, no more than 50 will be PIT tagged each year.
- Up to 1,000 age 0+ steelhead each year through net and minnow trap capture methods. The age 0+ steelhead will not be PIT tagged.

The above limits were proposed based on previous effectiveness monitoring at many locations on near the action area, including Martin Slough (Pagliuco 2021), and estimates of juvenile population sizes in Prairie Creek from many years of outmigrant monitoring at the mouth of the creek.

Water quality measurements would be taken at each fish monitoring location, and could include temperature and dissolved oxygen sampling. A series of water quality data sondes would also be deployed following Project implementation to record water level (via pressure transducer), pH, conductivity and temperature. In addition to the six photo points described above, up to twelve additional photo points may be established during effectiveness monitoring. A monitoring report would be developed annually and made available to the public.

1.3.7. Minimization Measures

The BA (GHD 2021), including its appendices, describes all minimization measures in detail, many of which have been summarized in the above sections. In addition, the Project includes other minimization measures that are especially important for protection of fish and aquatic habitat:

- Erosion and sediment control measures, such as straw wattles (or similar method to catch and trap sediment) will be placed around work zones.
- Dust control to prevent wind erosion, sediment tracking, and dust generation will be used and will include periodic watering of the work area using water from the onsite well or imported from the Orick Community Services District.
- Numerous construction BMPs, such as stormwater, project scheduling, preservation of existing vegetation, dewatering, vehicle and equipment fueling and maintenance, spill prevention and control are included during Project implementation.
- Sufficient erosion control supplies, including but not limited to: straw wattles, silt fences, jute mesh, and burlap, will be available and maintained on site until disturbed areas are stabilized.
- The contractor shall ensure that the site is prepared with BMPs prior to the onset of any storm predicted to receive 0.5 inches or more of rain over 24 hours.
- All equipment and vehicle maintenance and staging, and dispensing of fuel, oil, and coolant, shall occur within the staging areas at the previous mill site, and/or over liners, at least 300 feet from any water bodies. Equipment shall be checked for leaks daily prior to leaving the staging area and repaired as necessary.
- Concrete wash water will be collected on either an impervious surface (mill site foundation or liner) into leak proof container(s) and either recycled or disposed of at a municipal water treatment facility.

- All work related to the dewatering of Prairie Creek shall be conducted during the NOS.
- All herbicides will be stored in properly labeled and secured locations within property labeled and closed containers. No unlabeled or open containers will be stored, even temporarily. Keep herbicide spill kit at hand and know how to use it. The Spill Prevention and Response Plan which is included in the Project's Invasive Species Management Plan (GHD 2021), shall be followed in case of a spill. Training for herbicide applicators shall include familiarization with the Spill Response Plan.

We considered, under the ESA, whether or not the proposed action would cause any other activities, and determined that the building of the visitor center will require the California Department of Transportation (CalTrans) to install a southbound left turn lane from Highway 101 to Bald Hills Road for safe traffic flow. Included with the future southbound left turn lane project is shoulder widening on Highway 101, installation of a retaining wall, and signage. Planning for this project is being led by NPS and CalTrans.

The southbound left turn lane would be approximately 315 feet long, 12 feet wide with approximately 15 feet of shoulder on the western side of Highway 101. NPS has completed a schematic design and estimate of construction costs for the improvements and has coordinated with Caltrans to ensure that the improvements satisfy CalTrans' design standards (GHD 2021). Approximately 1.25 acres of vegetation from the western hillside would be removed to construct a retaining wall to accommodate the turning lane and shoulder widening. No work is proposed along the eastern side of the road adjacent to Prairie Creek. This project would occur during the dry season, and would incorporate applicable CalTrans BMPs, such as sediment management materials staged and used at the work zone. Should the final design deviate from proposed work as described, RNSP and CalTrans would contact NMFS. RNSP, in coordination with CalTrans, is currently seeking funding for the southbound left turn lane project through a Federal Lands Access Program (FLAP) grant, administered through the Highway Trust Fund. The visitor center will not open to the public until the intersection improvements are completed (GHD 2021).

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 provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence

of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

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

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

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

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

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that 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' "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 function of the PBFs that are essential for the conservation of the species.

2.2.1. SONCC Coho Salmon

Coho salmon have a generally simple 3-year life history. The adults typically migrate from the ocean and into bays and estuaries towards their freshwater spawning grounds in late summer and fall, and spawn by mid-winter. Adults die after spawning. The eggs are buried in nests, called redds, in the rivers and streams where the adults spawn. The eggs incubate in the gravel until fish hatch and emerge from the gravel the following spring as fry. These 0+ age fish typically rear in freshwater for about 15 months before migrating to the ocean. The juveniles go through a physiological change during the transition from fresh to salt water called smoltification. Coho salmon typically rear in the ocean for two growing seasons, returning to their natal streams as 3-year-old fish to renew the cycle.

2.2.2. CC Chinook Salmon

CC Chinook salmon are typically fall spawners, returning to bays and estuaries before entering their natal streams in the early fall. The adults tend to spawn in the mainstem or larger tributaries of rivers. As with the other anadromous salmon, the eggs are deposited in redds for incubation. When the 0+ age fish emerge from the gravel in the spring, they typically migrate to saltwater shortly after emergence. Therefore, Chinook salmon typically enter the estuary as smaller fish compared to coho salmon. Chinook salmon are typically present in the stream-estuary ecotone, which is located in the downstream portions of major tributaries to estuaries like Humboldt Bay, from early May to early September, with peak abundance in June/July (Wallace and Allen 2007). Similar to coho salmon, prey resources during out-migration are critical to Chinook salmon survival as they grow and move out to the open ocean. A study by MacFarlane (2010) indicated that juvenile Chinook salmon require less prey in the estuary, equivalent to one northern anchovy (Engraulis mordax) per day, compared to a range of one to four anchovies needed per day in the ocean.

2.2.3. NC Steelhead

Steelhead exhibit the most complex suite of life history strategies of any salmonid species. They have both anadromous and resident freshwater life histories that can be expressed by individuals in the same watershed. The anadromous fish generally return to freshwater to spawn as 4 or 5 year old adults. Unlike other Pacific salmonids, steelhead can survive spawning and return to the ocean only to return to spawn in a future year. It is rare for steelhead to survive more than two spawning cycles. Steelhead typically spawn between December and May. Like other Pacific salmonids, the steelhead female deposits her eggs in a redd for incubation. The 0+ age fish emerge from the gravel to begin their freshwater life stage and can rear in their natal stream for 1 to four years before migrating to the ocean.

Steelhead have a similar life history as noted above for coho salmon, in the sense that they rear in freshwater for an extended period before migrating to saltwater. As such, they enter the estuary

as larger fish (mean size of about 170 to 180 mm or 6.5 to 7.0 inches) and are, therefore, more oriented to deeper water channels in contrast to Chinook salmon that typically enter the estuary as 0+ fish. The CDFW data indicate that steelhead smolts generally migrate downstream toward the estuary between March 1 and July 1 each year, although they have been observed as late as September (Ricker et al. 2014e). The peak of the outmigration timing varies from year to year within this range, and generally falls between early April and mid-May.

2.2.4. Status of Species and Critical Habitat

In this biological opinion, NMFS assesses four population viability parameters to help us understand the status of each species and their ability to survive and recover. These population viability parameters are: abundance, population productivity, spatial structure, and diversity (McElhaney et al. 2000). While there is insufficient information to evaluate these population viability parameters in a thorough quantitative sense, NMFS has used existing information, including the Recovery Plan for SONCC Coho Salmon (NMFS 2014) and Coastal Multispecies Recovery Plan (NMFS 2016a), to determine the general condition of each population and factors responsible for the current status of each Distinct Population Segment (DPS) or Evolutionarily Significant Unit (ESU). We use these population viability parameters as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02).

Status of SONCC Coho Salmon

SONCC Coho Salmon Abundance and Productivity: 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 (Williams et al. 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.

SONCC Coho Salmon Spatial Structure and Diversity: 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 2001b, Good et al. 2005, Williams et al. 2011, Williams et al. 2016). Extant populations can still be found in all major river basins within the ESU (70 FR 37160; June 28, 2005). 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. The genetic and life history diversity of populations of SONCC coho salmon is likely very low and is inadequate to contribute to a viable ESU, given the significant reductions in abundance and distribution.

Status of CC Chinook Salmon

CC Chinook Salmon Abundance and Productivity: Low abundance, generally negative trends in abundance, reduced distribution, and profound uncertainty as to risk related to the relative lack of population monitoring in California have contributed to NMFS' conclusion that CC Chinook salmon are likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range. Where monitoring has occurred, Good et al. (2005) found that historical and current information indicates that CC Chinook salmon populations are

depressed. Uncertainty about abundance and natural productivity, and reduced distribution are among the risks facing this ESU. Concerns regarding the lack of population-level estimates of abundance, the loss of populations from one diversity stratum , as well as poor ocean survival contributed to the conclusion that CC Chinook salmon are likely to become an endangered species in the foreseeable future (Good et al. 2005, Williams et al. 2011, Williams et al. 2016).

CC Chinook Salmon Spatial Structure and Diversity: Williams et al. (2011) found that the loss of representation from one diversity stratum, the loss of the spring-run history type in two diversity substrata, and the diminished connectivity between populations in the northern and southern half of the ESU pose a concern regarding viability for this ESU. Based on consideration of this updated information, Williams et al. (2016) concluded the extinction risk of the CC Chinook salmon ESU has not changed since the last status review. The genetic and life history diversity of populations of CC Chinook salmon is likely very low and is inadequate to contribute to a viable ESU, given the significant reductions in abundance and distribution.

Status of NC Steelhead

NC Steelhead Abundance and Productivity: With few exceptions, NC steelhead are present wherever streams are accessible to anadromous fish and have sufficient flows. The most recent status review by Williams et al. (2016) reports that 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 viability assessment (Williams et al. 2011). Williams et al. (2016) found that population abundance was very low relative to historical estimates, and recent trends are downwards in most stocks.

NC Steelhead Spatial Structure and Diversity: NC steelhead remain broadly distributed throughout their range, with the exception of habitat upstream of dams on both the Mad River and Eel River, which has reduced the extent of available habitat. Extant summer-run steelhead populations exist in Redwood Creek and the Mad, Eel (Middle Fork) and Mattole Rivers. The 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 is at risk. Hatchery practices in this DPS have exposed the wild population to genetic introgression and the potential for deleterious interactions between native stock and introduced steelhead. However, abundance and productivity in this DPS are of most concern, relative to NC steelhead spatial structure and diversity (Williams et al. 2011).

Status of Critical Habitats

The condition of SONCC coho salmon, CC Chinook salmon, and NC steelhead critical habitat, specifically its ability to provide for their conservation, has been degraded from conditions known to support viable salmonid populations. NMFS has determined that currently depressed population conditions are, in part, the result of the following human induced factors affecting critical habitat: logging, agriculture, mining, urbanization, stream channelization, dams, wetland loss, and water withdrawals (including unscreened diversions for irrigation). Impacts of concern include altered stream bank and channel morphology, elevated water temperature, lost spawning and rearing habitat, habitat fragmentation, impaired gravel and wood recruitment from upstream sources, degraded water quality, lost riparian vegetation, and increased erosion into streams from upland areas (Weitkamp et al. 1995). Diversion and storage of river and stream flow has

dramatically altered the natural hydrologic cycle in many of the streams within the ESU's and DPS. Altered flow regimes can delay or preclude migration, dewater aquatic habitat, and strand fish in disconnected pools, while unscreened diversions can entrain juvenile fish.

Factors Responsible for the Decline of Species and Degradation of Critical Habitat

The factors that caused declines of species and degradation of critical habitat include hatchery practices, 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, climate change, and severe flood events exacerbated by land use practices (Good et al. 2005, Williams et al. 2016). Sedimentation and loss of spawning gravels associated with poor forestry practices and road building are particularly chronic problems that can reduce the productivity of salmonid populations. Late 1980s and early 1990s droughts and unfavorable ocean conditions were identified as further likely causes of decreased abundance (Good et al. 2005). From 2014 through 2016, the drought in California reduced stream flows and increased temperatures, further exacerbating stress and disease. Ocean conditions have been unfavorable in recent years (2014 to present) due to the El Nino in 2015 and 2016. Reduced flows can cause increases in water temperature, resulting in increased heat stress to fish and thermal barriers to migration.

One factor affecting the range wide status and aquatic habitat at large is climate change. Information since these species were listed suggests that the earth's climate is warming, and that this change could significantly impact ocean and freshwater habitat conditions, which affect survival of species subject to this consultation. In the coming years, climate change will influence the ability to recover coho and Chinook salmon in most or all of their watersheds. Steelhead are particularly vulnerable to climate change due to their need for year-round cool water temperatures (Moyle 2002). Through effects on air temperatures and stream flows, climate change is expected to increase water temperatures to the detriment of coho and Chinook salmon. Climate change effects on stream temperatures within Northern California are already apparent. For example, in the Klamath River, Bartholow (2005) observed a 0.5°C per decade increase in water temperature since the early 1960's, and model simulations predict a further increase of 1-2°C over the next 50 years (Perry et al. 2011).

In coastal and estuarine ecosystems, the threats from climate change largely come in the form of sea level rise and the loss of coastal wetlands. Sea levels will likely rise exponentially over the next 100 years, with possibly a 50-80 cm rise by the end of the 21st century (IPCC 2007). This rise in sea level will alter the habitat in estuaries and either provides an increased opportunity for feeding and growth or in some cases will lead to the loss of estuarine habitat and a decreased potential for estuarine rearing. Marine ecosystems face an entirely unique set of stressors related to global climate change, all of which may have deleterious impacts on growth and survival while at sea. In general, the effects of changing climate on marine ecosystems are not well understood given the high degree of complexity and the overlapping climatic shifts that are already in place (e.g., El Niño, La Niña, and Pacific Decadal Oscillation) and will interact with global climate changes in unknown and unpredictable ways. Overall, climate change is believed to represent a growing threat, and will challenge the resilience of listed salmonids in Northern California.

As more fully described in the two following sections, the Project is within the Prairie Creek sub-basin of the Redwood Creek watershed. The Redwood Creek watershed (including Prairie Creek) contains independent populations of SONCC coho salmon, CC Chinook salmon and NC steelhead. NMFS' SONCC Coho Salmon Recovery Plan (2014) and NMFS' Coastal Multispecies Recovery Plan (2016) describe that the Redwood Creek populations of these species are either core for recovery (SONCC coho salmon) or essential for recovery (CC Chinook salmon and NC steelhead), and that in general, the Prairie Creek sub-basin: 1) provides good to very good habitat with cool water, 2) is a stronghold for salmon and steelhead, 3) will provide an important anchor for species recovery (NMFS 2014, 2016a).

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The action area is within the lower part of the Prairie Creek sub-basin of the Redwood Creek watershed. The action area includes approximately 89 acres of disturbance at the site, including Prairie Creek downstream to its confluence with Redwood Creek, and Redwood Creek downstream of the confluence to the estuary, which is the extent of temporary increases in turbidity may occur (GHD 2021).

2.4. Environmental Baseline

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

The Project site is adjacent to Redwood National Park and is a high priority for restoration due to channel incision and Highway 101's proximity to the current channel limiting habitat formation and floodplain connectivity, and due to Prairie Creek's status as a salmon stronghold and an important source of cool water.

The climate in the Project area is defined by a dry season (summer and fall) and a mild wet season (winter and spring) (Wilzbach and Ozaki 2017). The action area is heavily influenced by cool, offshore marine air, which generates coastal fog, most prevalent in the region during the summer months (Cannata et al. 2006). Orick experiences high levels of seasonal precipitation at about 67 inches on average. Average temperatures range from 42.2 to 61.4° F (5.7 to 16.3 ° C) (GHD 2021)

The threat to SONCC coho salmon, CC Chinook salmon, and NC steelhead from climate change is low in the action area due to the coastal fog zone and the benefits of old growth redwood

forests, including shady, complex stream and riparian areas, and cool stream temperatures (NMFS 2014, 2016a). In future years and decades, we expect that Prairie Creek will continue being a refuge for SONCC coho salmon, CC Chinook salmon, and NC steelhead within the Redwood Creek watershed, and within their respective ESUs and DPS. The Prairie Creek sub-basin is 93 percent forested, and almost half of that forest is late seral stands of coast redwood and other conifers (Wilzbach and Ozaki 2017). The sub-basin's role as a continued habitat refuge for listed salmonids is due in part to the watershed being nearly all (98 percent) park lands, the large amount of old growth forest, the cool, coastal climate, and that there has been, and continues to be a focus on restoring the part of the sub-basin that was previously logged.

The Project area was logged, turned to ranchland and pasture, and then used as one of the Orick lumber mill sites from the late 1950s to 2009, when the mill was shut down (GHD 2021). These uses degraded aquatic habitat within the action area. In addition to the channel incision and close proximity to Highway 101, the previously managed section of lower Prairie Creek, which includes the action area, lacks instream large wood, particularly larger wood (Ozaki and Truesdell 2017).

Juvenile and adult salmonids are found throughout the action area. All three listed salmonids spawn in mainstem Prairie Creek. However, the most downstream section of Prairie Creek within the action area is mostly a migratory route for adult salmonids with deep resting pools on the way to upstream spawning habitat with coarser substrate. Listed salmonids rear throughout the action area, including in mainstem Prairie Creek year round. While accessible during winter when flows are high, low summer stream flows and high stream gradient makes eastside tributaries [Libby, Otter and Unnamed creeks (Figure 1)] inaccessible upstream of the Upper and Lower roads where the hillside steeply rises. The westside tributary Skunk Cabbage Creek provides year round rearing habitat for juvenile salmonids, but does not contain coarse substrate for spawning within the action area. A large floodplain and wetland contain seasonal habitat during overbank flows (GHD 2021).

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

Coho Salmon

Coho salmon occurring in the action area belong to the Redwood Creek population of SONCC coho salmon, which is considered at high risk of extinction in the NMFS SONCC Coho Salmon Recovery Plan (2014), with key threats being channelization/diking and roads, and key stresses being impaired estuarine function, and lack of floodplain and channel structure (NMFS 2014). Roads are also a very high threat, and sediment a high stress in this population. Current population-wide abundance estimates are low, averaging in the low to mid hundreds of adults, suggesting that the population is quite far from the number needed (4,900 adults, NMFS 2014) to be at low risk of extinction.

However, the Prairie Creek portion of the population is by far the most robust and productive in the watershed, and is considered a stronghold for coho salmon. Based on spawner surveys of coho salmon from 2009 to 2020, CDFW estimated adult returns to Prairie Creek numbering in low to mid hundreds of fish (Ricker et al. 2014 a, b, c, d, and Ricker 2011, Deibner-Hanson

2021), and estimates that Prairie Creek supports about 80 percent of the Redwood Creek coho salmon population.

Smolt abundance was monitored from 2011-2020 in the lowermost section of Prairie Creek, by Humboldt State University (HSU) in collaboration with CDFW. Data are summarized in Sparkman et al. (2015) for the years 2011-2014, in Wilzbach et al. (2016) for the years 2011-2015, in Wilzbach et al. (2017) for the years 2011-2016, and in Deibner-Hanson (2021) for 2017-2020. During 2011-2014, the annual estimate of 1+ coho salmon emigrating past the downstream migrant trap in lower Prairie Creek averaged 17,804 individuals, a majority (86 percent) of which were classified as smolts. The smolt population estimate averaged 18,550 from 2011-2015, and 17,615 from 2011-2016, and averaged 18,467 from 2017-2019, the estimate staying relatively consistent through the study period until the 2019-2020 spawning season. Diebner-Hanson (2021) estimated 34,807 age 1+ coho salmon smolts migrated in season 2019-2020. Drobny (2016) estimated a juvenile density of coho salmon in late summer 2014 to be 0.52 fish/square yard (SD=0.38, SE = 0.03, n = 159) using a 2-pass snorkeling method in pools distributed throughout the Prairie Creek watershed.

A two year freshwater life history has been documented in Prairie Creek (Bell and Duffy 2007, Ransom 2007, and Moore 2014). For the three Prairie Creek streams he studied (Prairie, Streelow, and Boyes creeks), Ransom found that the incidence of a two year freshwater life history ranged from 1.6 to 29.5 percent in 2000 through 2002. The largest proportions of individuals with a two year life history were observed during summer, following the winter with the mildest streamflow. Adults enter the action area November through February and the peak timing of smolt outmigration in Prairie Creek occurs in April and May.

Chinook Salmon

Chinook salmon in the action area belong to the Redwood Creek population. NMFS (2016) estimates the current abundance from the upper hundreds to a few thousand fish, suggesting that at least in some years, the population is close to the number needed (3,400 adults, NMFS 2016a) to be at low risk of extinction. Diebner-Hanson (2021) reported estimated from the low hundreds to tens of redds each year in Prairie Creek. Channel modification is a very high threat to this population and sediment from roads is a high threat (NMFS 2016a).

Adults typically enter Prairie Creek during the first two weeks in November, continuing through the end of December or early January. Chinook salmon juveniles typically rear for three to six months in the action area, and then migrate downstream from their natal streams to the Redwood Creek estuary to rear. Wilzbach et al. (2017) reported that average smolt production between 2011 and 2016 equals 47,106 individuals, showing more variability than the other salmonid species. Peak smolt outmigration typically occurs in April and May. Chinook salmon smolts from Prairie Creek have been found to enter the estuary earlier than smolts from Redwood Creek, and at a smaller size (Sparkman et al. 2015). This suggests a greater dependency of Prairie Creek Chinook salmon to complete their rearing in lower Redwood Creek and estuary to reach a size that increases marine survival. Juvenile population estimates for Chinook salmon were not reported for 2017 to 2020 (Diebner-Hanson 2021).

Steelhead

Steelhead in the action area belong to the coastal and interior Redwood Creek populations of NC steelhead, and are estimated to be below the number needed population-wide (5,400 adults, NMFS 2016a) to be at a low risk of extinction. NMFS (2016a) estimates that the steelhead populations range from hundreds to around a 1,000 adult fish (population-wide). Channel modification is a very high threat to this population and sediment from roads is a high threat (NMFS 2016a)

Numbers of redds were estimated from 121-158 during 2017-2020 (average of 106 redds from 2010-2020); however, Diebner-Hanson (2021) notes that the estimate is incomplete because surveys end in March and are for only a partial steelhead spawning season. Annual production of steelhead smolts from Prairie Creek averaged 7,059 during 2011-2014, 8,108 during 2011-2015, and 7,940 during 2011-2016 (Sparkman et al. 2015, Wilzbach et al. 2016, and Wilzbach et al. 2017), remaining relatively consistent. Diebner-Hanson (2021) did not estimate steelhead populations for 2017-2020. Although steelhead are the most widely distributed salmonid in the Redwood Creek basin (Anderson 1988), they are outnumbered by coho salmon in the Prairie Creek sub-basin. In each study year, 1+ steelhead juveniles outnumbered 2+ steelhead juveniles caught at the trap, with population estimates of 1+ juveniles being about twice as many as 2+ juveniles. All of the steelhead within the Prairie Creek sub-basin are fall or winter run (RNSP 2019), although there is a small summer run of steelhead in mainstem Redwood Creek, where pools are deeper and larger for summer holding.

Critical Habitat for all Listed Salmonids

The condition of SONCC coho salmon, CC Chinook salmon and NC steelhead critical habitat, specifically the habitat's ability to provide for species conservation, is in generally good to very good condition. Some of the action area provides good instream and riparian habitat, and some of the action area provides fair to poor habitat where legacy land use impacts remain. Many habitat parameters reflect this mix of conditions within the action area. Between the Highway 101 Bridge and the Bald Hills Bridge, the habitat quality of Prairie Creek is impaired by a deeply incised channel, eroding stream banks and lack of floodplain access (Anderson in RNSP 2019).

RNSP (2019) reports that number of LWD pieces per mile of stream in all reaches of Prairie Creek exceeded target values established by NMFS (2014) for ranking channel structure as very good. However, evidence of a legacy logging effect in lower reaches of the stream, such as the action area, is suggested by the reduced volume of LWD per mile relative to that observed in upper reaches, particularly in the largest size class of wood, and that most of the wood in the lower reaches of Prairie Creek was small (Ozaki and Truesdell 2017).

Water quality and quantity in the action area is good to very good. In the 2002, list update, Redwood Creek was listed under section 303(d) of the Clean Water Act as impaired for temperature, though no schedule has been set for the temperature TMDL (NCRWQCB 2021). Although Redwood Creek is listed as temperature impaired, water temperatures in Prairie Creek are suitable for salmonids throughout the year. Since 1997, stream temperature has been continuously monitored between June and September by RNSP at a number of sites throughout the Prairie Creek watershed, including the action area. Maximum weekly maximum temperatures

(MWMT) have very rarely exceeded 61 °F (16 °C) since 1997, and have not exceeded 61 °F since 2007. The U.S. Environmental Protection Agency (USEPA) uses a MWMT of 16 °C as the upper limit for core juvenile salmonid rearing areas (RNSP 2019). Hydrologic function in Prairie Creek is not impaired by dams or large diversions.

The Redwood Creek basin was listed on California's Clean Water Act Section 303(d) beginning in 1992 as sediment impaired, and a total maximum daily load (TMDL) was completed in 1998 to address sediment supply problems (Wilzbach and Ozaki 2017). The sediment TMDL for Redwood Creek acknowledged differences in the severity of sediment impairment between Prairie Creek and the rest of the Redwood Creek basin (Wilzbach and Ozaki 2017). The TMDL sediment load analysis demonstrated that most sediment inputs came from logging and road building; and Prairie Creek has had less human disturbance than the rest of Redwood Creek (Wilzbach and Ozaki 2017). Water quality monitoring has been conducted by the RNSP daily in Redwood Creek near the Highway 101 Bridge since water year 1993 (GHD 2021). Since October 2008, there have been only two instances (December 2012 at 1,690 mg/L and February 2019 at 1,210 mg/L) where suspended sediment concentration was above the 1,200 mg/L threshold of lethal effects to coho salmon at the Redwood Creek monitoring site. The reductions in suspended sediment loads likely indicates improvement in land use activities and additional land within the basin managed as parks.

In addition, Klein (2012) monitored turbidity associated with road removal projects in Lost Man Creek, just upstream of the action area, and found that stream crossing excavations contributed relatively large amounts of sediment on occasion, but sediment contributions decreased rapidly over time, with most sediment being transported after the first significant rain event post stream crossing excavation. At present, RNSP operates three long-term gaging stations within the Prairie Creek sub-basin, all upstream of the action area.

Several studies in Prairie Creek have documented that over-winter survival of anadromous salmonids is positively correlated with fish body size (Brakensiek and Hankin 2007, Moore 2014, Drobny 2016). In recent years, overwinter survival estimates of juvenile coho salmon have been higher in Prairie Creek (Moore 2014, Sparkman et al. 2015, Wilzbach et al. 2016) than in another coho salmon stronghold, Mill Creek, tributary to the Smith River. In comparison with Freshwater Creek, fewer juvenile coho salmon exhibited an early migration from Prairie Creek in fall of 2013 or 2014 [e.g., 2 percent of tagged fish in 2013 versus 30 percent in nearby Freshwater Creek (Rebenack et al. 2015)], perhaps reflecting more favorable instream habitat conditions.

Previous ESA Section 7 Consultations and Research Approvals in the Action Area

Routine road and bridge improvements occur regularly within the action area. Road removal and second growth forest thinning projects have been implemented in the Prairie Creek sub-basin near or within the action area in the recent past, and will be ongoing over the next 18 years [i.e., the Greater Prairie Creek Ecosystem Restoration Program (GPC Program)]. The GPC Program will result in small increases in suspended sediment and very small numbers of juvenile coho salmon and steelhead mortality associated with dewatering and relocation activities. As part of the GPC Program, LWD will be added in fall 2021 to lower Prairie Creek, and adjacent riparian areas improved with native riparian vegetation planting. Other projects completed in the sub-

basin include the Lost Man Creek road removal project (completed 2010), and thinning treatments in the South and Middle Forks of Lost Man Creek from 2009 to 2011, and from 2015 to 2019, respectively; both projects were determined unlikely to adversely affect listed salmonids.

NMFS' ESA Section 10(a)(1)(A) research and enhancement permits, and research projects that are part of the annual CDFW ESA Section 4(d) rule research program (4d program) occurred in the recent past in Prairie Creek, and in the action area, but funding for the future is not currently secured and uncertain. Previous research included juvenile salmonid outmigrant monitoring at the rotary screw trap at the mouth of Prairie Creek conducted by HSU, and visual spawning and carcass surveys conducted by CDFW throughout the sub-basin. In general, these activities are closely monitored and require measures to minimize take during the research activities. NMFS determined these research projects are unlikely to affect future adult returns.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The Project has the potential to result in:

1. Temporary reduction in food and cover.
2. Temporary increases in stream temperatures.
3. Delivery of petroleum products to stream channels.
4. Harm to fish from herbicide use.
5. Water use during and post-construction.
6. Temporary increase in sediment delivery and increased turbidity in stream channels.
7. Juvenile fish mortality due to fish relocation/handling during channel construction and monitoring.
8. Fish impingement, entrainment or displacement due to stream dewatering.

2.5.1. Temporary Reduction in Food and Cover

Implementation of the Project will remove approximately 5.60 acres of riparian habitat adjacent to 0.72 mile (3,830 feet) of Prairie Creek. Currently, there are about 9 acres of riparian habitat along the Prairie Creek that provide cover, food (via macroinvertebrates) and wood recruitment to Prairie Creek. Riparian habitat along the Prairie Creek channel will be replanted with native species at a ratio of more than two to one (and maintained), resulting in 11 acres of riparian habitat over time. Salmonid juveniles rely on benthic and drifting macroinvertebrates for food, and instream wood and riparian vegetation to provide cover from predators. Adult salmonids rely on cover to evade predators during upstream migration.

Benthic and drifting macroinvertebrates (invertebrates greater than 0.5 millimeter at maturity) from Prairie Creek have been sampled (Wilzbach and Ozaki 2017). Index of Biological Integrity (IBI) scores at sites throughout the Prairie Creek watershed were ranked as very good to fair (Wilzbach and Ozaki 2017) and Prairie Creek sites sampled by the NPS had IBI scores ranked as good or very good (Dinger 2015). Madej et al. (2006) did not find clear trends in macroinvertebrates in Prairie Creek between the 1970s and 2000s, of particular note was that the most pristine sites were not found to have the highest Index of Biological Integrity (IBI) ratings. Levin at al. (2003) also found that a small amount of timber harvest in a watershed has a positive effect on benthic macroinvertebrate metrics and IBI scores (Rehn and Ode 2005). In addition, a nine-year macroinvertebrate sampling effort on Wood Creek, a tributary to Freshwater Creek (tributary to Humboldt Bay) was analyzed to determine if there was a trend following habitat restoration. The analysis suggests within three years post-implementation, a similar project yielded macroinvertebrates at a higher than before project construction (GHD 2021). These findings suggest that temporary reductions in riparian habitat within the Prairie Creek sub-basin may potentially benefit macroinvertebrate production by temporarily opening part of the riparian canopy to increased light.

In addition, the proposed LWD additions to stream channels will support macroinvertebrate production and provide cover. Large amounts and pieces of LWD will be installed most years of project implementation throughout the newly constructed channel. Based on monitoring of a similar channel relocation and floodplain connectivity project at Muir Beach in coastal Marin County, riparian vegetation at the Project site should be completely re-grown within about four years (NPS 2021). Macroinvertebrates are expected to drift downstream from the upper Prairie Creek watershed, which has an IBI rating of good to very good (Dinger 2015) into the action area at the present rate (GHD 2021).

Based on: 1) some riparian habitat (about 3.5 acres) remaining at the site during project construction, 2) the anticipated riparian re-growth in about four years, 3) the healthy assemblage of macroinvertebrates that will drift downstream from the upper watershed, 4) the placement of large quantities of LWD instream to supplement macroinvertebrate production and to provide cover, and 5) the potential increase in macroinvertebrates from increased light to the stream, NMFS expects the temporary reduction in riparian habitat to have an negligible effect on availability of food and cover, with no reduction in individual fitness (all species and all life stages).

2.5.2. Temporary Increases in Stream Temperatures

The interim period of riparian reestablishment may also result in increased stream temperatures due to the temporary reduction in vegetative shading. Potential increases in summer water temperatures may occur within the four-year period of anticipated riparian reestablishment. Juvenile coho salmon and steelhead rear in Prairie Creek during summer months. However, all streams within the action area are within the coastal summer fog zone where ambient air temperature remains relatively low (i.e., up to about 70° F) all year long, and the average hours of summer sunshine are also relatively low (RNSP 2019). The upper Prairie Creek watershed is in a pristine state and Prairie Creek water temperatures are consistently below 16° C (Wilzbach and Ozaki 2017). Therefore, based on the cool water that flows into the Project area and the coastal summer fog zone, NMFS expects that temporary reductions in riparian vegetation will

have a negligible effect on stream temperatures within the action area and no reduction in individual fitness (all species and life stages).

2.5.3. Petroleum Products

During the NOS when heavy equipment will be operating, juvenile coho salmon and steelhead will be rearing in streams in the action area (Wilzbach and Ozaki 2017). Chinook salmon juveniles will not be rearing in the Project area until late winter or early spring, after the first big storms of the year that could wash petroleum products to the stream. With any heavy equipment and power tool use in the riparian area, there is the possibility that petroleum products may enter the stream, either through spills or leaks. Spill plans, checking equipment for fluid leaks, refueling and maintaining equipment at least 300 feet from any stream and in areas that are flat and infiltrate rather than drain to the stream (such as the old mill site), and having spill kits on site should prevent or minimize the probability of runoff of hazardous materials. Therefore, the potential for exposing juvenile coho salmon, Chinook salmon, and steelhead to petroleum products is negligible since the Project would adhere to all design features pertaining to containment and prevention of petroleum product spills.

2.5.4. Herbicide Use

Herbicides and adjuvants proposed for this Project have the potential to enter the aquatic environment if they make their way into surface water or ground water. As described in detail in the BA (GHD 2021) four aquatically approved herbicides and two adjuvants are proposed for use in riparian areas, but not within surface waters. Herbicide application will occur in summer or fall when there is less than ten percent chance of rain in the forecast for 48 hours. Herbicides and adjuvants could enter the aquatic environment via a number of pathways, including unintentional spray drift, accidental spills, or chemical transport by erosion and sediment transport, runoff, or soil percolation. However, numerous BMPs and minimization measures, such as reducing biomass before herbicide treatments, using spot treatments in riparian areas, and not using herbicides during wet weather, greatly reduce the likelihood of chemicals entering the stream by any pathway.

Although it is unlikely that herbicides will enter the stream network, only herbicides with a low potential degree of impact on listed fish species (i.e., those herbicides that are aquatically approved by the EPA or have aquatically approved formulations) and are slightly toxic or practically nontoxic to fish are the chemicals proposed for use in riparian areas. The EPA (2016) categorizes pesticides as moderately toxic to fish when the LC_{50} is between 1 and 10 ppm, slightly toxic to fish when the LC_{50} is between 10 and 100 ppm, and practically nontoxic to fish when the LC_{50} is greater than 100 ppm. Additionally, these herbicides do not show signs of bioaccumulating in fish (EPA 1998).

The lowest effective herbicide application rates and concentrations that do not exceed the label requirements would be used, reducing the chance of impacts on listed species by minimizing the amount of chemicals that are used during invasive plant control, and thus limiting the potential that listed species would be exposed to herbicides. Of the four herbicides proposed for use in riparian areas, imazamox, imazapyr, and triclopyr amine have no observable adverse effect concentrations (NOAEC) in excess of 100 ppm (RNP 2017) suggesting concentrations would need to be in excess of 100 ppm in streams before any harm would occur to fish.

Only glyphosate has a NOAEC that is below 100 ppm. Modeled estimated water concentrations of glyphosate using an application rate of 7 pounds per acre, which is above the maximum label rate, in the shallow zone of a pond where applications were made directly to emergent invasive plants did not exceed 3 ppm (Solomon and Thompson 2003) or $1/10^{th}$ the NOAEC. With concentrations from applications to emergent aquatic weeds an order of magnitude below the NOAEC, it is highly unlikely that water concentrations from spot applications for control of invasive plants within the riparian area could approach the NOAEC. The maximum label rate for broadcast applications is 5 pounds per acre, so spot treatments would be much lower than that.

As described previously, the two adjuvants proposed for use are Agri-Dex and Hasten® Modified Vegetable Oil. RNP (2017) describes the information available for Agri-Dex, which suggests the potential for harm is low. Mammalian toxicity data provided on the safety data sheet indicates very low toxicity (RNP 2017). Further, while the non-ionic surfactant in Hasten® Modified Vegetable Oil has moderate toxicity, it is unlikely that water concentrations from spot applications for control of invasive plants in the riparian zone would harm fish given the small amount of the non-ionic surfactant within the adjuvant. Given the many BMPs and minimization measures, it is unlikely that fish will be exposed to the herbicide or adjuvant used. In addition, it would take a large amount of Hasten (e.g., a spill) to harm fish in the unlikely event that they were exposed (Dillon 2017).

Based on: 1) the use of aquatically approved herbicides and adjuvants with generally low toxicity levels, 2) application methods, 3) environmental conditions during application, and 4) other BMPs, it is highly unlikely that concentrations of any of these herbicides could approach their respective NOAECs, and even less likely they could achieve concentrations that would be harmful to fish. In addition, glyphosate that comes in contact with soil binds tightly to particles and tends to remain within the top 6 inches of soil, which makes it unlikely to end up in surface or sub-surface runoff. Considering the area of use, the methods of application, and all of the minimization measures (e.g., weather restrictions and nozzle settings that reduce the chance of drift), these herbicides would not have the potential to enter the aquatic or riparian environment or expose threatened salmonids to these chemicals.

With any herbicide use near a stream, there is always the slight possibility of the substance entering the aquatic environment and exposing listed fish should a spill occur. Spill plans and BMPs for managing chemical products should minimize the probability of runoff of hazardous materials in the unlikely event of a spill associated with Project activities. In the unlikely event of a spill, BMPs include keeping a spill kit ready for use by previously trained personnel. The spill response plan described in RNP (2017) and adopted by this Project, would also minimize the effects of a spill on listed species by minimizing the volume and extent of the spill and expediting clean up.

Based on: 1) herbicides and adjuvants not being applied to surface waters or saturated soils, 2) application BMPs (e.g., herbicides applied only when less than a 10 percent chance of rain), 3) spot application methods, 4) use of aquatically approved chemicals in riparian areas, and 5) use of BMPs that address herbicide containment, prevention of spills, and safe handling and storage

procedures (GHD 2021), NMFS expects that the potential for exposing and injuring juvenile coho salmon, Chinook salmon and steelhead to herbicides is negligible.

2.5.5. Water Use

Surface and groundwater withdrawals have the potential to affect instream flows and habitat availability during the late summer and early fall when juvenile coho salmon and steelhead are rearing in the Project area. The aquifer that the groundwater is sourced from is at least partially confined (LACO 2011a, 2011b); however, there is potential that the partially confined portion of the aquifer could drain into Prairie Creek. Due to ample tank storage and tanks being mostly filled during the winter, the amount of daily groundwater pumping for potable water during the dry season will be very small, equal to about a 0.01 cfs reduction in surface flow in Prairie Creek during summer base flows of 2 to 4 cfs (0.25 to 0.5 percent reduction in surface flow). The 0.5 percent maximum reduction in surface flow is highly unlikely to occur during the five years of revegetation irrigation.

In addition, surface water from Prairie Creek is proposed for use during revegetation irrigation. During irrigation, there will be a maximum diversion of 0.2 cfs per day using up to three pumps (GHD 2021). The 0.2 cfs maximum irrigation diversion would correspond to a maximum of 10 percent reduction in flow and a 0.10-foot reduction in stage height. These mobile irrigation units will be in use immediately after native vegetation planting (September through November), until the start of the rainy season. Thus, total reductions in surface flow ranges from 5 to 10 percent of summer base flows for up to 5 years of post-construction revegetation irrigation. Richter et al. (2011) stated that daily flow alterations up to 10 percent of unimpaired flows provide a high level of protection to riverine function and ecosystem. In addition, Ozaki (2020) describes that 98 percent of the Prairie Creek sub-basin is managed as National and State park lands, with very few to no known surface diversions upstream and sustained flows entering the Project reach, even in drought years. NMFS (2014, 2016) also describes that water withdrawals are a low threat to Prairie Creek, and that Prairie Creek is not limited by volume or quality of water. Thus, the temporary and minor reductions in cfs and stage height will result in very little to no reductions in habitat availability from Project water use. In addition, temporary reductions in riparian vegetation may make more groundwater available as surface flow during the revegetation irrigation, as younger plants will use less water.

Based on: 1) water sourced for fire protection and drinking from the partially confined aquifer, with less than one percent corresponding reduction in surface flow, 2) ample water storage tanks being filled by groundwater pumping during the wet season, 3) revegtation irrigation temporarily causing up to 10 percent of surface flow reduction and a 0.10 reduction in stage height with very little to no reductions in habitat availability, 4) water for post-construction irrigation sourced from wells during the winter and stored for summer use, 5) Prairie Creek not used as a water source for dust control, and 6) the consistent source of water into the Project reach from upstream, even in drought years, NMFS expects that water use will result in negligible changes to flow and habitat availability in Prairie Creek. These negligible changes will not reduce the individual fitness of juvenile coho salmon and steelhead.

2.5.6. Increased Sediment and Turbidity

Increases in suspended sediment or turbidity can affect water quality, which in turn can affect fish health and behavior. Salmonids typically avoid areas of higher suspended sediment, which means they displace themselves from their preferred habitat in order to seek areas with less suspended sediment. Fish unable to avoid suspended sediment can experience negative effects from exposure, including changes in feeding and territorial defense (Berg and Northcote 1985, UBFM 2001, Gregory and Northcote 1993, Harvey and White 2008).

The Project requires a significant amount of earth moving. Approximately 350,000 cy of material will be relocated within the Project area. The largest source of sediment that could enter into aquatic habitat would come from Prairie Creek restoration activities. This potential sediment introduction into Prairie Creek would be temporary, and would flush downstream in suspension for five seasons post-construction from 2021-2025 (GHD 2021). Biotechnical bank and floodplain protection will be used within all portions of the new channel and off-channel habitat features to minimize erosion and enhance re-vegetation (Figure 3). The biotechnical materials will be biodegradable within 3 to 6 years and will provide temporary stability to soils while vegetation becomes established to provide long term soil stability. The biotechnical methods, in combination with planted vegetation, gravel additions to all disturbed channel beds, and channel grade control in two locations, would stabilize the majority of sediment sources and greatly reduce the amount of sediment available to enter Prairie Creek.

Biotechnical fabrics were used in a similar project at Muir Beach, and were found to be effective at controlling erosion (Ward et al. 2017). Channel incision upstream of the Project area is not a concern due to the low channel slope gradient between the Project and the upstream area (GHD 2021). Although biotechnical fabrics will secure the majority of sediment within constructed channels and floodplains, it is possible that sediment may wash downstream following rewatering of dewatered channel sections and the first winter following initial disturbance. Construction BMPs such as, straw wattles around disturbed areas, washing out fine sediment prior to rewatering channel areas, and the placement of sediment curtains downstream of the construction area, will minimize the amount of sediment entering Prairie Creek.

Construction of remaining Project components, such as Libby Creek enhancement, CCT construction, culvert replacements at Otter Creek and the Unnamed tributary, Lower Road minor ditch excavations and grading, and grading at the visitor center and Yurok Tribal site are not expected to contribute sediment into Prairie Creek due to a combination of construction BMPs, topography of the sites that will drain towards either the easterly wetlands or bioretention settling basins, and the distance of these features from Prairie Creek.

To ensure that BMPs and erosion control measures are effective and operating as designed, water grab samples that will be randomly collected upstream and downstream of the Project area (e.g., at the upstream and downstream bridges) during and after large storm events, throughout the fall and winter following construction seasons to monitor turbidity. During the site visits to collect grab samples, erosion control methods will be assessed for effectiveness and repaired or adjusted as needed as real time adaptive management of the site to improve BMPs and reduce erosion to the extent possible.

Due to use of biotechnical fabrics and mulch; covering disturbed channel bed with gravel; channel grade control to limit incision; construction BMPs for the creek restoration, visitor center, and Highway 101 southbound left turn lane project; natural site topography; intentional bioretention basins; and real-time adaptive management, the potential increase in sediment entering Prairie Creek from implementation of all Project components will be short term and small.

Sediment delivery to streams will occur during the first winter post-construction activities, particularly during the first large storms of the first winter (Klein 2012). Juvenile coho salmon, Chinook salmon and steelhead are present in the action area during winter and will be exposed to small increases in total suspended sediment (TSS).

Adults of all three species could also be present, depending on the timing of the first large storms. As described in Newcombe and Jensen (1996), juvenile salmonids are the most sensitive to suspended sediments, hence the concentration of research into effects to that life stage. Adult salmonids and eggs could also be affected by suspended sediments, and Lloyd (1987) summarizes sedimentation effects studies to all salmonid life stages. Studies completed by RNSP (2019) show that adverse effects to adult salmonids begin well above the expected suspended sediment levels from Project activities, and thus while adults of all species may experience exposure, they will not experience an adverse response.

Research has shown that length of exposure to total suspended solids (TSS) plays a more dominant role than TSS concentration (Anderson et al. 1996) and that it is important to consider the frequency and the duration of the exposure. Based on all of the minimization measures, particularly the biotechnical fabrics and mulch, as well as gravel placement and grade control in channels, NMFS expects that a small number of juvenile salmonids of all species that cannot escape slightly elevated TSS will be exposed to increased TSS and experience behavioral effects in the 1 to 3 range of the sedimentation severity of ill effects (SEV) scale described in Newcombe and Jensen (1996; Table 2). These behavioral effects include an alarm reaction, abandonment of cover and avoidance response. Not all exposed individuals will experience a response to the increase in TSS, nor will responses to the increase in TSS be the same for all individuals. Some exposed individuals (of all species) will be able to find areas of less turbid water, minimizing or avoiding even a low level behavioral response.

In addition, emergence timing will delay the exposure of Chinook salmon juveniles to later in the winter, past the first winter storms of the season when TSS values would be less, and the response lower on the SEV scale. NMFS also expects that a greater number of juvenile coho salmon and steelhead will be exposed to an increase in TSS due to their longer instream residency times, but that many of these individuals will be able to avoid turbid waters as well. For these reasons, NMFS expects that a very small number of Chinook salmon, coho salmon, and steelhead juveniles will experience short term behavioral responses, resulting in a small reduction in fitness for a very small number of juveniles during five subsequent winters.

Table 2. Description scale of SEV from Newcombe and Jensen (1996).

SEV	Description of Effect
Nil Effect	
0	No behavioral effect
Behavioral Effects	
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
Sub-lethal Effects	
4	Short term reduction in feeding rates; short term reduction in feeding success
5	Minor physiological stress; increase in rate in coughing, increase respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long term reduction in feeding rate; long term reduction in feeding success; poor condition

2.5.7. Fish Handling

Fish Relocation

Removing fish from restoration construction sites will reduce the number of fish potentially injured or killed from dewatering, thermal stress, desiccation, and physical injury from construction equipment. However, the stress of relocation can cause injury or mortality in juvenile salmonids (Reynolds 1983, Habera et al. 1996, Habera et al. 1999, Nielsen 1998, Nordwall 1999). The amount of unintentional injury or mortality attributable to fish removal varies depending on the method used, ambient conditions, and the expertise and experience of the field crew. Fish collecting gear, whether passive or active poses some risk to individuals, including stress, disease transmission, injury, or death (Hayes et al. 1996). Studies of fish response to electrofishing have shown that although often not externally obvious or fatal, spinal injuries and associated hemorrhages have been documented in over 50 percent of fish examined internally that were subject to electrofishing (Snyder 2003). Significantly fewer spinal injuries are reported when direct current, low-frequency pulsed direct current (<30 Hz), or specially designed pulse trains are used (Snyder 2003).

In addition, relocated fish may have to compete with other fish for available resources such as food and habitat, and the growth rate of fish can be slowed when population density is high (Ward et al. 2007). Juvenile coho salmon and steelhead will be rearing in the action area during relocation. Age 0+ Chinook salmon will have outmigrated prior to the late summer when fish relocation will occur, and age 1+ Chinook salmon are extremely rare in Prairie Creek and assumed not to be in the action area during dewatering and associated fish relocation. Existing steep stream banks provide little to no cover, ensuring total fish capture prior to dewatering,

eliminating the risk of fish being crushed or desiccated. The fish relocation protocol described in the *Proposed Action* section will greatly reduce the risk of harm or mortality, but not completely eliminate it.

There is approximately 11,175 square meters of instream habitat per dewatering event within Prairie Creek and lower Skunk Cabbage Creek. Coho salmon are more prevalent than steelhead in the Prairie Creek watershed (Wilzbach and Ozaki 2017), thus a conservative estimate is 0.60 fish per square meter for coho salmon, and 0.55 fish per square meter for steelhead (GHD 2021). GHD (2021) estimates that up to 6,705 juvenile coho salmon (age 0+ and 1+) and 6,146 juvenile steelhead (age 1+ and 2+) may be captured per dewatering event, which would occur once per year, for four years.

Data on fish relocation efforts from water diversion activities since 2004 (NMFS 2016b) show most average injury and mortality rates are below three percent for salmonids. Given the measures that would be implemented to avoid and minimize impacts to fish during relocation efforts, NMFS expects no more than three percent of all relocated fish would be subject to potential injury or mortality.

If the maximum kill/injury rate of three percent is applied to the maximum estimated 6,705 coho salmon and 6,146 steelhead expected to be caught per year, then 202 coho salmon juveniles and 185 steelhead juveniles could be harmed or killed during relocation per year for four years (beginning in 2022). Considering the quality of the habitat in Little Lost Man and Lost Man creeks where fish will likely be relocated, and that the number of relocated individuals will be low relative to available habitat, NMFS does not expect the relocated individuals to contribute to overcrowding or increased competition to a level that would decrease individual fitness or survival.

Fish Monitoring

Fish handling is proposed during effectiveness monitoring, including measuring fish length and weight, transferring of fish to aerated buckets, and potential incision and insertion with a PIT tag, as more fully described in the *Proposed Action* section. Since there are no examples of potential fish abundance in off channel habitats on Prairie or Redwood creeks, coho salmon estimates from Martin Slough were used to estimate capture and handling numbers for Prairie Creek, based on a number of similarities (GHD 2021) between the habitat created by these projects.

The monitoring will capture up to 1,000 age 0+ coho salmon, 1,000 age 1+ coho salmon, 1,000 age 0+ steelhead, 600 age 1+ or 2+ steelhead, and 1,700 0+ Chinook salmon each year for 10 years. The younger and smaller fish will not be PIT tagged, but may experience stress from handling. Based on monitoring of similar projects, and use of less invasive net and minnow trap methods, Pagliuco (2021) estimates mortality from trapping and handling at less than one percent, or no more than 10 age 0+ coho salmon, 6 age 1+ coho salmon, 10 age 0+ steelhead, 6 age 1+ or 2+ steelhead, and 17 0+ Chinook salmon each year for 10 years.

During handling, the greatest risk for injury and mortality is due to PIT tagging. PIT tagging mortality rates have been estimated for juvenile salmonids in a number of studies. Achord (2001) found less than one percent mortality for coho salmon, Dare (2003) found less than one percent

mortality for Chinook salmon, Brakensiek and Hankin (2007) estimate less than 1 percent PIT tagging mortality for coho salmon, and Prentice et al. (1987) found less than five percent mortality rate for Chinook salmon. The higher mortality rate for Chinook salmon may be size dependent, as Brakensiek and Hankin (2007) also found that mortality was strongly related to size of fish during tagging. For the following estimates of PIT tagging mortality, we use the conservative estimate of five percent mortality for smaller age 0+ Chinook salmon, and one percent mortality for the larger age 1+ and 2+ coho salmon and steelhead.

We expect that of the 400 age 1+ coho salmon juveniles that are PIT tagged every year for 10 years, four age 1+ coho salmon will be killed each year. Of the 50 age 0+ Chinook salmon proposed for PIT tagging per year, three age 0+ Chinook salmon will be killed each year for 10 years, and of the 50 age 1+ and 2+ steelhead that are PIT tagged each year, one juvenile steelhead will be killed per year for 10 years.

2.5.8. Fish Impingement, Entrainment or Displacement

Juvenile coho salmon and steelhead may be present during stream dewatering and diversion in up to 2,000 feet of Prairie Creek each year, for four years, during the lowest water levels of the year in late summer and early fall. To minimize effects to juvenile fish, fish will be relocated to nearby suitable habitat, and the stream will be diverted around the work site temporarily. Passage of redistributing juveniles may be limited by the diversion; however, the proposed work window minimizes exposure and avoids peak timing of juvenile redistribution.

The upstream block nets blocking hosing, the fine meshed net or screens used for excluding fish from the work area, placing the nets or screens in areas of low velocity, and checking and clearing the screens daily to maintain free flowing water, have found to be effective at avoiding entrainment or impingement of fish at restoration work sites in Northern California (NMFS 2016b, Pagliuco 2021) In particular, monitoring indicates that inspecting and cleaning the screens of debris twice daily, including weekends, ensures avoidance of entrainment or impingement (Pagliuco 2021).

Based on: 1) the work window timing that limits exposure, 2) the minimization measures for exclusion screening, 3) twice daily inspection (including weekends) of screens and clearing of debris, and 4) the good to very good habitat upstream and downstream of the construction area, NMFS does not expect stream dewatering and diversion, or exclusion fencing, to affect the fitness of any individuals, or to negatively influence the passage of any juvenile coho salmon or steelhead. In addition, LWD will only be added to dry stream channels, thus fish will not be displaced during this activity.

2.5.9. Effects to Critical Habitat

NMFS expects long-term improvement to the quality and quantity of PBFs of critical habitat due to the proposed Project. Recovery plans (NMFS 2014, 2016a) describe that poor instream habitat with lack of floodplain connection are high or very high threats and stresses to these populations. The Program will restore channel and floodplain connectivity, and will add large wood to channels, improving floodplain and tributary access, channel structure and habitat complexity.

The recovery plans (NMFS 2014, 2016a) identify important areas for restoration and recovery, and emphasize the importance of continuing to restore the Prairie Creek sub-basin to anchor it as a stronghold for salmon and steelhead, especially when considering its important source of cool water during climate change. Given that almost a mile of Prairie Creek and adjacent riparian and floodplain habitat will be improved, the Project will have a positive impact on the PBFs of designated critical habitat in the action area through habitat restoration.

As described in the previous section, we expect: 1) that water temperatures will not change, 2) negligible reductions in food and cover, 3) a temporary 10 percent decrease in surface water resulting in negligible changes to habitat availability, and 4) negligible risk of petroleum products or herbicides entering the stream network. However, small increases in TSS will result in temporary reductions in water quality through increased turbidity. We expect that the small increase in TSS will either stay in suspension, or be deposited behind large wood in channels, and will not affect pool depths, nor substrate quality, resulting in minor and temporary reductions in rearing habitat availability. During dewatering, migration will be temporarily blocked, but good quality habitat is available upstream and downstream of the temporary blockage, which will be reconnected prior to adult salmonids entering Redwood and Prairie creeks. However, we expect long-term improvements in substrate and pool quality, increased pool formation through additions of large wood and gravel, improvements in rearing habitat through floodplain connectivity and cover, and improvements in migratory habitat through creation of large resting pools with cover. The riparian area will be improved by removing non-native vegetation and planting native vegetation.

2.6. Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4). NMFS is not aware of any non-Federal activities planned for the action area that would result in an adverse effect to listed salmonids or their habitat.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: 1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution, or 2) appreciably

diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1. Context and Expectations

SONCC coho salmon, CC Chinook salmon, and NC steelhead in the action area consists of independent populations, which are core or essential to recovery of the species (NMFS 2014, 2016a). These populations have all declined to a large degree from historic abundance levels, with reductions in productivity and diversity as well. However, the Project is located in a sub-basin that has generally good to very good habitat conditions with high levels of species abundance and productivity. We expect the Project to create improvements in habitat forming processes, improved connectivity with floodplain rearing habitat and improvements in riparian habitat, which are all important recovery actions described by NMFS (2014, 2016). Although there will be temporary blockages to juvenile migration from channel dewatering and minor increases in suspended sediment during project construction, the overall improvements to substrate, cover, food, connectivity and riparian vegetation are much greater and longer lasting. Overall, the Project is expected to improve the status of PBFs of critical habitat in the action area after implementation, which will positively affect population abundance and productivity for the Redwood Creek populations of listed salmonids. These long term improvements will outweigh short term reductions in habitat availability during Project construction, such as the blockages to migration created by channel dewatering.

As explained more fully in the Effects of the Action section, the Project will result in harm or mortality to juvenile coho salmon and steelhead from relocation, and will result in harm or mortality to juvenile coho salmon, Chinook salmon, and steelhead from handling and insertion of PIT tags as part of effectiveness monitoring. During fish relocation, as many as 202 coho salmon and 185 steelhead juveniles could be killed each year for four construction seasons. As a result of Project effectiveness monitoring, four age 1+ coho salmon will be killed each year, three age 0+ Chinook salmon will be killed each year , and one juvenile (age 1+ or 2+) steelhead will be killed from PIT tagging each year for 10 years. In addition, up to 10 age 0+ coho salmon, 6 age 1+ coho salmon, 10 age 0+ steelhead, 6 age 1+ or 2+ steelhead, and 17 age 0+ Chinook salmon will be killed from trapping and handling each year for 10 years.

Additionally, a small number of coho salmon and steelhead juveniles, and to a lesser degree, Chinook salmon juveniles, would not be able to flee turbid waters and would be exposed to increased TSS over the five restoration construction seasons, particularly during the first winter storms of each year. Of these exposed juveniles, a smaller percentage would experience small reductions in individual fitness due to changes in behavior. Water quality monitoring (RNSP 2021) from the upstream GPC Program indicates very low levels of TSS are entering the action area from upstream activities. Due to good habitat availability in the action area, including ongoing effects of the upstream GPC Program, minimization measures that substantially reduce sediment inputs, and our estimate of behavioral effects rather than sub-lethal effects on the SEV scale, NMFS expects affected individuals will experience small reductions in fitness or growth rates, but that these reductions will not affect the likelihood of return as adults.
Relatively large numbers of coho salmon, Chinook salmon, and steelhead adults enter the Prairie Creek sub-basin each year to spawn, with large numbers of juveniles produced, so that spawning in future years would be expected to produce enough juveniles to replace any that are lost due to

relocation or effectiveness monitoring. We do not expect any loss of individuals or reduced fitness from reductions in food and cover, petroleum product exposure, herbicide use or handling, water use, impingement or entrainment. It is unlikely that the loss of such small percentages of the juvenile populations would reduce future adult returns.

2.7.2. Prairie Creek as a Stronghold

The action area could be subject to higher average summer air temperatures and lower total precipitation levels in the future as a consequence of climate change. Higher air temperatures are not likely to warm stream temperatures due to abundant shade and protected status as park lands. Reductions in the amount of precipitation may reduce stream flow and the estuary may also experience changes in productivity due to changes in freshwater flows, nutrient cycling, and sediment amounts. Given that Prairie Creek is part of the coastal redwood rain forest, with relatively high levels of precipitation now and into the future, and that this Project would be completed by 2031, reductions in precipitation are unlikely to be detected within the Project time frame. The short-term effects of Project implementation would have completely elapsed prior to changes in stream flow from climate change influencing decreased precipitation.

Restoring the ecosystem within the action area is expected to increase the carrying capacity of the Prairie Creek sub-basin and will promote species recovery. Because of its perennial cold water and robust population abundances, Prairie Creek is a stronghold for salmonids in the face of climate change effects. Therefore, the Program is unlikely to appreciably reduce the likelihood of survival and recovery of SONCC coho salmon, CC Chinook salmon, and NC steelhead, and the Program is unlikely to appreciably diminish the value of designated critical habitat for the conservation of these species.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and 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, or NC steelhead, or destroy or adversely modify their designated critical habitats.

2.9. Incidental Take Statement

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

2.9.1. Amount or Extent of Take

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

Fish Relocation Activities

Take of juvenile coho salmon and steelhead in the form of capture and mortality is expected during fish relocation activities. Up to 6,705 juvenile coho salmon and 6,146 juvenile steelhead are expected to be captured and relocated each year for four years. Also, during the four years of dewatering and fish relocation, up to 202 juvenile coho salmon and up to 185 juvenile steelhead mortalities are expected annually.

Effectiveness Monitoring Activities

Take of juvenile coho salmon, Chinook salmon, and steelhead in the form of capture and mortality is expected during Project effectiveness monitoring. Up to 1,000 age 1+ coho salmon, 1,000 age 0+ coho salmon, 1,700 age 0+ Chinook salmon, 600 age 1+ or 2+ steelhead, and 1,000 age 0+ steelhead will be captured each year for ten years. Up to 4 age 1+ coho salmon, 3 age 0+ Chinook salmon and 1 age 1+ or age 2+ steelhead will be killed each year for 10 years from PIT tagging. In addition, up to 10 age 0+ coho salmon, 6 age 1+ coho salmon, 10 age 0+ steelhead, 6 age 1+ or 2+ steelhead, and 17 age 0+ Chinook salmon will be killed by trapping and handling each year for 10 years.

Increases in Sediment

It is not possible to quantify the amount of individual juvenile coho salmon, Chinook salmon, and steelhead injured or killed as a result of elevated turbidity because it is not possible to meaningfully measure the number of juvenile coho salmon, Chinook salmon, and steelhead that use the action area due to the variation in annual juvenile population size and variation in habitat utilization in the action area during winter. When NMFS cannot quantify the amount or extent of incidental take in terms of the numbers of individuals, NMFS uses surrogates to estimate the amount or extent of incidental take. Thus, 2,000 feet of Prairie Creek, which is the maximum extent of stream to be dewatered in a year, will be used as the surrogate for the extent of take, for four years.

Total Amount of Take

Combined, there are 46,820 SONCC coho salmon juveniles of all age classes, 40,584 juvenile NC steelhead of all age classes, and 17,000 age 0+ CC Chinook salmon juveniles that will be captured over the 10 year Project. In addition, 1,008 SONCC coho salmon juveniles of all age classes, 910 NC steelhead juveniles of all age classes, and 200 age 0+ Chinook salmon are expected to be killed over the 10 year Project duration. A total of approximately three-quarters mile of Prairie Creek will experience small increases in TSS during the five winters post restoration activities.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). In order to be exempt from the prohibitions of section 9 of the ESA, the federal agency and applicant must comply with the terms and conditions necessary for carry out the reasonable and prudent measures.

NMFS believes the following reasonable and prudent measures are necessary and appropriate to minimize take of SONCC coho salmon, CC Chinook salmon, and NC steelhead. The Corps and NOAA RC shall:

1. Undertake measures to ensure that harm and mortality to Chinook salmon, coho salmon and steelhead resulting from fish relocation, effectiveness monitoring, creek restoration, and visitor center construction and maintenance are minimized.
2. Prepare and submit an annual report regarding the effects of fish relocation, effectiveness monitoring, and restoration activities.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agencies must comply (or must ensure that any applicant complies) with the following terms and conditions. The Corps and NOAA RC, or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

a. Qualified biologists with expertise in the areas of anadromous salmonid biology shall conduct effectiveness monitoring activities.
b. The Corps and NOAA RC shall ensure that electrofishers will not be used during effectiveness monitoring.
c. The Corps and NOAA RC shall ensure that salmonids be handled with extreme care and kept in water to the maximum extent possible during effectiveness monitoring activities. All captured fish must be kept in cool, shaded, and aerated water protected from excessive noise, jostling, or overcrowding or potential predators any time they are not in the stream, and fish will not be removed from this water except when released. Captured salmonids will be relocated as soon as possible to an instream location in which suitable habitat conditions are present to allow for adequate survival for transported fish and fish already present. Fish will be distributed between multiple pools if biologists judge that overcrowding may occur in a single pool.

d. The Corps and NOAA RC, or the applicant's contractor, shall monitor all screens used to block fish access on a twice daily basis (including weekends), or more frequently if necessary, to ensure that no impingement occurs. If impingement is unexpectedly found, NMFS will be contacted immediately, at the address and phone number listed below.
e. If any salmonids are found dead or injured, the biologist will contact NMFS hydrologist Leslie Wolff or the North Coast Branch Chief by phone immediately at (707) 822-7201, or (707) 601-5455. The purpose of the contact is to review the activities resulting in the take and to determine if additional protective measures are required. All salmonid mortalities will be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location, fork length, and be frozen as soon as possible. Frozen samples will be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than the NMFS Northern California Office in Arcata, California without obtaining prior written approval from the North Coast Branch Chief.
f. The Corps and NOAA RC, or their applicant, shall allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the Project area during activities described in this opinion.
g. The Corps and NOAA RC, or their applicant, shall contact NMFS if any form of take approaches their annual limit (e.g., approximately 75%) to begin discussions on potential measures to best ensure take limits are not exceeded. The Corps and NOAA RC, or their applicant, shall contact NMFS within 24 hours of meeting or exceeding take of listed species prior to Project completion. Notify Leslie Wolff or the North Coast Branch Chief at (707) 822-7201, or at (707) 601-5455. This contact acts to review the activities resulting in take and to determine if additional protective measures are required.
h. If it is necessary to move additional juvenile fish while monitoring exclusion screens, the Corps and NOAA RC, or their applicant, will contact NMFS immediately to determine whether screens need to be removed to allow continued migration.

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

- The Corps and NOAA RC shall ensure that the results of water quality grab samples and visual estimates of erosion are included in the annual report.
- The Corps and NOAA RC, or their applicant shall provide a written report to NMFS by January 15 of each Project year. The report will include those items as described in the *Proposed Action* section specific to fish handling and mortality, water grab samples, visual estimates of erosion control effectiveness, revegetation success, photo points, and effectiveness monitoring. The annual report shall be sent to NMFS via email to Leslie.wolff@noaa.gov or Leslie Wolff at 1655 Heindon Road, Arcata, California 95521.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS does not have additional conservation recommendations for this Project.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Redwood National and State Park Restoration and Visitor Center Project. As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and 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 identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

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

This analysis is based, in part, on the EFH assessment provided by the Corps and NOAA RC and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

Waters, as defined by EFH, include aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle. The term "adverse effect" means any impacts which reduce the quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrates and loss of, or injury to, benthic

organisms, prey species, and their habitats, and other ecosystem components. Adverse effects may be site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.910). The EFH consultation mandate applies to all species managed under a Fishery Management Plan (FMP) that may be present in the action area.

There is suitable habitat for juvenile salmon rearing, and adult salmon migration in Prairie Creek within the action area. Habitat Areas of Particular Concern (HAPC) are described as complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation. HAPCs exist in the action area as complex channel and floodplain habitat, and as thermal refugia.

3.2. Adverse Effects on Essential Fish Habitat

The adverse effects to EFH and HAPCs in the action area are included in the effects of the action section of this Opinion. They include a temporary reduction in water quality caused by a small and temporary increase in suspended sediment and turbidity. In addition, a temporary reduction in food and cover, riparian vegetation, and rearing habitat availability are expected during construction of the restoration portion of the Project.

3.3. Essential Fish Habitat Conservation Recommendations

The anticipated adverse effects from the proposed action are temporary and relatively minor. The Program is designed to improve habitat conditions both immediately by adding large wood to stream channels, over time by improving channel and floodplain connectivity, and by promoting native vegetation in the riparian areas. NMFS has determined that all desirable and feasible habitat improvements are incorporated into the Project. Therefore, NMFS has no EFH recommendations at this time.

3.4. Supplemental Consultation

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

4. Data Quality Act Documentation and Pre-Dissemination Review

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Army Corps of Engineers (Corps), the NOAA Restoration Center (NOAA RC) and their applicant, Save the Redwood League. Other interested users could include Redwood National and State Parks and the California Department of Fish and Wildlife. Individual copies of this opinion were provided to the Corps and NOAA RC. The document will be available within two

weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. 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 EFH, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

Achord. 2001. PIT Tagging Juvenile Salmonids in the Lake Washington Ship Canal for the Lake Washington General Investigation Study. Fish Ecology Division, Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA.

Anderson, D. G. 1988. Juvenile salmonid habitat of the Redwood Creek basin, Humboldt County, California. M.S. Thesis, Humboldt State University, Arcata, CA.

Anderson, P. G., B. R. Taylor, and G. C. Balch. 1996. Quantifying the Effects of Sediment Release on Fish and their Habitats. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2346, Department of Fisheries and Oceans.

Bartholow, J. M. 2005. Recent water temperature trends in the Lower Klamath River, California. North American Journal of Fisheries Management 25(1):152–162.

Bell, E. and W. G. Duffy. 2007. Previously undocumented two-year freshwater residency of juvenile Coho Salmon in Prairie Creek, California. Transactions of the American Fisheries Society 136:966-970.

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

Brakensiek, K. E. and D. G. Hankin. 2007. Estimating overwinter survival of juvenile coho salmon in a northern California stream: accounting for effects of passive integrated transponder tagging mortality and size-dependent survival. Transactions of the American Fisheries Society 136: 1423-1437.

CDFW (California Department of Fish and Wildlife). 2002. California Salmonid Stream Habitat Restoration Manual.

Cannata, S., R. Henly, J. Falls, D. McGuire, and J. Sunahara. 2006. Redwood Creek Watershed Assessment Report. North Coast Watershed Assessment Program.

Dare, M.R. 2003. Mortality and Long-Term Retention of Passive Integrated Transponder Tags by Spring Chinook Salmon. North American Journal of Fisheries Management 23:1015–1019.

Deibner-Hanson, J. 2021. Life Cycle Monitoring of Coho Salmon in Prairie Creek, Annual Reports. In coordination with Mark Henderson, U.S. Geological Survey, California Cooperative Fish and Wildlife Research Unit, Humboldt State University. Prepared in partial fulfillment of FRGP.

Dillon, J. 2017. Personal communication with NMFS water quality specialist. Santa Rosa, CA

Dinger, E. C. 2015. Integrated aquatic community and water quality monitoring of wadeable streams in the Klamath network – Annual report: 2012 results from Oregon Caves National Monument, Redwood National and State Parks, and Crater Lake National Park. Natural Resource Report NPS/KLMN/NRR – 2015/1015. National Park Service, Fort Collins, Colorado.

Drobny, P. 2016. Influence of intra- and inter-specific salmonid densities and habitat on overwinter survival of juvenile Coho Salmon (*Oncorhynchus kisutch*) in Prairie Creek, California. M.S. Thesis, Humboldt State University.

EPA. (Environmental Protection Agency). 1998. Reregistration Eligibility Decision (RED): Triclopyr. United States Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Washington, DC. EPA 738-R-93-014.

EPA. 2016. Ecological Risk Assessment for Pesticides: Ecotoxicity Categories for Terrestrial and Aquatic Organisms. Internet website: https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/technical-overview-ecological-risk-assessment-0#Ecotox.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 2010. California salmonid stream habitat restoration manual, 4th edition. California Department of Fish and Game.

GHD. 2021. A biological assessment of Redwood National and State Parks Visitor Center and Restoration Project for NMFS-regulated species. Prepared for Save the Redwoods League. April 2021.

Gregory, R.S., and T.G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile Chinook salmon (*Oncorhynchus tshawytcha*) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50:233-240.

Good, T. P., R. S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-NWFSC-66. 597 pp.

Habera, J.W., R.J. Strange, B.D. Carter, and S.E. Moore. 1996. Short-term mortality and injury of rainbow trout caused by three-pass AC electrofishing in a southern Appalachian stream. No. Am. J. Fish. Manage. 11:192-200.

Habera, J.W., R.J. Strange, and A.M. Saxton. 1999. AC electrofishing injury of large brown trout in low-conductivity streams. No. Am. J. Fish. Manage. 19:120-126.

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

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.

Klein, R. D. 2012. Erosion and turbidity monitoring in Lost Man Creek, Redwood National and State Parks Water Years 2003-2011. Final Lost Man Creek Monitoring Report to Redwood National Park: WY2003-2011.

LACO Associates (LACO). 2011a. Water Well Production Testing Results – Former Orick Mill. Prepared for Green Diamond Resources Co. LACO, Eureka, California, USA.

LACO Associates (LACO). 2011b. Wet-weather testing and wastewater disposal system feasibility report of findings. Prepared for Green Diamond Resource Company. LACO, Eureka, California, USA.

Levin, L., C. Fischer, L. Mahon, S. Parks, B. Maurizi, J. Suero, P. Longmire, and P. Roffers. 2003. Monitoring land cover changes in California, a USFS and CDF cooperative

program, North Coast California Project Area. State of California Resources Agency, Department of Forestry and Fire Protection, Sacramento, CA.

Lloyd, D.S. 1987. Turbidity as a water quality standard for salmonid habitats in Alaska. North American Journal of Fisheries Management 7: 34-45.

MacFarlane, R.B. 2010. Energy dynamics and growth of Chinook salmon (*Oncorhynchus tshawytscha*) from the Central Valley of California during the estuarine phase and first ocean year. Canadian Journal of Fisheries and Aquatic Sciences 67(10):1549-1565.

Madej, M. A., H. Ambrose, C. Currens, and S. Hadden. 2006. Assessing changes in stream health following watershed restoration: A 30-year perspective, Redwood Creek Basin, Humboldt County, California.

McBain Associates. 2020. Design Considerations for Invasive Species. November 17.

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. 156 pp.

Moore, T. R. 2014. Overwinter survival and redistribution of juvenile Coho Salmon, *Oncorhynchus kisutch*, in Prairie Creek, California. M.S. Thesis, Humboldt State University, Arcata, California.

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

NMFS (National Marine Fisheries Service). 2001a. Water Drafting Specifications. Southwest Region.

NMFS. 2001b. 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.

NMFS. 2014. Final recovery plan for the Southern Oregon/Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). September 2014. Arcata, California.

NMFS. 2016a. Final Multispecies Recovery Plan. California Coast Chinook Salmon, Northern California Steelhead, Central California Coast Steelhead. Santa Rosa, California.

NMFS. 2016b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Issuance of a Regional General Permit to the California Department of Fish and

Wildlife for Implementation of Anadromous Fish Habitat Restoration Projects under the Fisheries Restoration Grants Program. May.

NMFS. 2017. Endangered Species Act Section 7(a)(2) Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for Redwood National Park's Invasive Plant Management Program. June.

NPS. 2017. Invasive Plant Management Plan and Environmental Assessment for Redwood National Park and Santa Monica Mountains National Recreation Area. October.

NPS. 2021. Muir Beach Restoration. Available at: https://www.nps.gov/goga/learn/nature/muir-beach.htm

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

Newcombe, C.P. and Jensen, J. 1996. Channel suspended sediment and fisheries: A synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management. V 16. No. 4

Nordwall, F. 1999. Movements of brown trout in a small stream: effects of electrofishing and consequences for population estimates. N. Am. J. Fish. Manage. 19:462-469.

North Coast Regional Water Quality Control Board (NCRWQCB). 2021. Redwood Creek TMDL. Available at: https://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/redwood_creek/

NHE. (Northern Hydrology and Engineering). 2017. Concept Design and Project Description for the Libby Creek Restoration Project as a part of the Proposed Redwood Visitor Center Project. Technical Memorandum. August.

NHE. 2018a. Redwood Visitor Center & Prairie Creek Restoration Project Overview. NHE, McKinleyville, California, USA.

NHE. 2018b. Technical Memorandum: Prairie Creek Ordinary High Water Mark Estimate in Support of the Prairie Creek Restoration Project, Humboldt County, CA. Technical Memorandum. NHE, McKinleyville, California, USA.

Ozaki, V. 2020. Personal communication with Redwood National Park hydrologist. Arcata, CA.

Ozaki, V. 2021. Greater Prairie Creek WY 2020 Turbidity and Stream Temperature Monitoring Report. RNSP.

Ozaki, V. and R. Truesdell. 2017. Lower Prairie Creek Stream Channel Assessment. Redwood National Park. Completion Report funded by Save the Redwoods League Grant #2. May 2017, updated December 2017.

PFMC. (Pacific Fishery Management Council). 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.

Pagliuco, R. 2021. Personal communication with NOAA RC habitat restoration specialist. Arcata, CA.

Perry, R.W., Risley, J.C., Brewer, S.J., Jones, E.C., and Rondorf, D.W. 2011. Simulating daily water temperatures of the Klamath River under dam removal and climate change scenarios: U.S. Geological Survey Open-File Report 2011-1243. 78 pp.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1987. A study to determine the biological feasibility of a new fish tagging system. Report (contract DE-A179-83BP11982, project 83-19) to Bonneville Power Administration, Portland, Oregon.

Richter, B.D., M.M. Davis, C. Apse, and C. Konrad. 2011. A Short Communication: A Presumptive Standard for Environmental Flow Protection. The Nature Conservancy. Charleston, Virginia.

Ransom, B. O. 2007. Extended freshwater rearing of juvenile Coho Salmon (*Oncorhynchus kisutch*) in northern California streams. M.S. Thesis, Humboldt State University, Arcata, California.

Redwood National Park (RNP). 2017. A biological assessment of impacts on aquatic and terrestrial endangered and threatened species from invasive plant management in Redwood Nation Park. March 2017.

RNSP. (Redwood National and State Parks). 2019. A biological assessment of impacts on aquatic threatened species from the Greater Prairie Creek Ecosystem Restoration Program in Redwood Nation and State Parks. May 2019.

Rehn, A. C. and P. R. Ode. 2005. Development of a Benthic Index of Biotic Integrity (B-IBI) for Wadeable Streams in Northern Coastal California and its Application to Regional 305(b) Assessment. North Coast Regional Water Quality Control Board. Available at: https://www.waterboards.ca.gov/water_issues/programs/swamp/docs/reports/final_north_calif_ibi.pdf

Ricker, S., K. Lindke, and C. Anderson. 2014a. Results of regional ground surveys and estimates of total salmonid redd construction in Redwood Creek, Humboldt County, California, 2013. CDFW.

Ricker, S., K. Lindke, M. Reneski, and C. Anderson. 2014b. Results of regional ground surveys and estimates of total salmonid redd construction in Redwood Creek, Humboldt County, California, 2010. CDFW.

Ricker, S., K. Lindke, M. Reneski, and C. Anderson. 2014c. Results of regional ground surveys and estimates of total salmonid redd construction in Redwood Creek, Humboldt County, California, 2011. CDFW.

Ricker, S., K. Lindke, M. Reneski, and C. Anderson. 2014d. Results of regional ground surveys and estimates of total salmonid redd construction in Redwood Creek, Humboldt County, California, 2012. CDFW.

Ricker, S.J., D. Ward, C.W. Anderson, and M. Reneski. 2014e. Results of Freshwater Creek salmonid life cycle monitoring station 2010-2013. California Department of Fish and Wildlife, Anadromous Fisheries Resource Assessment and Monitoring Program, Fisheries Restoration Grant P0910513.

SHN Engineering (SHN). 2020a. 100% Design Development Stormwater Mitigation Report. Redwood Visitor Center, Orick, California. Prepared for Save the Redwoods League. SHN, Eureka, California, USA. August.

SHN Engineering (SHN). 2020b. 100% Design Development Domestic and Fire Protection Water Supply. Redwood Visitor Center, Orick, California. Prepared for Save the Redwoods League. SHN, Eureka, California, USA. August.

Solomon, K. and D. Thompson. 2003. Ecological risk assessment for aquatic organisms from over-water uses of glyphosate. Journal of Toxicology and Environmental Health, Part B 6(3):289-324.

Snyder, D. 2003. Electrofishing and its harmful effects on fish. U.S. Geological Survey. Available at: https://pubs.er.usgs.gov/publication/53886

Sparkman, M. D., M. A. Wilzbach, P. Y. Drobny, M. E. Gordon, and C. M. G. Boone. 2015. Prairie Creek Monitoring Project, 2014 Season: A report to the Fisheries Restoration Grants Program (Project No. P1210321).

Umatilla Basin Fishery Managers (UBFM). 2001. Umatilla Basin TMDL and WQMP. Appendix 5: Turbidity Goal. 4 pp. U.S. Department of the Interior, National Park Service. 2016. Foundation Document Redwood National and State Parks California. Crescent City California. 66 pp.

Ward, D. M., K. H. Nislow, J. D. Armstrong, S. Einum, C. L. Folt. 2007. Is the Shape of the Density–Growth Relationship for Stream Salmonids Evidence for Exploitative Rather than Interference Competition? Journal of Animal Ecology, 76:135–138.

Ward, K. D. Fong, M. Reichmuth, B. Pryor, E. Bell, A. Jacobson and C. Shoulders. 2017. Effectiveness and Validation Monitoring Report, Part 1. Redwood Creek Restoration at Muir Beach, 2009-2016. National Park Service, Northern Hydrology and Engineering, Stillwater Sciences, U.C. Berkeley. February 28.

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, Washington. 258 pp.

Wallace, M., and S. Allen. 2007. Juvenile salmonid use of the tidal portions of selected tributaries to Humboldt Bay, California. California Department of Fish and Wildlife, Fisheries Restoration Grants Program Grant P0410504.

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

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

Wilzbach, M. A. and V. Ozaki. 2017. Fisheries and aquatic resources of Prairie Creek, Redwood National Park. Natural Resource Report NPS/REDW/NRR—2017/1492. National Park Service, Fort Collins, Colorado.

Wilzbach, M. A., M. D. Sparkman, P. Y. Drobny, M. E. Gordon, and C. M. G. Boone. 2016. Prairie Creek Monitoring Project, 2015 Season: a report to the Fisheries Restoration Grants Program, Project No. P1210321.

Wilzbach, M.A., M.D. Sparkman, N. Van fleet, B. Sheppard, and M. Settelmayer. 2017. Prairie Creek Monitoring Project, 2016 Season: a report to the Fisheries Restoration Grants Program (Project No. P1210321).