National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion

Consultation on the Issuance of a Special Use Permit on National Forest System Lands and an ESA Section 10(a)(1)(A) Permit for Scientific Research Affecting Lower Columbia River Steelhead

NMFS Consultation Number: WCR-2017-7358

Action Agencies: National Marine Fisheries Service (NMFS)
National Science Foundation (NSF)
U.S. Forest Service (USFS)

Affected Species and 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?
Lower Columbia River (LCR) steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No

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

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List of Acronyms

CFR – Code of Federal Regulation
DPS – Distinct Population Segment
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
FR – Federal Register
GPNF – Gifford Pinchot National Forest
ISAB – Independent Scientific Advisory Board
LCR – Lower Columbia River
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NEON – National Ecological Observatory Network
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NSF – National Science Foundation
PBF – Physical or Biological Feature
USFS – United States Forest Service
VSP – Viable Salmonid Population

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402. It constitutes NMFS' review of the Gifford Pinchot National Forest (GPNF), Mt. Adams Ranger District's proposal to issue a special use permit to the National Ecological Observatory Network (NEON) and NEON's application for an ESA scientific research permit from NMFS. Our review is based on information provided in GPNF's Fisheries Biological Assessment (GPNF 2017), NEON's application for the proposed scientific research permit, published and unpublished scientific information on the biology and ecology of LCR steelhead, and other sources of information.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System [https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts]. A complete record of this consultation is on file with the Protected Resources Division in the Portland, Oregon office of NMFS's West Coast Region: 1201 NE Lloyd Blvd, Portland, Oregon 97232.

1.2 Consultation History

NEON proposes to construct and operate a long-term ecological research site at Martha Creek in the Trout Creek sub-watershed (Wind River) in GPNF in Washington State. LCR steelhead is the only affected species.

On September 15, 2016, GPNF sent NMFS Oregon Washington Coastal Area Office (OWCAO) a draft Biological Assessment (BA) for GPNF's proposed action to issue a special use permit to NEON. GPNF sent a final BA on June 14, 2017 (GPNF 2017).

NEON submitted an application for an ESA Section 10(a)(1)(A) scientific research permit to NMFS West Coast Region's Protected Resources Division (PRD) on February 21, 2017. We asked NEON for additional information on March 15 and March 22, 2017 to clarify the proposed sampling methods and take levels. We had multiple phone and email correspondences with NEON staff from March 15 to March 28, 2017, during which we provided information about the permitting process, *Oncorhynchus mykiss* life history, and measures to minimize take of listed LCR steelhead during the proposed research activities. We received all necessary information from NEON on April 4, 2017, and deemed their research permit application to be complete on April 17, 2017. We provided information on the research permit application in a Federal Register notice published on May 26, 2017 (82 FR 24304). We accepted public comments on the research permit application until June 26, 2017, and then commenced consultation. We do not present the full consultation history here because it is lengthy and not directly relevant to the analysis. We maintain a complete record of this consultation at NMFS Protected Resources Division in Portland, Oregon.

1.3 Proposed Federal Actions

"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). When analyzing the effects of the action, we also consider the effects of other activities that are interrelated or interdependent with the proposed action. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this instance, we found no actions that are interrelated to or interdependent with the proposed action.

"Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct. This opinion constitutes formal consultation and an analysis of effects for LCR steelhead, which is the only distinct population segment (DPS) that is a subject of this opinion.[1]

The proposed Federal actions are GPNF's issuance of a special use permit and NMFS' issuance of a section 10(a)(1)(A) scientific research permit for activities proposed by NEON. As action agencies, GPNF and NMFS are responsible for complying with section 7 of the ESA, which requires Federal agencies to ensure any actions they fund, permit, or carry out are not likely to jeopardize listed species' continued existence nor destroy or adversely modify their critical habitat. This consultation examines the effects of the proposed action and the effects of GPNF and NMFS' proposal to issue special use and scientific research permits. Thus it fulfills section 7 consultation obligations for NMFS and GPNF.

The GPNF proposes to issue a special use permit that would allow NEON to construct and operate a long-term ecological monitoring site on Forest Service lands (GPNF 2017). NEON proposes to install infrastructure and conduct research along the mainstem of Martha Creek, which is in the Trout Creek sub-watershed of the Wind River watershed in the Gifford-Pinchot National Forest in Washington State. NEON proposes to conduct aquatic and riparian research within a 0.6 mile (1 km) sampling reach, located 1.1 miles upstream of the confluence of Martha Creek with Trout Creek. The purpose of this research is to monitor climate change, land use change, and invasive species for the next 30 years as part of a continental-scale ecological observatory network.

NEON proposes to install small amounts of instream and near-stream infrastructure. These would include access paths, power and communication conduits, device posts and portals, a

[1] A DPS of steelhead (71 FR 834) is considered to be a "species" as defined in section 3 of the ESA.

meteorological station, groundwater wells, and instream sensor suites. We describe these aspects of the proposed action below, under *"Construction and Installation of Research Infrastructure."*

NEON proposes to use the instream and riparian sensors in combination with field sampling, for a period of 30 years, to characterize chemical, physical, and biological properties of the stream and riparian ecosystem at Martha Creek. The aquatic sampling suite consists of chemical measurements of surface and shallow ground water, physical measurements of stream and riparian habitat, and biological measurements of the aquatic community. We describe these aspects of the proposed action below, under *"Scientific Research Activities."*

1.3.1 Construction and Installation of Research Infrastructure

NEON proposes to construct and widen paths by hand felling trees, hand lopping branches and shrubs, and cutting gaps through logs laying across the trails. NEON proposes to widen an existing 2,500-foot-long trail to 4 feet width. The trail would be widened from Forest Road (FR) 4101 to the most-downstream sampling site at Martha Creek. NEON proposes to construct a 2,122-foot-long trail from FR 4101 to the upstream sampling site and construct a 3,200-foot-long trail along Martha Creek that connects the two sampling sites. (Figure 1).

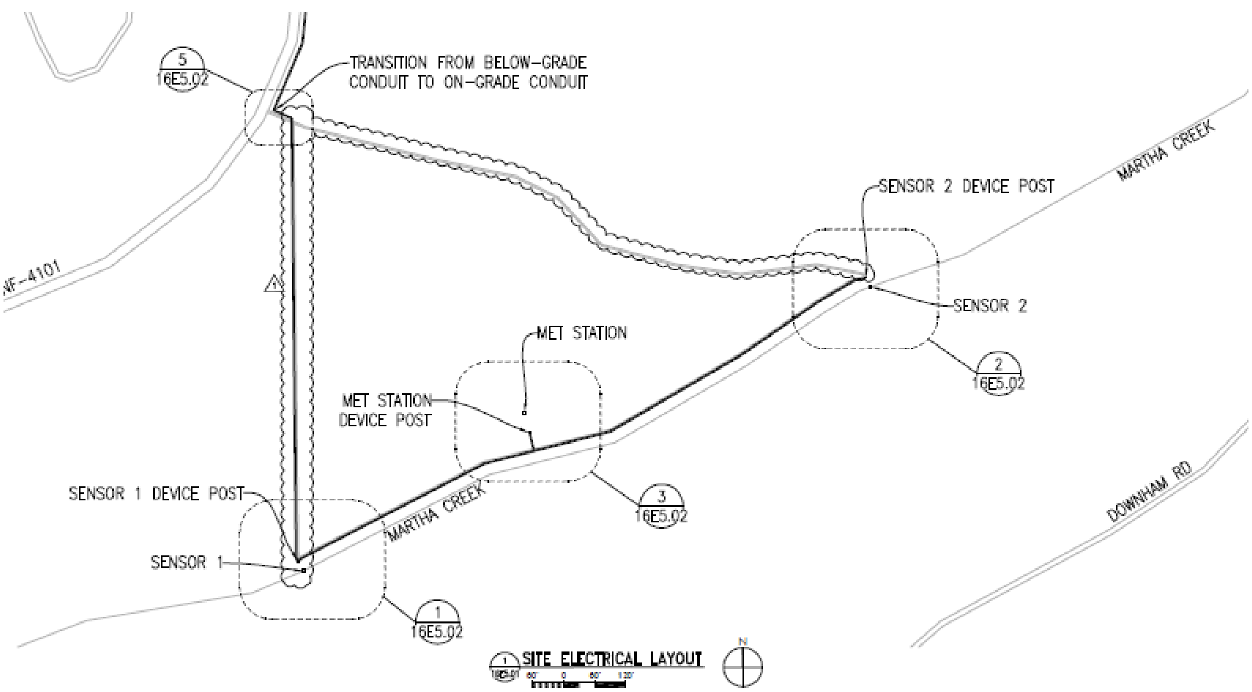

Figure 1. Proposed NEON trail network.

NEON proposes to install a meteorological station 100 feet from the Martha Creek channel. The meteorological sensors include temperature, relative humidity, barometric pressure, 2D wind speed and direction, net radiometer and PAR. The sensor suite would be mounted on a tripod frame that would have three anchors to provide stability to the structure. The sensors would be located at a height of 112 inches from the ground, including a further 36 inches in height for the lightning rod. The total width of the meteorological station is 90 inches.

NEON proposes to drill eight 8- to15-foot-deep groundwater monitoring wells (Figure 2) in the riparian zone adjacent to the surface water sensors. Two wells would be approximately 20 feet from the stream edge and six wells would be 50 to 100 feet from the stream edge. The wells would measure groundwater elevation, temperature and specific conductance autonomously.

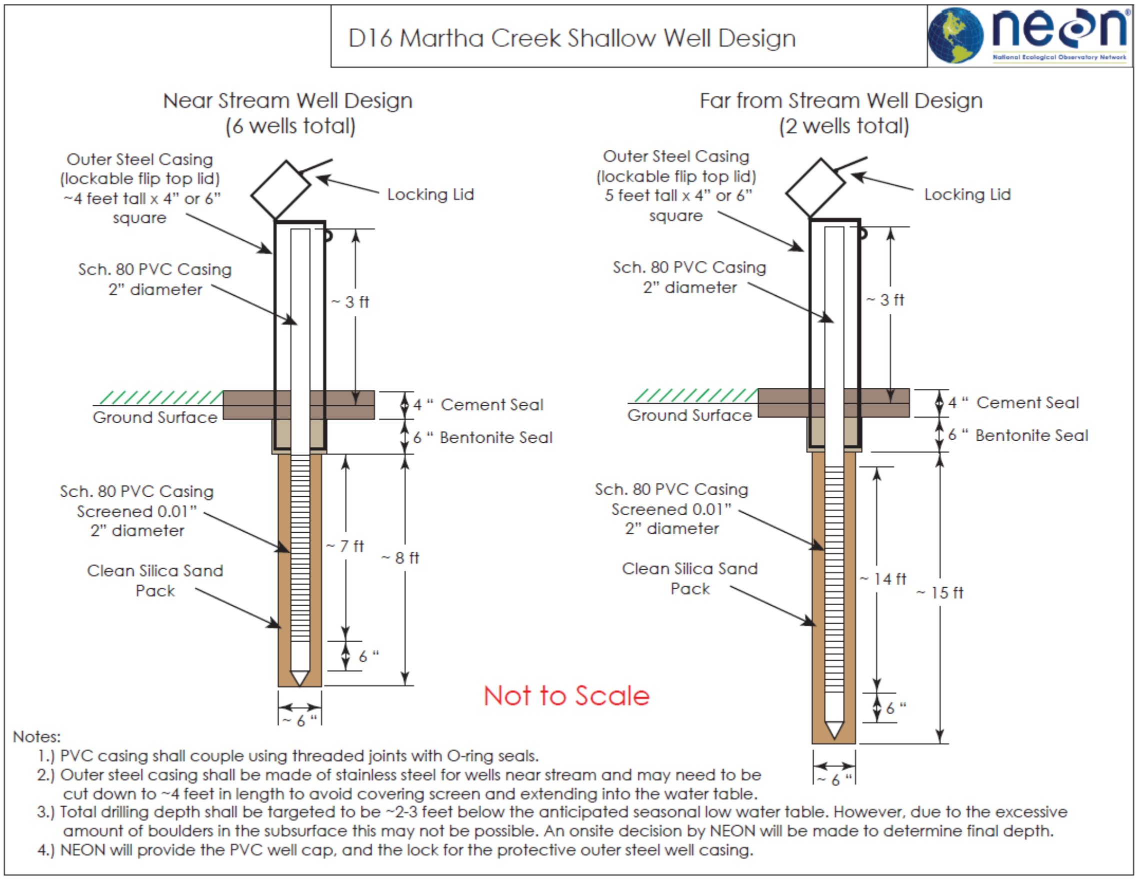

Figure 2. NEON groundwater monitoring wells.

NEON proposes to install surface water sensor suites at two locations within the aquatic monitoring site, which would require driving a post 48 inches into the streambed at each location (Figure 3).

Figure 3. Surface water sensor.

1.3.2 Scientific Research Activities

NEON proposes to conduct scientific research activities within the 0.6-mile-long survey reach in lower Martha Creek and riparian sampling within a 656-foot-wide buffer along either side of the survey reach. NEON proposes to sample chemical (e.g., dissolved oxygen, pH, conductivity, dissolved organic matter, chlorophyll, and nutrients in surface and shallow groundwater), physical (e.g. stream morphology, water and air temperature, wind speed and direction), and biological parameters (e.g., algae, microbes, aquatic plants, invertebrates, and fish). NEON proposes to conduct this research for a period of 30 years. GPNF would issue the special use permit for the full 30 year period. NMFS issues scientific research permits for a maximum of five years and so NEON would need to apply to renew the scientific research permit at least 6-9 months before it expires, to ensure continuing authorization for the research during the 30-year research period.

NEON proposes to:

a. Take four- to eight-gallon groundwater samples from four of the groundwater monitoring wells in the riparian zone, twice a year.

b. Access and maintain the instream sensor suites every 2 weeks, year-round.

c. Measure stream stage and discharge multiple times per year, at a range of flows, to convert continuous stage monitoring data into discharge estimates.

d. Collect water samples for analysis of surface water chemistry (four liters collected 26 times per year) and microbes (four liters collected 12 times per year).

e. Measure stream reaeration 6 to 12 times per year, which will involve bubbling sulfur hexafluoride (SF6) gas into the stream at 100 to 300 milliliters per minute (for stream discharge rates of 50 to 1000 liters per second), adding chloride or bromide ion at a concentration of 50 to 100 mg/L above the background concentration for one to two hours, and collecting water and gas samples from the stream at three or four locations downstream.

f. Collect aquatic plants, bryophytes, lichens, algae, and microbes from the stream bed or other stream substrates (e.g., woody debris) three times per year

g. Collect sediment samples of 5 liters or less from Martha Creek three times per year for 30 years.

h. Collect benthic invertebrates using nets, corers, or scrub samples in riffles, runs, pools, and on snags up to three times per year.

i. Sample fish using three-pass electrofishing up to three times per year, using a backpack electrofisher and block nets placed at upstream and downstream locations.

Because threatened LCR steelhead occur in the project area, NEON applied for a ESA Section 10(a)(1)(A) scientific research permit from NMFS (Section 1.2). NEON described the sampling in detail and attached to their research permit application copies of their standardized protocols for aquatic sampling. This scientific research permit would expire December 31, 2021, and would authorize the direct take of LCR steelhead juveniles and adults in Martha Creek.

NEON proposes to train all field staff to identify juvenile and adult *O. mykiss* and steelhead redds. NEON proposes to avoid electrofishing between March 15 and July 15, when LCR steelhead adults and eggs generally are present. Outside of the March 15 through July 15 timeframe, NEON proposes to consult as needed with GPNF fish biologists to obtain the best-available information on timing of movement of LCR steelhead adults into spawning areas in Trout Creek and Martha Creek. Furthermore, NEON proposes to conduct visual reconnaissance surveys of the sampling reach on each sampling date, prior to initiating electrofishing or other instream sampling. If either adults or redds are found, NEON proposes to postpone electrofishing surveys until a date when adults and eggs are no longer present. During all sampling events, including when sampling parameters other than fish, NEON proposes to avoid walking in the stream in the vicinity of LCR steelhead adults or redds.

During times when LCR steelhead adults and redds are not present, NEON proposes to survey fish using three-pass backpack electrofishing with block nets placed at the upper- and lower-boundaries of the survey reach. NEON proposes to hold fish in buckets of cool stream water, anesthetize fish using AQUIS20E (10% eugenol), identify, photograph, and measure fish, allow fish to recover, and then release fish back to the stream. If any adult steelhead are encountered during electrofishing, NEON proposes to immediately turn of electricity, let the fish swim away, and halt surveys until the researchers determine through consultation with NMFS and GPNF that listed adults or redds are no longer in the research area. Although NEON's standardized fish survey protocols describe tissue sampling and vouchering fish specimens, NEON does not propose to tissue-sample or intentionally kill any *O. mykiss* at the Martha Creek research site.

Scientific Research Permit Conditions

Research permits issued by NMFS prescribe conditions to be followed before, during, and after research is conducted. These conditions are intended to (a) ensure that research activities are coordinated among permit holders and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the species concerned. All research permits NMFS' NWR issues have the following conditions:

1. The permit holder[2] must ensure that listed species are taken only at the levels, by the means, in the areas and for the purposes stated in the permit application, and according to the terms and conditions in the permit.

2. The permit holder must not intentionally kill or cause to be killed any listed species unless the permit specifically allows intentional lethal take.

3. The permit holder must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated water. When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

4. The permit holder must stop handling listed juvenile fish if the water temperature exceeds 70 degrees Fahrenheit at the capture site. Under these conditions, listed fish may only be visually identified and counted. In addition, electrofishing is not permitted if water temperature exceeds 64 degrees Fahrenheit.

5. If the permit holder anesthetizes listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

[2] "Permit holder" means the permit holder or any employee, contractor, or agent of the permit holder.

6. The permit holder must use a sterilized needle for each individual injection when passive integrated transponder tags (PIT-tags) are inserted into listed fish.

7. If the permit holder unintentionally captures any listed adult fish while sampling for juveniles, the adult fish must be released without further handling and such take must be reported.

8. The permit holder must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Researchers must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when the only activity is determining fish presence.

9. The permit holder using backpack electrofishing equipment must comply with NMFS' Backpack Electrofishing Guidelines (June 2000) available at: http://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/section4d/electro2000.pdf.

10. The permit holder must obtain approval from NMFS before changing sampling locations or research protocols.

11. The permit holder must notify NMFS as soon as possible but no later than two days after any authorized level of take is exceeded or if such an event is likely. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

12. The permit holder is responsible for any biological samples collected from listed species as long as they are used for research purposes. The permit holder may not transfer biological samples to anyone not listed in the application without prior written approval from NMFS.

13. The person(s) actually doing the research must carry a copy of this permit while conducting the authorized activities.

14. The permit holder must allow any NMFS employee or representative to accompany field personnel while they conduct the research activities.

15. The permit holder must allow any NMFS employee or representative to inspect any records or facilities related to the permit activities.

16. The permit holder may not transfer or assign this permit to any other person as defined in section 3(12) of the ESA. This permit ceases to be in effect if transferred or assigned to any other person without NMFS' authorization.

17. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

18. The permit holder must obtain all other Federal, state, and local permits/authorizations needed for the research activities.

19. On or before January 31st of every year, the permit holder must submit to NMFS a post-season report in the prescribed form describing the research activities, the number of listed fish taken and the location, the type of take, the number of fish intentionally killed and unintentionally killed, the take dates, and a brief summary of the research results. The report must be submitted electronically on our permit website, and the forms can be found at https://apps.nmfs.noaa.gov/. Falsifying annual reports or permit records is a violation of this permit.

20. If the permit holder violates any permit condition they will be subject to any and all penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA or if NMFS determines that its ESA section 10(d) findings are no longer valid.

For specific permit actions, NMFS may include additional condition(s) specific to the proposed research activities. NMFS uses annual reports filed by permit holders to monitor the actual number of listed fish taken annually in scientific research activities. NMFS may adjust the permitted take level if it is deemed to be excessive or if cumulative take levels for all research permits rise to the point where they are detrimental to the listed species.

1.3.3 Proposed Best Management Practices

NEON proposes to use Best Management Practices (BMPs) during construction and operation of the monitoring site. Contaminant BMPs are:

a. There will be a written Spill Prevention Control and Containment Plan (SPCCP) prepared by NEON in place prior to implementation which describes measures to prevent or reduce impacts from potential spills. The SPCCP will include measures for containing and cleaning up any chemicals/fluids associated with the heavy equipment used at the now-decommissioned FR 4101, hand tools, and sampling instrumentation and methods. The SPCCP will contain a description of the hazardous materials that will be used, including inventory, storage, handling, and monitoring.

b. All equipment used for instream work will be cleaned and leaks repaired prior to arriving at the Martha Creek aquatic sampling site. Thereafter, inspect equipment daily for leaks or accumulations of grease or any other chemicals, and fix any identified problems before entering Martha Creek or its riparian zone.

c. Hand tools/equipment will be fueled and serviced in the parking area at the end of Hemlock Road or, if this is not possible, they will be fueled and serviced in a dry area at least 200 feet from Martha Creek or any intermittent tributary, perennial tributary, wetland area, or area with a high water table (even if no wetland-associated plants are present).

d. If hand tools/equipment used in the stream or in the riparian area require oil, grease, gas, desiccants, or any other chemicals, then oil absorbing booms and/or absorbent material will be available on-site during all phases of construction, as well as heavy-duty plastic trash bags with labels that can be carried out and disposed of in an appropriate hazardous waste disposal site. Spill materials will be placed in a location that facilitates an immediate response to potential chemical leakage.

Erosion BMPs are:

a. All provisions of the Clean Water Act and provisions for maintenance of water quality standards, as described by the State of Washington Department of Ecology (Washington National Forests), will be followed.

b. Ground-disturbing impact areas on engineering designs will be delineated and work will be confined to these areas. Ground-disturbance will be confined to the minimum area necessary to complete the project.

c. Ground-disturbing activities, both instream and in the riparian area, will be conducted in the late spring to early fall period and, if possible, will be done when there is little or no precipitation.

d. The removal of hazard trees will be minimized to the greatest extent possible and will be accomplished by hand-felling or pulling them over manually (i.e. no heavy equipment) and then leaving them in the riparian area.

e. No heavy equipment will be allowed instream or in the riparian area beyond the now-decommissioned FR 4101.

f. During the 30 year research period, NEON will implement all necessary erosion control measures within the Martha Creek sampling site that are deemed necessary by USFS personnel. As long as the site is accessible, erosion control measures will be implemented within 30 days for non-emergency erosion control and immediately for emergency erosion control, with the USFS deciding what constitutes "emergency" vs. "non-emergency."

Site Preparation BMPs are:

a. Clearing activities associated with the access paths, on-grade conduit, and sampling instrumentation will be minimized.

b. Cutting of down logs for access to the site will be avoided or minimized.

c. Equipment will be hand-carried in and out, or it will be taken in and out with the assistance of a Dingo or similar piece of light equipment, via the now-decommissioned FR 4101 and the access trails. Vegetation disturbance will be minimal and will primarily consist of a small amount of branch, small shrub, and sapling removal.

Site Restoration BMPs are:

a. Upon project completion, all instrumentation and infrastructure associated with the Martha Creek aquatic sampling site will be removed from the Forest.

b. All disturbed areas will be rehabilitated in a manner that results in similar or better than pre-work conditions through seeding and/or planting with native seed mixes or plants, as well as mulching with straw that is WA-State certified as weed-free.

c. Necessary site restoration activities will be completed during the dryer summer months and prior to the late fall season when heavier precipitation occurs.

Aeration Sampling BMPs are:

a. Propane gas will not be utilized in place of SF6 during reaeration sampling.

b. Tracer will only be added to Martha Creek when there are no adult steelhead spawners or redds present. This means SF6 tracer cannot be added to Martha Creek during the March 15 to July 15 time period.

c. Tracer will be added to riffle or glide areas, not pools where the majority of rainbow trout and steelhead trout are found in Martha Creek.

d. Tracer will be added where there is a moderate to high level of flow for about 50 feet downstream of the introduction site so the salt can dissipate to levels that will not negatively affect fish or other aquatic organisms.

e. Tracer will be added to the stream thalweg in order to avoid overhanging streambanks or similar areas where fish tend to be present.

f. A visual inspection will be conducted prior to adding tracer to the stream water to determine if there are rainbow trout or steelhead trout present at or within approximately 20 feet of the introduction site. If fish are detected in a particular stream reach, a different site will be chosen to add the tracer.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

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

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

The designation of critical habitat for LCR steelhead uses the term primary constituent element (PCE) or essential features. New critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ‘‘destruction or adverse modification’’ analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.* In Section 2.2, we describe the current status of LCR steelhead and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" paper (VSP; McElhaney et al. 2000). The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. The VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the range-wide status of LCR steelhead, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its PBFs - which were identified when the critical habitat was designated.

- *Describe the environmental baseline in the action area*. In Section 2.4, we describe the environmental baseline, which includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area*. The environmental baseline includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- *Analyze the effects of the proposed action on LCR steelhead and its habitat using an "exposure-response-risk" approach.* In Section 2.5, we consider how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP characteristics. We also evaluate the proposed action's effects on critical habitat features.
- *Describe any cumulative effect in the action area*. In Section 2.6, we describe cumulative effects, which are defined in NMFS' implementing regulations (50 CFR 402.02) as the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- *Integrate and synthesize the above factors by: (1) Reviewing the status of LCR steelhead and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to LCR steelhead and critical habitat.* In Section 2.7 we integrate and synthesize our analysis. We add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of LCR steelhead in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of LCR steelhead. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).
- *Reach a conclusion about whether LCR steelhead is jeopardized or critical habitat is adversely modified.* In Section 2.8 we describe our conclusions regarding jeopardy and the destruction or adverse modification of critical habitat. These conclusions flow from the logic and rationale presented in the Integration and Synthesis (Section 2.7).
- *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' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

The ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS adopted a policy for identifying salmon DPSs in 1991 (56 FR 58612). It states that a population or group of populations is considered an ESU if it is "substantially reproductively isolated from conspecific populations," and if it represents "an important component of the evolutionary legacy of the species." The steelhead listing unit in this opinion constitutes a DPS of the species *O. mykiss*. This opinion examines the status of LCR steelhead, which is the only species under NMFS' jurisdiction that would be adversely affected by the proposed action. The LCR steelhead listing unit in this biological opinion constitutes a DPS of the species *O. mykiss*. The LCR steelhead DPS includes natural-origin populations and hatchery populations.

The status of LCR steelhead is determined by the level of extinction risk based on parameters considered in documents such as the most recent recovery plan, status review, and listing decision. This informs the description of the likelihood of survival and recovery. The species status section informs the description of current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the watershed in the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1 Status of Lower Columbia River Steelhead

Criteria for Assessing Population Viability

NMFS uses four parameters to assess the viability of steelhead populations, abundance, productivity, spatial structure, and diversity (McElhaney et al. 2000). These "viable salmonid population" (VSP) criteria encompass the "reproduction, numbers, or distribution" of a species, which are described in 50 CFR 402.02. Adequate population abundance, productivity, spatial structure, and diversity reflects that a population is well adapted to environmental conditions and other influences that affect individuals throughout the life cycle (e.g., biological interactions, harvest).

“Abundance” generally refers to the number of naturally-produced adults (i.e., the progeny of naturally-spawning parents) in the natural environment (e.g., on spawning grounds).

“Productivity” refers to the entire life cycle; i.e., the number of naturally-spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents, the population is declining. McElhaney et al. (2000) use the terms “population growth rate” and “productivity” interchangeably when referring to production over the entire life cycle. They also refer to “trend in abundance,” which is the manifestation of long-term population growth rate.

“Spatial structure” refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population’s spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

“Diversity” refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life-history traits (McElhaney et al. 2000).

For species with multiple populations, NMFS assesses the status of the species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, having some viable populations separated in space to avoid concurrent extinctions from mass catastrophes, and having other populations close in space to allow functioning as metapopulations (McElhaney et al. 2000).

Detailed information on the status and distribution of LCR steelhead can be found in the following discussions and documents:

- Status review of West Coast steelhead from Washington, Idaho, Oregon, and California (Busby et al. 1996)
- Updated status of Federally listed ESUs of West Coast salmon and steelhead (Good et al. 2005)
- Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (Ford 2011)
- Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (NWFSC 2015)

Geographic Range and General Description

The LCR steelhead DPS includes 30 historical populations in five strata (Table 1). The LCR steelhead DPS was originally listed as threatened on March 19, 1998 (63 FR 13347) and remains listed as threatened (81 FR 33468). The listing includes naturally spawned anadromous *O. mykiss* (steelhead) originating below natural and manmade impassable barriers from rivers between the Cowlitz and Wind Rivers, Washington (inclusive) and the Willamette and Hood Rivers, Oregon (inclusive). The listing excludes such fish originating from the upper Willamette River basin above Willamette Falls. The DPS includes steelhead from seven artificial propagation programs: the Cowlitz Trout Hatchery Late Winter-run Program; Kalama River Wild Winter-run and Summer-run Programs; Clackamas Hatchery Late Winter-run Program; Sandy Hatchery Late Winter-run Program; Hood River Winter-run Program; and the Lewis River Wild Late-run Winter Steelhead Program (79 FR 20802).

Table 1. Historical Population Structure and Viability Status for LCR Steelhead, VL = very low, L = low, M = moderate, H = high, VH = very high (ODFW 2010; LCFRB 2010).

Stratum (Run)	Population	A&P	Spatial	Diversity
Cascade (Winter)	Lower Cowlitz	L	M	M
	Upper Cowlitz	VL	M	M
	Cispus	VL	M	M
	Tilton	VL	M	M
	South Fork Toutle	M	VH	H
	North Fork Toutle	VL	H	H
	Coweeman	L	VH	VH
	Kalama	L	VH	H
	North Fork Lewis	VL	M	M
	East Fork Lewis	M	VH	M
	Salmon Creek	VL	H	M
	Washougal	L	VH	M
	Clackamas	M	VH	M
	Sandy	L	M	M
Cascade (Summer)	Kalama	H	VH	M
	North Fork Lewis	VL	VL	VL
	East Fork Lewis	VL	VH	M
	Washougal	M	VH	M
Gorge (Winter)	Lower Gorge	L	VH	M
	Upper Gorge	L	M	M
	Hood	M	VH	M
Gorge (Summer)	Wind	VH	VH	H
	Hood	VL	VH	M

O. mykiss individuals can exhibit two distinct life histories. All *O. mykiss* hatch in gravel-bottomed, fast-flowing, well-oxygenated rivers and streams. The resident form, rainbow trout, completes its entire life cycle in freshwater. The anadromous form, steelhead, rears in freshwater for one to four years and then migrates to the ocean for two to three years before returning to freshwater to spawn. Rainbow trout and steelhead cannot be distinguished morphologically as juveniles. Adult steelhead develop a more pointed head, become more silver in color, and typically grow much larger than rainbow trout.

LCR steelhead may mature sexually in the ocean or in freshwater streams. Summer-run steelhead enter freshwater between May and October, in a sexually immature condition, and require several months to mature and spawn. Summer steelhead tend to spawn in small, intermittent tributaries. Winter-run steelhead enter freshwater between November and April, with well-developed gonads, and spawn shortly thereafter. Winter steelhead tend to spawn in medium to large streams. LCR steelhead have both summer and winter runs, and several river basins, including the Wind River, have both.

Steelhead spawn throughout the Wind River basin. Summer steelhead spawn in Martha Creek and Trout Creek, and winter steelhead spawn lower in the drainage, in Trout Creek and the Wind River mainstem. Adult summer steelhead enter the Wind River continuously from spring through fall with the peak passage typically in June and July. Steelhead move into spawning areas in Trout Creek in the fall when water temperatures decrease and flow increases with seasonal rainfall. Spawning in Martha Creek and Trout Creek occurs from approximately mid-March through May (GPNF 2017).

At the time of spawning, females dig a nest, called a redd, in an area with suitable gravel, water depth, and velocity. They may deposit eggs in 4 to 5 "nesting pockets" within a single redd. Steelhead are iteroparous, meaning they are capable of spawning more than once before death. However, it is rare for steelhead to spawn more than once before dying, and almost all that do so are females (Nickelson et al. 1992, Busby et al. 1996).

Steelhead eggs hatch in 3 to 4 weeks, with timing of fry emergence dependent upon spawning time and stream temperature. In Martha Creek and Trout Creek, fry typically emerge from the gravel in June and July. After emergence, juveniles rear near stream margins with relatively shallow depths and low velocities. By August, juveniles move into slightly deeper riffles and cascades with cobble/boulder substrate. Juveniles rear both upstream and downstream of spawning areas. Juvenile steelhead rear in freshwater for 1 to 4 years; most juveniles in the Wind River watershed are thought to stay for 2 years before migrating to the ocean. Smolt abundance peaks in Trout Creek from mid-April to mid-May (GPNF 2017).

LCR steelhead are thought to use estuarine habitats extensively during outmigration, smoltification, and spawning migrations. After migrating to the ocean, subadults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in their natal streams.

Abundance and Productivity

All populations in the LCR steelhead DPS increased in abundance during the early 2000s, generally peaking in 2004. Abundance of most populations has since declined back to levels close to the long-term mean. Exceptions are the Washougal summer and North Fork Toutle winter populations, for which abundance is higher than the long-term average, and the Sandy, for which abundance is below the long-term average. The North Fork Toutle winter steelhead population appears to be experiencing an increasing trend dating back to 1990, which is likely partially the result of recovery of habitat since the eruption of Mt. St. Helens in 1980. In general, LCR steelhead populations do not show any sustained, dramatic changes in abundance since the previous status review (Ford et al. 2010).

The recovery plans identified 16 populations as currently at low to very low viability and five with moderate viability. The Wind River and Kalama River summer-run populations are the only populations rated high to very high for abundance and productivity. Despite a “Very High” rating for abundance and productivity in the Wind River (Table 1), abundance is still depleted relative to historic abundance. In the 1950s, the USFWS estimated a summer steelhead run size in the Wind River of 3,250 with an escapement of 2,500 spawners (GPNF 2017). In the 1990s, WDFW estimated that the abundance of steelhead spawners had dropped to only about 200 in the Wind River subbasin. More recently, abundance of wild summer steelhead spawners increased to around 763 natural-origin spawners in the Wind River. Part of this increase is attributable to the removal of Hemlock Dam on the Trout Creek mainstem in 2009 (WDFW 2010).

Mesa et al. (2007) surveyed NEON’s proposed project area in Martha Creek in August to October, 2006. The reported that density of juvenile (age-0 and age-1) *O. mykiss* ranged from 0.23 to 1.4 individuals/m^2 (GPNF 2017).

The Oregon and Washington recovery plans (ODFW 2010; LCFRB 2010) developed ranges for abundance of viable LCR steelhead populations (Table 2). Some abundance goals were not set; the range of abundance targets is from 322 in the Upper Gorge to 10,655 in the Clackamas. The viability ratings are based on long-term trends whereas recent abundance estimates show a slightly different picture. Several populations, including the Wind River population, approached the abundance targets, and one population (E.F. Lewis) exceeded it.

Table 2. Abundance Estimates for Adult LCR Steelhead Populations (Streamnet 2016; WDFW 2016; ODFW 2016).

Stratum (Run)	Population	Years	Total	HOR(1)	NOR(2)	Recovery Target(3)
Cascade (Winter)	Lower Cowlitz	2009	4,559	4559		
	Upper Cowlitz/Cispus	2010-2014	489	51	438	500
	Tilton	2010-2013	279	0	279	200
	South Fork Toutle	2010-2014	508	7	501	500
	North Fork Toutle	2010-2014	507	121	387	600
	Coweeman	2010-2014	462	166	296	600
	Kalama	2011-2015	930	455	475	600
	North Fork Lewis	2007-2011	2,355	2,126	129	400
	East Fork Lewis	2010-2014	364	0	364	500
	Washougal	2010-2014	362	195	167	350
	Clackamas	2014-2015	5,483	1,876	3,607	10,655
	Sandy	2013-2015	4,094	284	3,810	1,510

Stratum (Run)	Population	Years	Total	HOR(1)	NOR(2)	Recovery Target(3)
Cascade (Summer)	Kalama	2011-2015	626	499	127	500
	North Fork Lewis	2009	10,508	10,508		
	East Fork Lewis	2011-2015	928	168	760	500
	Washougal	2012-2015	723	621	102	500
Gorge (Winter)	Upper Gorge	2010-2014	36		36	322
	Hood	2003-2007	818	380	438	1,633
Gorge (Summer)	Wind	2010-2014	805	42	763	1,000
	Hood	2003-2007	480	239	241	1,988
Total			35,316	22,297	12,920	

(1) Hatchery Origin (HOR) spawners.
(2) Natural Origin (NOR) spawners.

For adult steelhead, the availability of data on abundance of is highly variable, particularly for natural origin spawners (Table 2). The years of record vary considerably for each population and for some populations we could only find one year of data. Based on the best available data, we estimate the spawning population of LCR steelhead to be approximately 12,920 natural origin and 22,297 hatchery origin adults. For the hatchery fraction, we can further estimate the numbers of adults with intact- versus clipped-adipose fins by applying the ratio of these two groups known for juveniles and assuming equal survival to the adult life stage (Table 3).

The Northwest Fisheries Science Center publishes estimates for juvenile abundance each year in the annual memorandum estimating percentages of listed Pacific salmon and steelhead smolts arriving at various locations in the Columbia River basin. The average outmigration for the years 2012-2016 is shown in Table 3 (Zabel 2013, 2014a, 2014b, 2015, 2016).

Table 3. Estimated abundance for natural-origin and hatchery origin (LHAC = listed hatchery adipose-clipped, LHIA = listed hatchery intact adipose) LCR steelhead. Juvenile abundance represents average (2012-2016) smolt abundance and adult abundance data are described in Table 2 and text.

ESU/DPS	Life Stage	Origin	Abundance
LCR steelhead	Adult	Natural	12,920
	Adult	LHAC	22,055
	Adult	LHIA	242
	Adult	Total	35,217
	Juvenile	Natural	351,966
	Juvenile	LHAC	1,134,744
	Juvenile	LHIA	12,449
	Juvenile	Total	1,499,159

The estimate for 5-year average outmigration for natural-origin LCR steelhead should be viewed with caution, as it only addresses smolts, one of several juvenile life stages. Estimating juvenile abundance is complicated by a host of factors, including: (1) spawner counts and associated sex ratios and fecundity estimates can vary widely between years; (2) multiple juvenile age classes (fry, parr, smolt) are present yet comparable data sets may not exist for all of them; (3) it is difficult if not impossible to distinguish visually non-listed juvenile rainbow trout and listed juvenile steelhead; and (4) survival rates between life stages are poorly understood and influenced by numerous natural and anthropogenic factors (e.g., predation, floods, harvest).

Spatial Structure

To assess spatial structure, the Oregon and Washington recovery plans evaluated the proportion of stream miles currently accessible to the species relative to the historical miles accessible (ODFW 2010; LCFRB 2010). The recovery plans adjusted the rating downward if portions of the currently accessible habitat were qualitatively determined to be seriously degraded. The recovery plans also adjusted the rating downward if the portion of historical habitat lost was a key production area.

The Oregon and Washington recovery plans rate spatial structure to be moderate to very high in nearly all populations of LCR steelhead. The populations that rate lowest have fish passage barriers. Trap and haul operations on the Cowlitz River pass adults upriver, but downstream passage and survival of juvenile fish is very low. This problem also affects spatial structure in the Cispus and Tilton populations. Merwin Dam blocks access to most of the available spawning habitat in the North Fork Lewis populations. However, the relicensing agreement for Lewis River hydroelectric projects calls for reintroduction of steelhead. Condit Dam on the White Salmon River blocked access to most of the historical spawning habitat up until the date it was removed in 2011. Thus, the LCR steelhead current spatial structure is less diverse than its historical structure, but management actions are underway to improve the situation.

Diversity

The Oregon and Washington recovery plans (ODFW 2010; LCFRB 2010) rate diversity as moderate to high in all but one population (Table 1). One of the leading factors affecting the diversity of this DPS is the loss of habitat associated with construction of dams. As described above, many historical populations were affected by dams built 60 to 90 years ago in upper tributaries.

Artificial propagation has been identified as a major factor affecting diversity of LCR steelhead. In many basins, the number of stocks planted, the size and frequency of annual releases, and the percentage of smolts released changed a great deal between the time periods before and after 1985. At present, fewer stocks are used, fewer hatchery fish are released, and a higher percentage of the fish that are released migrate quickly to the ocean. This change came about in response to the development of wild fish policies in Oregon and Washington. In Washington, the development and implementation in 1991 of a new stock transfer policy (WDFW 1991), designed to foster local brood stocks, resulted in a substantial reduction in the transfer of eggs and juveniles between watersheds. The policy mandates that hatchery programs use local brood stocks in rivers with extant indigenous stocks.

Limiting Factors

The status of LCR steelhead reflects combined effects of habitat degradation, dam building and operation, fishing, hatchery operations, ecological changes, and natural environmental fluctuations. Habitat for LCR steelhead has been affected adversely by changes in access, stream flow, water quality, sedimentation, habitat diversity, channel stability, riparian conditions, channel alternations, and floodplain interactions. These large-scale changes have altered habitat conditions and processes important to migratory and resident fish and wildlife. Additionally, habitat conditions have been altered throughout the Columbia River basin by the construction and operation of tributary and mainstem dams and reservoirs for power generation, navigation, and flood control. LCR steelhead are affected adversely by hydrosystem-related flow and water quality effects, obstructed and/or delayed passage, and ecological changes in impoundments. Dams in many larger subbasins have blocked anadromous fishes' access to large areas of productive habitat.

Fishery impacts on wild summer steelhead are currently limited to incidental mortality in freshwater fisheries. Populations above Bonneville are also subject to treaty tribal subsistence and commercial fisheries. Interception of steelhead in ocean salmon fisheries is rare. Fishing rates on wild steelhead have been reduced from their historical peaks in the 1960s by over 90% following prohibition of commercial steelhead harvest in the mainstem (except the mainstem above Bonneville) and hatchery-only retention regulations for recreational fisheries. Wild steelhead mortality is incidental (less than 10% of the wild run). Ongoing threats to wild steelhead populations from fishing include illegal harvest and the incidental mortality from fisheries targeting hatchery fish and other species.

Hatchery programs can harm salmonid viability in several ways: hatchery-induced genetic change can reduce fitness of wild fish; hatchery-induced ecological effects—such as increased competition for food and space—can reduce population productivity and abundance; hatchery imposed environmental changes can reduce a population's spatial structure by limiting access to historical habitat; hatchery-induced disease conveyance can reduce fish health. Practices that introduce native and non-native hatchery fish can increase predation on juvenile life stages. Hatchery practices that affect natural fish production include removal of adults for broodstock, breeding practices, rearing practices, release practices, number of fish released, reduced water quality, and blockage of access to habitat.

In the Wind River Watershed, timber harvest, road building, and other land use activities have reduced the quality and quantity of salmonid habitat. In Trout Creek and lower Martha Creek, limiting factors for steelhead include excess fine sediments, lack of habitat diversity, decreased channel stability, and impaired riparian function. The Wind River is designated as a Tier I Key Watershed under the Northwest Forest Plan, is a Focus Watershed within the Lower Columbia Priority Basin, and is State-designated as an Intensively Monitored Watershed and a wild steelhead gene. The USFS has designated the Trout Creek subwatershed as the highest priority subwatershed within the Wind River watershed (GPNF 2017).

Carson National Fish Hatchery was constructed at river mile 18 on the Wind River mainstem in 1938 to mitigate for the construction of Bonneville Dam. The hatchery currently produces 1.2

million spring Chinook smolts, which are not included as part of the LCR Chinook salmon ESU. Shipherd Falls, located 4.3 miles upstream from the historic mouth of the Wind River, was a natural barrier to all anadromous fish except steelhead before a fish ladder was installed at Shipherd Falls in the 1930s to allow salmon access to the hatchery (GPNF 2017).

Status Summary

Most LCR steelhead populations are at relatively low abundance, and those with enough data to be modeled are estimated to have a relatively high extinction probability. The Willamette/Lower Columbia Technical Recovery Team described two historical populations as either extinct or at very high risk; most other populations are at high risk. The hatchery contribution to natural spawning remains high in many populations. Some populations, particularly summer run, have shown higher returns in recent years. Additionally, trap and haul programs are re-introducing steelhead to many miles of habitat improving the spatial structure and diversity of the species. The Wind River watershed is a relative stronghold for LCR steelhead, and is one of only two summer-run populations that are rated high to very high for abundance and productivity.

2.2.2 Status of Critical Habitat for LCR Steelhead

We review the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area. These features support one or more life stages (spawning, rearing, migration, or foraging) and thus are essential to the conservation of LCR steelhead.

NMFS ranked watersheds within designated critical habitat of LCR steelhead at the scale of the fifth-field hydrologic unit code (HUC5) in terms of conservation value;[3] the conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review team (CHART; NOAA Fisheries 2005) evaluated the quantity and quality of habitat features such as spawning gravels, wood and water condition, and side channels. The CHART assessed the relationship of the watershed compared to other areas within the range of LCR steelhead, and the significance to the species of the population occupying that area. Thus, even a location with poor quality habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or serving other important roles (e.g., obligate area for migration to upstream spawning areas).

The CHART identified habitat-related human activities that affect PCE (i.e., PBF) quantity and/or quality. The primary categories of habitat-related activities identified by the CHART are (1) forestry, (2) agriculture, (3) channel modifications/diking, (4) road building/maintenance, (5) urbanization, (6) dams, (7) irrigation impoundments and withdrawals, and (8) wetland

[3] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

loss/removal. All of these activities have PBF-related impacts because they have altered one or more of the following: stream hydrology, flow and water-level modifications, fish passage, geomorphology and sediment transport, temperature, dissolved oxygen, vegetation, soils, nutrients and chemicals, physical habitat structure, and stream/estuarine/marine biota and forage. The degrees to which these alterations have affected the region's watersheds are the main factors that lead to high-, medium-, and low conservation value ratings.

We designated critical habitat for LCR steelhead on September 2, 2005 (70 FR 52630). Critical habitat for LCR steelhead includes approximately 2,338 square miles of streams in Oregon and Washington. There are 1,114 miles of spawning/rearing sites, 165 miles of rearing/migration sites, and 1,059 miles of migration corridors. The CHART rated two watersheds as having low, 11 as having medium, and 28 as having high rating for their conservation value to the DPS. Of the 41 watersheds considered for designation, we excluded one low conservation value and three medium-value watersheds in their entirety, and the tributary-only portions of one low-value watershed. Also, we excluded approximately 125 miles of stream covered by two habitat conservation plans because the benefits of exclusion outweigh the benefits of designation. As a result of the considerations, 335 miles of stream habitats were excluded from the designation.

2.2.3 Climate Change

Average annual air temperatures in the Pacific Northwest have increased by approximately 1°C since 1900 and climate models predict that air temperatures will increase 0.1 to 0.6°C per decade over the next century. This change in air temperature affects freshwater, estuarine, and marine ecosystems (ISAB 2007).

Projected Climate Change

The Intergovernmental Panel on Climate Change (IPCC) and U.S. Global Change Research Program recently published updated assessments of anthropogenic influence on climate, as well as projections of climate change over the next century (IPCC 2013; Melillo et al. 2014). Reports from both groups document increasing evidence that recent warming is due to rising concentrations of greenhouse gas emissions. There is moderate certainty that the 30-year average temperature in the northern hemisphere is now higher than it has been over the past 1,400 years. In addition, there is high certainty that ocean acidity has increased with a drop in pH of 0.1 (NWFSC 2015).

Trends in warming and ocean acidification are highly likely to continue during the next century (IPCC 2013). In winter across the west, the highest elevations will shift from consistent longer (>5 months) snow-dominated winters to a shorter period (3-4 months) of reliable snowfall (Klos et al. 2014). Lower, more coastal, or more southerly watersheds will shift from consistent snowfall during winter to alternating periods of snow and rain. Lower elevations or warmer watersheds will lose snowfall completely, and rain-dominated watersheds will experience more intense precipitation events and possible shifts in the timing of the most intense rainfall (e.g., Salathe et al. 2014). Warmer summer air temperatures will increase both evaporation and direct radiative heating. When combined with reduced winter water storage, warmer summer air temperatures will lead to lower minimum flows in many watersheds. Higher summer air temperatures will depress minimum flows and raise maximum stream temperatures even if annual precipitation levels do not change (e.g., Sawaske and Freyberg 2014; NWFSC 2015).

Higher sea surface temperatures and increased ocean acidity are predicted for marine environments in general (IPCC 2013). However, regional marine impacts will vary, especially in relation to productivity. The California Current is strongly influenced by seasonal upwelling of cool, deep, water that is high in nutrients and low in dissolved oxygen and pH. An analysis of 21 global climate models found that most predicted a slight decrease in upwelling in the California Current, although there is a latitudinal cline in the strength of this effect, with less impact toward the north (Rykaczewski et al. 2015; NWFSC 2015).

Impacts on Steelhead

Climate variation can affect steelhead populations via numerous mechanisms. These include direct effects of temperature such as mortality from heat stress, changes in growth and development rates, and disease resistance. Changes in streamflow regimes, such as flooding and low flow events, affect survival and behavior. Expected behavioral responses include shifts in seasonal timing of important life history events, such as the adult migration, spawn timing, fry emergence timing, and juvenile migration (NWFSC 2015).

Climate impacts in one life stage generally affect body size or timing in the next life stage and can be negative across multiple life stages (Healey 2011; Wade et al. 2013; Wainwright and Weitkamp 2013). Changes in winter precipitation will likely affect incubation and/or rearing life stages. Changes in the intensity of cool season precipitation could influence migration cues for fall and spring adult migrants, such steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within a DPS (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations (Quinn 2005; Crozier and Zabel 2006; Crozier et al. 2010). Adults that migrate or hold during peak summer temperatures can experience high mortality in unusually warm years. Climate-induced contraction of thermally suitable habitat also can affect marine migration patterns. Abdul-Aziz et al. (2011) modeled changes in summer thermal ranges in the open ocean for Pacific salmon under multiple IPCC warming scenarios. For anadromous salmonids, they predicted contractions in suitable marine habitat by the 2080s under medium and high emissions scenarios (NWFSC 2015).

Freshwater Habitat

Likely impacts of climate change on fish in freshwater systems in the Northwest include reduction of cold water habitat, variation in quality and quantity of tributary rearing habitat, alterations to migration patterns, accelerated embryo development, premature emergence of fry, and competition among species. Recent modeling results indicate that increased summer temperatures or decreased fall streamflow are likely to significantly reduce parr-smolt survival of steelhead by 2040, and this result may also be applicable to other species with similar life history strategies in the Northwest (ISAB 2007).

Estuarine Habitat

In estuaries, higher winter freshwater flows and higher sea level elevation may lead to increased sediment deposition and wave damage; lower freshwater flows in late spring and summer may lead to upstream extension of the salt wedge, possibly influencing the distribution of salmonid prey and predators; and increased temperature of freshwater inflows may extend the range of warm-adapted non-indigenous species that are normally found only in freshwater. In all of these cases, the specific effects on steelhead abundance, productivity, spatial distribution and diversity are poorly understood (ISAB 2007).

Marine Habitat

Climate change is likely to cause increased ocean temperature, increased stratification of the water column, and changes in intensity and timing of coastal upwelling. These continuing changes will alter primary and secondary productivity, the structure of marine communities, and in turn, the growth, productivity, survival, and migrations of salmonids. A mismatch between earlier smolt migrations (due to earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates. Increased concentration of CO2 reduces the availability of carbonate for shell-forming invertebrates, including some that are prey items for juvenile salmonids (ISAB 2007).

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). NEON proposes to construct and operate the long-term monitoring site in a relatively small area in and around Martha Creek. For the purposes of this opinion, the action area includes the geographic extent of construction and research infrastructure and the 1-km-long sampling reach in and adjacent to Martha Creek (see Figures 2, 5, 12, 21, 17 and Table 2 in GPNF 2017).

The proposed action would take place in designated critical habitat. Detailed habitat information for LCR steelhead may be found in the Federal Register notice designating critical habitat for the species (70 FR 52630).

2.4 Environmental Baseline

The "environmental baseline" includes past and present impacts of all Federal, state, or private actions and other human activities in the action area, anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and impacts of state or private actions that are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for this opinion is therefore the result of the impacts that activities in Martha Creek have had on survival and recovery of LCR steelhead.

2.4.1 Factors Limiting Recovery

Multiple factors have contributed to the decline of LCR steelhead (NMFS 2005a). A major factor limiting recovery of LCR steelhead is habitat degradation, evidenced by decreased floodplain connectivity and stream channel complexity, altered stream flow and stream substrate composition, and degraded water quality. In addition, fish passage barriers have limited some populations. Biological effects, such as predation, interspecific competition, and disease transmission, also pose a threat to LCR steelhead. For detailed information on how various factors have degraded PCEs for LCR steelhead see *Section 2.2.1, Limiting Factors*, and Busby et al. (1996), Ford (2011), Good et al. (2005), LCFRB (2010), McElhaney et al. (2004), NMFS (2004, 2005a, 2006), Nickelson et al. (1992), ODFW (2010), and WDFW (2010).

2.4.2 Research Effects

Scientific research has the potential to affect the survival and recovery of LCR steelhead by killing fish, although research has never been identified as a factor for decline or a threat preventing recovery of LCR steelhead. At the time of issuance of this opinion, eighty-six section 10(a)(1)(A) scientific research permits authorize take of LCR steelhead. These prior authorizations expire between 2017 and 2021. NMFS also issues annual authorizations for take of LCR steelhead for scientific research to the states of Oregon and Washington under ESA section 4(d). The total take permitted in 2017 by prior Section 10(a)(1)(A) and 4(d) authorizations, i.e., the “baseline” take, relative to abundance, is reported in Table 4.

Table 4. Previously Authorized Take of LCR Steelhead for Scientific Research and Monitoring in 2017.

ESU/DPS	Life Stage	Origin	Abundance	Previous Authorizations			
				Take	Proposed % Taken	Mortality	Proposed % Killed
LCR steelhead	Adult	Natural	12,920	3,558	27.5%	34	0.3%
	Adult	LHAC	22,055	161	0.7%	4	0.02%
	Adult	LHIA	242	0	0%	0	0%
	Adult	Total	35,217	3,719	10.6%	38	0.1%
	Juvenile	Natural	351,966	62,951	17.9%	1,187	0.3%
	Juvenile	LHAC	1,134,744	51,681	4.6%	1,074	0.1%
	Juvenile	LHIA	12,449	0	0%	0	0%
	Juvenile	Total	1,499,159	114,632	7.6%	2,261	0.1%

Actual take levels associated with scientific research are almost certain to be lower than the total levels permitted for research permits. Most researchers do not handle or kill the full number of fish that they are allowed. Our research tracking database reveals that researchers, on average, end up taking only about 28% of the number of fish they request and the actual mortality is only about 15% of what they request.

2.5 Effects of the Action on LCR Steelhead and Designated Critical Habitat

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

NEON proposes to install a small amount of instream and near-stream infrastructure at Martha Creek, which would include access paths, power and communication conduits, device posts and portals, instream sensor suites, a meteorological station, and groundwater wells. NEON proposes to use the instream and riparian sensors in combination with field sampling to characterize the chemical, physical, and biological properties at the aquatic sampling site in Martha Creek. We describe the proposed action in detail in Section 1.3. We describe (1) the short-term effects of the proposed construction and installation of infrastructure, and (2) the ongoing effects of scientific research activities on LCR steelhead and critical habitat in Sections 2.5.1 and 2.5.2.

2.5.1 Effects on LCR Steelhead

Construction and Installation of Research Infrastructure

NEON proposes construction of paths and installation of research infrastructure, including (1) building and widening paths; (2) installing a meteorological station in the riparian zone; (3) drilling eight groundwater monitoring wells in the riparian zone; and (4) driving posts 48 inches into the streambed for sensor suites at two locations (Section 1.3.1). We detail the proposed action in Section 1.3.1 and the effects of these activities on critical habitat in Section 2.5.2.

Sediment from construction of the trail adjacent to Martha Creek and installation of the meteorological station in the riparian zone would be extremely unlikely to reach the stream and in any way affect adult or juvenile steelhead or steelhead eggs. When technicians install the instream posts to support the surface water sensors, the mass of sediment released to the water column would be much too small to in any way affect adult or juvenile steelhead or steelhead eggs.

Juvenile steelhead would have to swim around the fence posts and the attached surface water sensors, slightly altering their mobility at two locations in Martha Creek. However, the fence posts and surface water sensors would not affect juvenile steelhead mobility in any way that differs from effects of natural objects, such as logs and rocks in the stream. Therefore, the effect of the posts and surface water sensors on juvenile mobility would extremely small.

Given NEON's proposed protocols and Best Management Practices (Section 1.3.3), we expect that direct and indirect effects on LCR steelhead from construction and research infrastructure emplacement would be unmeasurably small.

Scientific Research Activities

Reconnaissance Surveys for LCR Steelhead Adults and Redds

Prior to conducting any research in the stream channel, NEON proposes to do reconnaissance surveys to determine if LCR steelhead adults or redds are present in the sampling reach. If adults or redds are present, NEON would avoid any instream research in the vicinity of adults or redds. *"In the vicinity of"* means close enough to cause any behavioral response (e.g., seeking cover) in adults or to affect redds in any way (e.g., dislodging gravels in or near redds or suspending sediment upstream of redds). NEON would not electrofish on any date that adults or redds are observed in any part of the project site.

Research Activities with No Effects on LCR steelhead

NEON proposes to take four- to eight-gallon groundwater samples from four of the groundwater monitoring wells in the riparian zone, twice a year. This activity would not affect stream flow measurably and would not affect LCR steelhead.

Effects of Researchers Wading in the Stream

All of NEON's proposed instream research would require that researchers wade in the stream. The research activities for which the *only* effects would come from researchers wading in the stream include NEON's proposal to (1) maintain the instream sensor suites every two weeks year-round; (2) measure stream stage and discharge multiple times per year at a range of flows; and (3) collect 4-liter water samples for analysis of surface water chemistry (26 times per year) and microbes (12 times per year).

Juvenile steelhead may be frightened by turbulence and sound from researchers wading in the stream. These fish would likely seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, fish might leave a particular pool or other habitat area, and return when researchers leave the area. NEON proposes to avoid sampling in stream microhabitats if juvenile steelhead are observed to be present. Adult fish are likely to be more sensitive than juvenile fish to disturbance from human presence, particularly during periods of pre-spawn staging and spawning. NEON proposes to avoid working in any area with adults or redds. We determine that effects from wading on steelhead behavior and mobility, for both juvenile and adults, would be unmeasurably small.

Wading in the stream could potentially suspend small masses of sediment from the streambed to the water column. The mass of sediment would be much too small to in any way affect adult of juvenile steelhead of steelhead eggs in redds. Given NEON's adherence to their proposed sampling protocols and Best Management Practices, we determine that the research activities described above would have an unmeasurably small effect on LCR steelhead.

Effects of Reaeration Studies

NEON proposes to conduct stream reaeration studies 6 to 12 times per year. The researchers would bubble sulfur hexafluoride and chloride or bromide into the stream for one to two hours, and collect water and gas samples from the stream at three or four locations downstream. Sulfur hexafluoride is used in reaeration studies because it is chemically and biologically inert, extremely volatile, not naturally present in the atmosphere, and it can be quantified at concentrations less than 10^{-16} moles per liter. Because the gas would be bubbled into the stream, most of it would be lost to the atmosphere and less than 1% would become dissolved into the stream. The concentration of gas in the stream would be approximately 4.3×10^6 picomole per liter during reaeration studies (GPNF 2017). Although sulfur hexafluoride is believed to be non-toxic to aquatic organisms, NEON states that they researchers would not conduct reaeration studies when steelhead adults or redds are present. Juvenile steelhead could be exposed to extremely low concentrations of SF6 and halogen ion during reaeration tests but we expect that the effects of any such exposure would be unmeasurably small.

Effects of Research Activities that Disturb the Streambed

NEON proposes research activities that would disturb the streambed or dislodge organisms associated with the streambed. These activities include NEON's proposal to (1) collect aquatic plants, bryophytes, lichens, algae, and microbes from the stream bed or other stream substrates (e.g., macrophytes, woody debris), by scrubbing substrate or hand-picking, three times per year; (2) collect benthic invertebrates from riffles, runs, snags, and pools using a Surber net, kick net, snag net, corer, or petite ponar dredge, three times per year , and (3) collect sediment samples of five liters or less using a hand corer or scoop, three times per year.

NEON proposes to collect several square meter samples of aquatic macrophytes, which would reduce slightly the primary production in this reach of Martha Creek. NEON also proposes to collect macroinvertebrates that might otherwise have been consumed by juvenile steelhead. In both cases, the sampling scale is much too small to affect the growth of juvenile steelhead. We determine that the effects of these proposed research activities would be unmeasurably small.

Suspended sediment affects fish health as a function of its concentration and duration. In 1996, Newcombe and Jensen (1996) created charts that summarized the reported effects of salmonid exposure to different concentrations of suspended sediment for a given time. For example, exposure to 400 mg/L of suspended sediment for 2.7 hours yielded minor physiological stress (coughing) and exposure to 400 mg/L for 7.3 hours caused major physiological stress (long term reduction in feeding success). Suspended sediment caused by NEON staff wading in the stream would be far below the concentration-duration combinations the cause minor physiological stress to fish. Sediment that becomes entrained in the water column when NEON staff wade in Martha Creek already is a part of the bedload-substrate continuum, and it is transported downstream by high flow events that occur naturally. Such sediment does not represent new material introduced into the channel. We determine that any effects on fish, redds, or egg survival from sediment entrainment in the water column would be unmeasurably small.

Effects of Fish Surveys

NEON proposes to sample fish using three-pass electrofishing with block nets placed at upstream and downstream locations (Section 1.3.2). NEON proposes to hold fish that are captured in buckets or aerated stream water, identify, photograph, and measure fish, and then release the fish to the stream. NEON requests to take up to 500 juvenile and 3 adult, natural-origin LCR steelhead annually from 2017 through 2021. The researchers do not intend to kill any LCR steelhead, but a small percentage may be killed as an inadvertent result of the activities.

Effects of Electrofishing. During electrofishing, electrical current is passed through water in order to stun fish, which makes them easier to capture. Electrofishing can cause a suite of effects ranging from disturbing the fish to killing them. Rates of injury and mortality of fish from electrofishing vary widely depending on the equipment used, the settings on the equipment, and the expertise of technicians. Electrofishing can have severe effects on adult fish. Spinal injuries in adult salmonids from forced muscle contraction have been documented. Sharber and Carothers (1988) reported that electrofishing killed 50 percent of the adult rainbow trout in their study.

Most of the studies on the effects of electrofishing have been conducted on adult fish greater than 300 mm in length (Dalbey et al. 1996). The relatively few studies that have been conducted on juvenile salmonids indicate that spinal injury rates are substantially lower than they are for large fish. Smaller fish are subjected to a lower voltage gradient than larger fish (Sharber and Carothers 1988) and may, therefore, be subject to lower injury rates (e.g., Hollender and Carline 1994, Dalbey et al. 1996, Thompson et al. 1997). McMichael et al. (1998) found a 5.1% injury rate for juvenile Middle Columbia River steelhead captured by electrofishing in the Yakima River subbasin. The incidence and severity of injury from electrofishing is partly related to the type of equipment used and the waveform produced (Sharber and Carothers 1988, McMichael 1993, Dalbey et al. 1996; Dwyer and White 1997). Continuous direct current (DC) or low-frequency (30 Hz) pulsed DC have been recommended for electrofishing (Fredenberg 1992; Snyder 1992, 1995; Dalbey et al. 1996) because lower spinal injury rates, particularly in salmonids, occur with these waveforms (Fredenberg 1992, McMichael 1993, Sharber et al. 1994, Dalbey et al. 1996). Only a few studies have examined the long-term effects of electrofishing on salmonid survival and growth (Dalbey et al. 1996, Ainslie et al. 1998). These studies indicate that although some of the fish suffer spinal injury, few die as a result. However, severely injured fish grow at slower rates and sometimes they show no growth at all (Dalbey et al. 1996).

Research permit conditions would require that all researchers follow NMFS' electrofishing guidelines (NMFS 2000). The guidelines require that field crews be trained to recognize signs of stress in fish and that staff know how to adjust electrofisher settings to minimize that stress. The guidelines also require that researchers: (1) visually search all areas for fish before electrofishing; (2) avoid electrofishing in the vicinity of redds or spawning adults; (3) receive training by qualified personnel to be understand equipment handling, settings, maintenance, and safety; (4) work in pairs to increase both the number of fish that may be seen and the ability to identify individual fish without having to net them; (5) net fish quickly; (6) use DC units in proper operating condition; and (7) test water conductivity at the start of every electrofishing session and adjust voltage, pulse width, and rate to minimal effective levels. Due to the low settings used, shocked fish normally revive instantaneously. When fish require reviving, they should receive immediate and adequate care. In all cases, electrofishing should only be used only when other survey methods are not feasible. Furthermore, permit conditions prohibit researchers from targeting adult fish and the researcher must stop electrofishing if they encounter an adult fish.

Effects of Handling Fish. The primary effect of the proposed research on LCR steelhead would be from capturing and handling fish. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of impact on individuals, populations, and species (Sharpe et al. 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe et al. 1998). The permit conditions identified in subsection 1.3.2 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling.

Population- and DPS-Scale Effects of the Proposed Take. NEON proposes to capture, handle, and then release up to 500 juvenile LCR steelhead annually in Martha Creek. In addition, NEON requests to take up to 3 adults, which most likely would occur through observation of an adult during an electrofishing survey (Table 5). If this occurred, the researchers would immediately turn off electricity, allow the fish to swim away, and suspend electrofishing surveys until a date when adults and eggs were no longer present. Given NEON's proposed research methods, we expect at least 97% of the fish captured during research activities to survive with no long-term consequences. To determine the effects of the research, we compared the numbers of fish that may be killed to the abundance of naturally produced juveniles and adults that we expect to occur at the Wind River population scale and at the DPS scale.

Table 5. Requested Take for Permit 21220. 'Unintentional Mortalities' are also counted in the 'Requested Take' column.

ESU/DPS	Life Stage	Origin	Take Activity	Requested Take	Unintentional Mortalities
LCR Steelhead	Adult	Natural	Capture/Handle/Release Fish	3	0
LCR Steelhead	Juvenile	Natural	Capture/Handle/Release Fish	500	15

For the Wind River population, direct measurements of juvenile steelhead abundance are not available so we estimated smolt abundance for the Wind River population using estimates for the number of spawners (763, Table 2), proportion of spawners that are female (assumed 50%), fecundity (4923, from Quinn, 2005) and egg-to-smolt survival (0.014, Quinn, 2005):

 # smolts = 763 spawners x 0.5 females/spawner x 4923 eggs/female x 0.014 smolt/egg

We estimated average annual abundance of natural-origin smolts in the Wind River population to be 26,294. The proposed research permit would allow handling of up to 500 juveniles (1.9% of the population estimate for smolts) and unintentional mortalities of up to 15 juveniles (0.06% of the population estimate for smolts).

Average abundance of natural origin adults in the Wind River population is 763 (Table 2). The proposed research would permit take of up to 3 adults (0.4% of the spawner population) and no unintentional mortalities. This limited, non-lethal take of adults would occur if adults were encountered inadvertently during electrofishing.

At the DPS scale, average abundance of natural origin smolts was 351,966 (Table 3). The proposed research permit would allow handling of up to 500 natural origin juveniles annually (0.1% of natural origin smolts in the DPS). The proposed research permit would allow mortalities of up to 15 natural origin juveniles annually (0.004% of natural origin smolts in DPS; Table 6).

Table 6. Take and mortalities for proposed permit #21220 analyzed in this Opinion (‘Proposed’) relative to abundance (LHAC[a] = Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose).

				Proposed			
ESU/DPS	Life Stage	Origin	Abundance	Proposed Take	Proposed % Taken	Proposed Mortality	Proposed % Killed
LCR steelhead	Adult	Natural	12,920	3	0.0%	0	0.0%
	Adult	LHAC	22,055	0	0.0%	0	0.0%
	Adult	LHIA	242	0	0.0%	0	0.0%
	Adult	Total	35,217	3	0.0%	0	0.0%
	Juvenile	Natural	351,966	500	0.1%	15	0.004%
	Juvenile	LHAC	1,134,744	0	0.0%	0	0.0%
	Juvenile	LHIA	12,449	0	0.0%	0	0.0%
	Juvenile	Total	1,499,159	500	0.0%	15	0.001%

[a]We estimate the abundance of LHAC adults using data on (1) abundance of all hatchery adults (LHAC + LHIA) and (2) the ratio of LHAC:LHIA for juveniles, assuming equal survival of LHAC and LHIA juveniles to the adult life stage.

We determine that the proposed research would have a very small impact on abundance, a similarly small impact on productivity, and no measureable effect on spatial structure or diversity for LCR steelhead. NEON has requested take numbers that are slightly higher than they expect to occur, in order to avoid exceeding their take limits due to unforeseen circumstances, such as higher-than-expected population abundance causing higher-than-expected encounter rates. Inflating take estimates also helps us to conduct a conservative analysis of the effects of the actions, because the actual levels of take typically are lower than analyzed.

This research would benefit listed fish by generating long term data sets on the animals’ health, abundance, and status in general. Those data would be used to inform management decisions on the Gifford Pinchot National Forest and the lower Columbia River ecosystem. In addition, the proposed research would contribute to an unprecedented effort to better understand the ecological impacts of climate change, land-use change, and invasive species at a continental scale.

2.5.2 Effects on Critical Habitat

The PBFs for freshwater steelhead critical habitat in the action area include freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams, and beaver dams, aquatic vegetation, large rocks and boulders, side channels and undercut banks.

Construction and Installation of Research Infrastructure

The effects of the proposed construction activities on critical habitat for spawning and juvenile rearing include: (1) effects of sediment mobilization from activities in the riparian area (trail construction, installation of a meteorological station, and drilling groundwater wells) on water quality and spawning substrate; and (2) effects of installing two surface water sensor posts in the stream bed on water quality.

Construction of new and widened trails, particularly the 3,200 foot long access trail along to Martha Creek, and installation of the meteorological station, would remove vegetation that hold sediment in place. This in turn, would create potential for erosion to carry sediment into Martha Creek where it would degrade spawning and rearing water quality and spawning substrate quality. NEON proposes to maintain a 20-foot-wide vegetated buffer between the meteorological station trail and the channel, except where the trail enters the two sampling sites. This buffer would trap any eroded sediment and prevent it from reaching the stream.

Drilling groundwater wells at various distances from the stream would liberate sediment that could be washed into the stream by rainfall. However, the closest wells to the stream would have a 20-foot vegetated buffer that would capture and hold mobilized sediment before it reaches the stream. We determine that the effect of drilling groundwater wells on spawning and rearing water quality and spawning substrate would be extremely small.

NEON proposes to drive steel fence posts into the channel substrate to hold surface water sensors. Driving the fence posts into the stream would displace small amounts of substrate and may cause some entrainment of fine sediment in the water column. However, the mass of fine sediment that could be transferred to the water column by this action is much too small to result in suspended sediment concentrations that have any biologically meaningful effect on water quality or, once deposited, to alter the fine sediment fraction in substrate used to construct steelhead redds.

We conclude that the effect of sediment mobilization from construction of trails, installation of a meteorological station, drilling groundwater wells, and installing posts for instream sensors would be unmeasurably small and thus would not affect spawning and rearing water quality and spawning substrate.

Scientific Research Activities

NEON's proposal to conduct the research activities described in Section 1.3.2 and *"Effects on LCR Steelhead,"* above, would affect critical habitat for spawning and rearing through: (1) effects on water quantity from collecting groundwater and surface water samples; and (2) effects on water quality from activities that could potentially entrain sediment in the water column, which include wading in the stream to maintain sensors and conduct surveys, collecting plants and invertebrates from the streambed, and collecting sediment samples.

NEON proposes to take four- to eight-gallon groundwater samples from four of the groundwater monitoring wells in the riparian zone, twice a year. NEON also proposes to remove approximately 152 liters per year of surface water from Martha Creek for water chemistry and microbe sampling, spilt between approximately 26 sampling dates. Martha Creek is a steep mountain stream with low flow rates of approximately 1000 liters per second. Proposed water sampling rates would have an unmeasurably small effect on spawning and rearing water quantity.

NEON proposes to wade in the stream to maintain water sensors and conduct measurements, collect plants and invertebrates from the streambed, and collect sediment samples, all of which could cause a small amount of fine sediment to become entrained in the water column and be transported as a plume. However, the mass of fine sediment that could be transferred to the water column by this action is too small to result in suspended sediment concentrations that have any effect on water quality or, once deposited, to alter the fine sediment fraction in substrate used to construct steelhead redds. Similarly, the proposed electrofishing surveys would have little to no effect on habitat because they involve little, if any, disturbance to streambeds or adjacent riparian zones.

Overall, we conclude that any effects of the proposed research activities on designated critical habitat, including the fish surveys associated with the Section 10(a)(1)(A) research permit, would unmeasurably small.

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). We do not consider future Federal actions that are unrelated to the proposed action 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 versus cumulative effects. Therefore, we describe all relevant future climate-related environmental conditions in the action area in the environmental baseline (Section 2.4).

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could affect listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and speculative. However, projects affecting salmon, steelhead, and other listed fish species generally require Federal funding or authorization to be completed, and so we can reasonably state that the vast majority of such actions in the region will undergo section 7 consultation.

In developing this biological opinion we considered efforts at the local, tribal, state, and national levels to conserve listed salmonids. These include the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010), the ESA Recovery Planning for Salmon and Steelhead in the Willamette and Lower Columbia River Basins (NMFS 2005b), the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead (ODFW 2010), the Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan (WDFW 2010), and the Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest (Ford et al. 2011). The result of that review was that salmon take—particularly associated with research, monitoring, and habitat restoration—is likely to continue to increase in the region for the foreseeable future. However, as noted above, all actions falling in those categories would also have to undergo consultation before they are allowed to proceed.

One final point to consider regarding cumulative effects is the length of time over which the proposed action would occur. The scientific research permit would be approved for five years. Considering the life history of LCR steelhead, the proposed actions could affect the listed species for up to four years after the action ceases, with effects diminishing gradually over that time. We are unaware of any major non-Federal activity that could affect listed salmonids and is certain to occur in the action area during that time frame.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to LCR steelhead and critical habitat due to implementing the proposed action. In this section, we assess this risk by integrating information on the status of the LCR steelhead DPS and critical habitat (Section 2.2), the environmental baseline (Section 2.4), the potential effects of the proposed action (Section 2.5), and cumulative effects (Section 2.6). We formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) diminish appreciably the value of designated or proposed critical habitat for the conservation of the species.

We analyzed effects of proposed construction, installation of research infrastructure, and ongoing research activities on LCR steelhead and critical habitat (Section 2.5). We determined that the only proposed activity that is likely to adversely affect LCR steelhead or critical habitat is electrofishing surveys. All other proposed activities would produce unmeasurably small effects on LCR steelhead and critical habitat.

For the research permit, we integrate the directed take levels that NEON proposes with take for ongoing research permits that have been previously authorized under ESA Sections 10(a)(1)(A) or 4(d) to determine total take. We then compare this total take for research permits to the estimated annual abundance of LCR steelhead (Table 7). As discussed in Section 2.5.2, effects of the proposed research on LCR steelhead are likely to be lower than the levels calculated in this analysis, because actual take described in annual reports is typically far less than the levels analyzed and authorized for research permits.

Table 7. Take and Mortalities for Proposed Permit #21220 Analyzed in this Opinion ('Proposed') and Proposed Permits Plus Already Authorized Permits ('Proposed Plus Baseline') Relative to Abundance (LHAC[a] = Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose).

				Proposed				Proposed Plus Baseline			
ESU/DPS	Life Stage	Origin	Abundance	Proposed Take	Proposed % Taken	Proposed Mortality	Proposed % Killed	Total Take	Total % Take	Total Mortality	Total % Mortality
LCR steelhead	Adult	Natural	12,920	3	0.02%	0	0.0%	3,561	27.6%	34	0.3%
	Adult	LHAC	22,055	0	0.0%	0	0.0%	161	0.7%	4	0.02%
	Adult	LHIA	242	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Adult	Total	35,217	3	0.0%	0	0.0%	3,722	10.6%	38	0.1%
	Juvenile	Natural	351,966	500	0.1%	15	0.004%	63,451	18.0%	1,202	0.3%
	Juvenile	LHAC	1,134,744	0	0.0%	0	0.0%	51,681	4.6%	1,074	0.1%
	Juvenile	LHIA	12,449	0	0.0%	0	0.0%	0	0.0%	0	0.0%
	Juvenile	Total	1,499,159	500	0.0%	15	0.001%	115,132	7.7%	2,276	0.2%

[a]We estimate the abundance of LHAC adults using data on (1) abundance of all hatchery adults (LHAC + LHIA) and (2) the ratio of LHAC:LHIA for juveniles, assuming equal survival of LHAC and LHIA juveniles to the adult life stage.

LCR Steelhead

Electrofishing surveys are the only part of the proposed action that is likely to have an adverse effect on LCR steelhead. Electrofishing surveys would result in directed take of 500 juvenile and 3 adult LCR steelhead annually. NMFS would authorize this take in the ESA Section 10(a)(1)(A) scientific research permit. The research permit would include conditions to ensure that research activities other than electrofishing do not result in take of LCR steelhead.

The proposed fish surveys would cause low rates of non-lethal take and low numbers of mortalities of LCR steelhead (Table 7). Most fish that researchers capture and release would recover quickly with no long-term consequences. The proposed research may kill, in sum, as much as 0.004% of natural origin juveniles in the LCR steelhead DPS. No mortalities of natural origin adults have been requested. These very small effects would occur within a single population (see Section 2.5.1).

When adding effects of the proposed research to previous ESA Sections 10(a)(1)(A) and 4(d) research authorizations (i.e., the baseline), total effects of research on LCR steelhead remain small. We estimate that the proposed plus baseline mortalities would always be less than 0.3% of the total abundance for natural origin juvenile LCR steelhead (Table 7). Thirty-four mortalities for natural origin adults could occur annually, representing 0.3% of the estimated abundance for natural origin adult LCR steelhead. None of these mortalities would be due to NEON's proposed project considered here.

Our analysis of effects is likely to be conservative. Permit applications tend to overestimate actual take so that researchers are not likely to exceed their take authorization. In addition, we use conservative estimates of juvenile abundance. While we describe potential effects on all juvenile LCR steelhead life stages (smolts, suyearlings, parr, and fry) as effects on "juveniles," we estimate abundance of juveniles using data for smolts. Sub-yearlings, parr, and fry are life stages that represent multiple spawning years and have many more individuals than survive to the smolt life stage – perhaps as much as an order of magnitude more.

Critical Habitat

As noted earlier, we do not expect the proposed actions to have any appreciable effect on LCR steelhead critical habitat. The short duration, minimal intrusion, and overall lack of measureable effect of the action on critical habitat signifies that the proposed action would have no discernible impact on critical habitat.

Summary

For LCR steelhead to recover, there must be substantial improvement in habitat and other factors affecting survival. While the proposed action would have some negative effect on abundance and productivity of LCR steelhead, these effects are so small as to be negligible. Research activities have never been identified as a threat to listed fish in the Pacific Northwest and, given the analysis above, we conclude that that will continue to be the case even when that activities here are added to all other ongoing or likely effects.

While specific future cumulative effects are uncertain, cumulative effects will likely continue to be negative. The effects of climate change are also likely to continue to be negative. However, the very small effects from the proposed action on abundance and productivity, and even smaller effects on spatial structure and diversity, will not exacerbate any negative cumulative effects on LCR steelhead.

The proposed research activities may benefit LCR steelhead by providing data to inform NMFS' 5-year status reviews and GPNF management activities for LCR steelhead. Such information improves our understanding of steelhead life histories and biological requirements. By issuing research authorizations, NMFS facilitates science-based management of fisheries resources.

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, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed actions are not likely to jeopardize the continued existence of LCR steelhead or destroy or adversely modify designated critical habitat for LCR steelhead.

2.9 Incidental Take Statement

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

There is no incidental take for the proposed action considered in this opinion, which includes NEON's proposed infrastructure installation and research, GPNF's issuance of a special use permit, and NMFS' issuance of a Section 10 research permit. The take associated with the scientific research permit is direct rather than incidental take, because the purpose of the research is to take the animals while carrying out a lawfully permitted activity. Thus, the take cannot be considered "incidental" under the definition given above. Nonetheless, one of the purposes of an incidental take statement is to lay out the amount or extent of take beyond which individuals carrying out an action cannot go without being in possible violation of section 9 of the ESA. That purpose is fulfilled here by the amounts of direct take laid out in the effects section above (2.5). Those amounts constitute hard limits on both the amount and extent of take that the permit holder would be allowed in a given year. This concept is also reflected in the reinitiation clause just below.

2.10 Reinitiation of Consultation

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

As noted above, in the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in (1) is not applicable. However, if the direct take amount specified in section 2.5 is exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in (2) and/or (3) will have been met.

3. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

3.1 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 applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation.
Individual copies of this opinion were made available to the applicants and it will be posted on the Public Consultation Tracking System website (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

3.2 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.

3.3 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.

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

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

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

5. REFERENCES

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