UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232-1274

Refer to NMFS No.:
WCR-2014-1203

January 23, 2015

Daniel M. Mathis
Division Administrator
Federal Highway Administration
Evergreen Plaza Building
711 S. Capitol Way, Suite 501
Olympia, Washington 98501

Re: Endangered Species Act Section 7(a)(2) Biological and Conference Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Lake River Bridge Replacement Project.

Dear Mr. Mathis:

The enclosed document contains a biological and conference opinion (opinion) prepared by the National Marine Fisheries Service (NMFS) pursuant to section 7(a)(2) of the ESA on the effects of the Lake River Bridge Replacement Project. In this opinion, the NMFS concludes that the proposed action is not likely to jeopardize the continued existence of the Lower Columbia River (LCR) Chinook salmon, LCR steelhead, and LCR coho salmon. Additionally, the NMFS concludes that the proposed project is not likely to adversely affect Pacific eulachon, Columbia River (CR) chum, and designated critical habitats (CH) for CR chum salmon and proposed CH for LCR coho salmon.

This document also includes a description of the action's likely effects on Essential Fish Habitat (EFH) for two Pacific salmon pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act and includes a conservation recommendation to offset impacts to EFH. Federal agencies must provide a detailed written response to the National Marine Fisheries Service's EFH conservation recommendations within 30 days of receipt of these recommendations (50 CFR 600.920(j)(1)). The response must include a description of measures proposed to avoid, mitigate, or offset the adverse effects that the activity has on EFH.

Please contact Michael Grady of the Oregon/Washington Coastal Area Office at (206) 526-4645 or by email at Michael.Grady@noaa.gov if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

for William W. Stelle, Jr.
Regional Administrator

cc: Steve Morrow – FHWA-WFL project manager

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

Lake River Bridge Replacement Project

NMFS Consultation Number: WCR-2014-1203

Action Agencies: Federal Highway Administration (lead)
U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Adversely Affect Critical Habitat	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Lower Columbia River coho salmon (*Oncorhynchus kisutch*)	Threatened	Yes	Yes	No	No*
Lower Columbia River Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No
Columbia River chum salmon (*O.keta*)	Threatened	No	Yes	No	No
Lower Columbia River steelhead salmon (*O. mykiss*)	Threatened	Yes	No	No	No
Eulachon (*Thaleichthys pacificus*)	Threatened	No	NA	NA	NA

*Critical habitat is proposed for Lower Columbia River coho salmon

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

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

Issued By:

for William W. Stelle, Jr.
Regional Administrator

Date: January 23, 2015

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1. INTRODUCTION

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

1.1 Background

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

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (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 at the Oregon-Washington Coastal Area Office in Lacey, Washington.

1.2 Consultation History

The Federal Highway Administration (FHWA), U.S. Fish and Wildlife Service (USFWS), the Washington State Department of Transportation (WSDOT) and the NMFS liaison staff met at the proposed project site on May 28, 2014 to discuss the timing of in-water work, pile-driving methods, installing drilled shafts, and fish presence. The meeting was to support the preparation of a biological assessment (BA). The proposed project is partially funded by FHWA and will also require a fill permit from the U.S. Army Corps of Engineers.

The FHWA drafted the BA and the NMFS previewed portions and sent comments to the author. On July 24, 2014, a final BA was received by the NMFS. A revised EFH section was sent via electronic mail to the NMFS on September 8, 2014. After numerous telephone and email conversations with the FHWA and WSDOT, we considered the information provided to us was sufficient to complete formal consultation. We therefore formally initiated consultation on December 8, 2014.

The effect determinations for this consultation are:

- Likely to adversely affect- Lower Columbia River (LCR) Chinook salmon, LCR coho salmon, LCR steelhead, Columbia River chum salmon critical habitat and proposed critical habitat for LCR coho salmon
- •Not likely to adversely affect- eulachon and Columbia River chum salmon.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried-out, in whole or in part, by federal agencies (50 CFR 402.02).

The FHWA, in partnership with the USFWS is proposing to improve access to the River S Unit of the Ridgefield National Wildlife Refuge (NWR) by constructing a new bridge over Lake River adjacent to the existing bridge, which is functionally obsolete and structurally deficient to support vehicles. The River S Unit has up to 120 vehicle trips per day during summer months. The Lake River Bridge provides the only access over Lake River to the Unit S portion of the Ridgefield NWR for routine refuge operations and visitors.

The existing bridge is constructed with trestle bents and abutments and contains timber and steel piles, and timber bracing and caps. The bridge deck is 16 feet wide and functions as a narrow two-way single lane bridge. The bridge has been subject to frequent upgrades and repairs since it was constructed. These repairs have been necessary to keep the bridge open to the public. In the 1990s, the replacement piles were constructed, the electrical line across the bridge was upgraded, and running planks were replaced on the deck. In the 2000s, the bridge's west abutment was reconstructed and guardrails were replaced. The FHWA bridge engineers estimate the existing bridge's serviceable life span is 5-10 years based on their 2010 inspection report.

The project requires two temporary work bridges supported on a combined total of approximately 150 steel piles; approximately 108 of the piles will be located below the ordinary high water mark (OHWM) to facilitate construction of two mid-channel piers. The work bridges will extend from both banks. They are approximately 24 feet wide and 380 feet long with approximately 60-foot by 40-foot work platforms at the end of each pier. The steel piles will be vibrated-in and proofed to load-bearing capacity. The piles will be vibrated-in during any time of the year but impact proofing will be restricted to the in-water work window of June 1 to September 15. The temporary work bridges will be in place for up to one year. The work bridges will be removed in reverse order with all piles vibrated-out.

The new structure will be a four-span bridge supported on three, eight-foot diameter drilled shaft piers. The bridge will be approximately 500 feet long to span both the navigation channel of Lake River and the Burlington Northern Santa Fe (BNSF) railroad tracks that run adjacent to the right bank of the River. To construct the shaft, a "can" will be lowered into position on the riverbed and the soil within will be augured out. The can also serves to isolate the construction from the water and to minimize turbidity. Excavated soil and water in the can will be removed to an upland disposal area or storage tank. When the desired depth is reached, the area will be filled with rebar and concrete to form the base of the piers.

Two piers will be in the river channel with a third pier on the right bank to support the railroad overcrossing portion of the bridge. The abutments will be set back from the edge of Lake River about 50 feet to the west and 200 feet to the east. The total bridge width will be 32 feet wide, and will include two 12-foot travel lanes plus a 2-foot wide pedestrian walkway. The bridge superstructure will be built of pre-cast concrete girders with a cast-in-place deck. All concrete

that contacts the River will be cured for a minimum of seven days before they are exposed to water.

The existing bridge will remain in place during construction and continue to be used for public access and then removed after the new bridge is completed. The best management practices (BMPs) will be in place to prevent debris from falling into the River. All of the debris will be disposed of at an appropriate disposal site. All in-water work will be completed during two seasons.

Season 1:

- Install temporary work trestles (approximately 47 days).
- Construct drilled shafts (approximately 28 days).

Season 2:

- Remove existing bridge and temporary work trestles (approximately 40 days).

The new bridge will create 0.4 acres of new impervious surface. Nearly all of the stormwater runoff (95 percent) from the bridge will be diverted to the right bank side of the bridge where it will infiltrate into a forested area. The remaining stormwater runoff will flow to the left bank side of the bridge where it will infiltrate into a grassy field. There will be no direct stormwater discharges to the river. Forty-eight, creosote-treated timber piles from the old bridge located below the OHWM will be vibrated-out. If the piles break during extraction, they will be cut-off at the mudline. The new drilled shaft piers will permanently displace approximately 50 square feet; however, removing the 48 wood piles will restore 38 square feet for a net increase of 12 square feet of benthic habitat taken up by the proposed project.

All in-water work will be monitored for water quality. Turbid plumes will not exceed five nephelometric turbidity units above background levels at 300 feet downstream of the source. The BMPs will be in place to minimize erosion of disturbed soils. Vegetable-based hydraulic oil will be used in equipment operating in the water.

“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). Interrelated actions in this project include removing an additional six creosote-treated stub piles in the River near the bridge in addition to those piles supporting the existing bridge. This interrelated action is beneficial to listed species and habitats.

1.4 Action Area

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

The action area for the proposed project is defined by the extent of underwater noise created by impact pile-driving 24-inch hollow steel piles in Lake River. The River has a slow current without riffles and tumbling water; thus, ambient underwater noise is estimated to be relatively

quiet at approximately 120 decibels (dB). The Practical Spreading Loss noise calculator was used to estimate how far out construction noise would exceed ambient conditions. Sound levels[1] used in the calculation include 212 dBpeak, 189 dBrms[2], and 181 dBsel[3]. It is estimated that there will be 25 impact strikes to proof each pile. Up to 15 piles (a daily total of 375 strikes) will be proofed per day. Results from the calculation indicate that noise from construction could exceed ambient levels up to 247 miles from the source. However, the noise is truncated when the sound waves traveling through the water encounter land. The sinuosity of the River stops the sound waves at 1,600 feet downstream and 1,900 feet upstream of the bridge.

The action area is occupied by LCR Chinook salmon, LCR coho salmon, and LCR steelhead. Lake Creek in the action area is critical habitat for LCR chum salmon although members of this species are not likely to be in the action area during project activities. The action area is proposed as critical habitat for LCR coho salmon. The action area is EFH for Pacific salmon.

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

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

The FHWA determined that the proposed action is not likely to adversely affect Columbia River (CR) chum salmon, and eulachon. The analysis for these species is found in the "Not Likely to Adversely Affect" Determinations section 2.11. The FHWA also determined the project was not likely to adversely affect Lower CR (LCR) coho salmon critical habitat (CH) and CR chum CH. However, we disagree with these determinations and believe the project will adversely affect critical habitats for these species based on the project in-water actions and continuation of the bridge piers occupying benthic habitat and shading on Lake River.

2.1 Analytical Approach

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

[1] (re: 1 μPa2·sec)
[2] Root mean squared
[3] Sound exposure level

CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the federal action on the conservation value of designated critical habitat. This opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[4]

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

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

2.2 Range-wide Status of the Species 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 physical and biological features that help to form that conservation value.

Climate change is likely to play an increasingly important role in determining the abundance of ESA-listed species and the conservation value of designated critical habitats in the Pacific Northwest. These changes will not be spatially homogenous across the Pacific Northwest. Areas with elevations high enough to maintain temperatures well below freezing for most of the winter and early spring would be less affected. Low-lying areas that historically have received scant precipitation contribute little to total stream flow and are likely to be more affected.

[4] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

During the last century, average regional air temperatures increased by 1.5 degrees Fahrenheit (^{o}F) and increased up to 4 ^{o}F in some areas (USGCRP 2009). Warming is likely to continue during the next century as average temperatures increase another 3 to 10 ^{o}F. Overall, about one-third of the current cold-water fish habitats in the Pacific Northwest are likely to exceed key water temperature thresholds by the end of this century (USGCRP 2009).

Precipitation trends during the next century are less certain than for temperature trends. More precipitation is likely to occur during October through March with less during the summer months. More of the winter precipitation is likely to fall as rain rather than snow (ISAB 2007, ISGCRP 2009).

Higher winter stream flows increase the risk that winter floods in sensitive watersheds will damage spawning redds and wash away incubating eggs. Earlier peak stream flows will also flush some young salmon and steelhead from rivers to estuaries before they are physically mature, thus increasing stress and the risk of predation. Lower stream flows and warmer water temperatures during summer will decrease summer rearing conditions, in part by increasing the prevalence and virulence of fish diseases and parasites. Other adverse effects are likely to include altered migration patterns, accelerated embryo development, premature emergence of fry, variation in quality and quantity of tributary rearing habitat, and increased competition and predation risk from warm-water, non-native species (ISAB 2007).

The earth's oceans are also warming, with considerable inter-annual and inter-decadal variability superimposed on the longer-term trend (Bindoff et. a. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances (Scheuerell and Williams 2005, Zabel et al 2006, USGCRP 2009).

2.2.1 Status of the Species

For Pacific salmon, steelhead, and other relevant species, the NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"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 (McElhany *et al.* 2000).

"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," as applied to viability factors, 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. McElhany *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 a long-term population growth rate. For species with multiple populations, once the biological status of a species' populations has been determined, the NMFS assesses the status of the entire 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, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

The summaries that follow describe the status of the three ESA-listed species and their designated critical habitats that occur within the action area. More detailed information on the status and trends of these listed resources, and their biology and ecology, are in the listing regulations and critical habitat designations published in the Federal Register (Table 1).

Table 1. Listing status, status of critical habitat designations and protective regulations, and relevant Federal Register (FR) decision notices for ESA-listed species considered in this opinion.

Species	**Listing Status**	**Critical Habitat**
Lower Columbia River Chinook salmon (*Oncorhynchus tschawytscha*) Evolutionary Significant Unit	Threatened 06/28/2005 70 FR 37160	09/02/2005 70 FR 52630
Lower Columbia River steelhead (*O. mykiss*) Distinct Population Segment	Threatened 01/05/2006 71 FR 834	09/02/2005 70 FR 52630
Lower Columbia River coho salmon (*O. kisutch*) Evolutionary Significant Unit	Threatened 06/28/2005 70 FR 37160	Proposed 01/14/3013 78 FR 2726
Columbia River chum salmon (*O. keta*) Evolutionary Significant Unit	Threatened 06/28/2005 70 FR 37160	09/02/2005 70 FR 52630

For each recovery domain, a technical review team (TRT), appointed by the NMFS, developed criteria necessary to identify independent populations for each species. They have also recommended viability criteria for the species and descriptions of factors that limit the species' survival. Viability criteria are prescriptions of the biological conditions for populations,

biogeographic strata, and evolutionarily significant units (ESU) that, if met, would indicate that an ESU will have a negligible risk of extinction over a 100-year time frame[5].

Although the TRTs operated from the common set of biological principals described in McElhany *et al.* (2000), they worked semi-independently from each other and developed criteria suitable to the species and conditions found in their specific recovery domains. All of the criteria have qualitative as well as quantitative aspects. The diversity of salmonid species and populations makes it impossible to set narrow quantitative guidelines that will fit all populations in all situations. For this and other reasons, viability criteria vary among species, mainly in the number and type of metrics and the scales at which the metrics apply (*i.e.*, population, major population group (MPG), or ESU) (Busch *et al.* 2008).

The abundance and productivity (A&P) score considers the TRT's estimate of a populations' minimum threshold population, natural spawning abundance and the productivity of the population. Productivity over the entire life cycle and factors that affect population growth rate provide information on how well a population is "performing" in the habitats it occupies during the life cycle. Estimates of population growth rate that indicate a population is consistently failing to replace itself are an indicator of increased extinction risk. The four metrics (abundance, productivity, spatial structure, and diversity) are not independent of one another and their relationship to sustainability depends on a variety of interdependent ecological processes (Wainwright et al. 2008).

Integrated spatial structure and diversity (SS/D) risk combines risk for likely, future environmental conditions, and diversity (Ford 2011; McElhany *et al.* 2007; McElhany *et al.* 2000). Diversity factors include the following:

- Life history traits. This includes the distribution of major life history strategies w within a population, variability of traits, mean value of traits, and loss of traits.
- Effective population size. This is one of the indirect measures of diversity. A population at chronic low abundance or experiencing even a single episode of low abundance is at a higher extinction risk because of its loss of genetic variability, inbreeding and the expression of inbreeding depression, or the effects of mutation accumulation.
- Impact of hatchery fish. Interbreeding of wild populations and hatchery origin fish are a significant risk factor to the diversity of wild populations if the proportion of hatchery fish in the spawning population is high and their genetic similarity to the wild population is low.
- Anthropogenic mortality. The susceptibility to mortality from harvest or habitat alterations will differ depending on size, age, run timing, disease resistance or other traits.

[5] For Pacific salmon, NMFS uses its 1991 ESU policy, that states that a population or group of populations will be considered a Distinct Population Segment if it is an Evolutionarily Significant Unit. An ESU represents a distinct population segment of Pacific salmon under the Endangered Species Act that 1) is substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species. The species *O. mykiss* is under the joint jurisdiction of NMFS and the Fish and Wildlife Service, so in making its listing January, 2006 determinations NMFS elected to use the 1996 joint FWS-NMFS DPS policy for this species.

- Habitat diversity. Habitat characteristics have clear selective effects on populations, and changes in habitat characteristics are likely to eventually lead to genetic changes through selection for locally adapted traits. In assessing risk associated with altered habitat diversity, historical diversity is used as a reference point.

The boundaries of each population were defined using a combination of genetic information, geography, life-history traits, morphological traits, and population dynamics that indicate the extent of reproductive isolation among spawning groups. The overall viability of a species is a function of the VSP attributes of its constituent populations. Until a viability analysis of a species is completed, the VSP guidelines recommend that all populations should be managed to retain the potential to achieve viable status to ensure a rapid start along the road to recovery, and that no significant parts of the species are lost before a full recovery plan is implemented (McElhany *et al.* 2000).

The size and distribution of the populations considered in this opinion generally have declined over the last few decades due to natural phenomena and human activity, including climate change (as described in Section 2.2), the operation of hydropower systems, over-harvest, effects of hatcheries, and habitat degradation. Enlarged populations of terns, seals, California sea lions, and other aquatic predators in the Pacific Northwest may also be limiting the productivity of some Pacific salmon and steelhead populations (Ford 2011).

Species considered in this opinion and further described below, include LCR Chinook salmon, LCR coho salmon, and LCR steelhead. Of these species, the TRT has identified 79 demographically-independent populations (LCR Chinook salmon: 32, LCR coho salmon: 24, LCR steelhead 23). These populations were further aggregated into strata, or groupings above the population level that are connected by some degree of migration and based on ecological sub-regions.

All 79 populations use parts of the mainstem of the Columbia River and the Columbia River estuary for migration, rearing, and smoltification. Of these populations, only one population each of LCR Chinook salmon, LCR coho salmon, and LCR steelhead occurs in the action area. All of these populations are associated with Salmon Creek, a tributary to Lake River located upstream of the project. Adults from these three populations must pass through the action area to reach spawning habitat and, consequently, juveniles out-migrate through the area to rearing and ocean habitats.

Status of LCR Chinook Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of Chinook salmon in the Columbia River and its tributaries from its mouth at the Pacific Ocean upstream to a transitional point between Washington and Oregon just east of the Hood and White Salmon rivers. The species is exclusive of spring-run Chinook salmon in the Clackamas River and progeny of seventeen artificial propagation programs[6]. The LCR Chinook populations

[6] In 2009, the Elochoman tule fall Chinook salmon program was discontinued and four new fall Chinook salmon programs have been initiated. In 2011, NMFS recommended removing the Elochoman program from the ESU and adding the new programs to the ESU (NMFS 2011a).

exhibit three different life history types base on return timing and other features: fall-run (a.k.a. "tules"), late-fall-run (a.k.a. "brights"), and spring-run. The TRT identified 32 historical populations of LCR Chinook salmon— seven in the coastal subregion, six in the Columbia Gorge, and 19 in the Cascade Range. Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers and other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among the LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (Lower Columbia Fish Recovery Board 2010; NMFS 2013; ODFW 2010). Out of the 32 populations that make up this ESU, only the two late-fall runs, the North Fork Lewis and Sandy, are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years, and some are extirpated or nearly so. (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013; ODFW 2010). Five of the six strata fall significantly short of the TRT criteria for viability; one stratum, the Cascade late-fall, meets the TRT criteria (NMFS 2013).

Abundance and Productivity. The A&P ratings for most of the LCR Chinook salmon populations are currently "low" to "very low", except for spring Chinook salmon in the Sandy River, which are "moderate" and late-fall Chinook salmon in North Fork Lewis River and Sandy River, which are "very high" (NMFS 2013). The low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook salmon populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners.

Poor data quality prevents precise quantification of population abundance and productivity, particularly for tule fall Chinook salmon populations. Data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (Ford 2011).

Limiting Factors include the following (NMFS 2013; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system.
- Degraded freshwater habitats; including floodplain connectivity and function, channel structure and complexity, riparian areas, stream substrate, stream flow, and water quality. These habitats are degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects.
- Hatchery-related effects.
- Harvest-related effects on fall Chinook salmon.
- Modified flow regimes that have altered the temperature regime, the estuarine food web, and ocean productivity.
- Reduced access to off-channel rearing habitat in the lower Columbia River.
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary.
- Juvenile fish stranding from ship wakes.
- Contaminants in the water that affect fish health and reproduction.

Status of LCR Coho Salmon

Spatial Structure and Diversity. This species includes all naturally-spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon, from the mouth of the Columbia up to and including the Big White Salmon and Hood rivers; in the Willamette River to Willamette Falls, Oregon; and progeny of 25 artificial propagation programs[7]. Spatial diversity is rated "moderate" to "very high" for all the populations, except the North Fork Lewis River, which has a "low" rating for spatial structure.

Three status evaluations of LCR coho salmon, all based on WLC-TRT criteria, have been conducted since the last NMFS review in 2005 (McElhany *et al.* 2007; NMFS 2013). Out of the 24 populations that make up this ESU, 21 are considered to have a very low probability of persisting for the next 100 years, and none is considered viable (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013; ODFW 2010).

Abundance and Productivity. In Oregon, the Clatskanie Creek and Clackamas River populations have "low" and "moderate" persistence probability A&P scores, while the rest are rated "very low." All of the Washington populations have "very low" A&P ratings. The persistence probability for diversity is "high" in the Clackamas population; "moderate" in the Clatskanie, Scappoose, Lower Cowlitz, South Fork Toutle, Coweeman, East Fork Lewis, and Sandy populations; and "low" to "very low" in the rest (NMFS 2013). Uncertainty is high because of a lack of adult spawner surveys. Smolt traps indicate some natural production in Washington populations, though given the high fraction of hatchery origin spawners suspected to occur in these populations it is not clear that any are self-sustaining. Overall, the new information considered does not indicate a change in the biological risk category since the last status review (Ford 2011; NMFS 2011a; NMFS 2013).

Limiting Factors include the following (NMFS 2013; NOAA Fisheries 2011):

- Degraded estuarine and near-shore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system.
- Fish passage barriers that limit access to spawning and rearing habitats.
- Degraded freshwater habitats including; floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, stream flow, and water quality. These habitats have been degraded as a result of cumulative impacts of agriculture, forestry, and development.
- Hatchery-related effects.
- Harvest-related effects.
- Modified flow regimes that have altered the temperature regime, the estuarine food web, and ocean productivity
- Reduced access to off-channel rearing habitat in the lower Columbia River
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary
- Juvenile fish stranding because of ship wakes

[7] The Elochoman Hatchery Type-S and Type-N coho salmon programs were eliminated in 2008. The last adults from these two programs returned to the Elochoman in 2010. NMFS has recommended that these two programs be removed from the ESU (NMFS 2011a).

- Contaminants in the water that affect fish health and reproduction

Status of LCR Steelhead

Spatial Structure and Diversity. Four strata and 23 historical populations of LCR steelhead occur within the distinct population segment (DPS); 17 winter-run populations and six summer-run populations within the Cascade and Gorge ecological subregions[8]. The DPS also includes the progeny of ten artificial propagation programs[9].
Summer steelhead return to freshwater long before spawning. Winter steelhead, in contrast, return from the ocean much closer to maturity and spawn within a few weeks. Summer steelhead spawning areas in the Lower Columbia River are found above waterfalls and other features that create seasonal barriers to migration. Where no temporal barriers exist, the winter-run life history dominates.

It is likely that genetic and life history diversity has been reduced as a result of pervasive hatchery effects and population bottlenecks. Spatial structure remains relatively high for most populations Out of the 23 populations, 16 are considered to have a "low" or "very low" probability of persisting over the next 100 years, and six populations have a "moderate" probability of persistence (Ford 2011; Lower Columbia Fish Recovery Board 2010; NMFS 2013; ODFW 2010). All four strata in the DPS fall short of the WLC-TRT criteria for viability (NMFS 2013).

Baseline persistence probabilities were estimated to be "low" or "very low" for three out of the six summer steelhead populations that are part of the LCR DPS; moderate for two, and high for one, the Wind, which is considered viable. Thirteen of the 17 LCR winter steelhead populations have "low" or "very low" baseline probabilities of persistence, and the remaining four are at "moderate" probability of persistence (Lower Columbia Fish Recovery Board 2010; NMFS 2013; ODFW 2010).

Abundance and Productivity. The "low" to "very low" baseline persistence probabilities of most LCR steelhead populations indicates low abundance and productivity (NMFS 2013). All of the populations increased in abundance during the early 2000s. Most populations have since declined back to levels within one standard deviation of the long-term mean. Exceptions are the Washougal summer-run and North Fork Toutle winter-run, which are still higher than the long-term average, and the Sandy, which is lower. In general, the populations do not show any sustained changes in abundance or fraction of hatchery origin spawners since the 2005 status review (Ford 2011). Although current LCR steelhead populations are depressed compared to historical levels, and long-term trends show declines, many populations are substantially

[8] The White Salmon and Little White Salmon steelhead populations are part of the Middle Columbia steelhead DPS and are addressed in a separate species-level recovery plan, the Middle Columbia River Steelhead Distinct Population Segment ESA Recovery Plan (NMFS 2009).
[9] In 2007, the release of Cowlitz Hatchery winter steelhead into the Tilton River was discontinued; in 2009, the Hood River winter steelhead program was discontinued; and in 2010, the release of hatchery winter steelhead into the Upper Cowlitz and Cispus rivers was discontinued. In 2011, NMFS recommended removing these programs from the DPS. A Lewis River winter steelhead program was initiated in 2009, and in 2011, NMFS proposed that it be included in the DPS (NMFS 2011a).

healthier than their salmon counterparts, because of better habitat conditions in core steelhead production areas (Lower Columbia Fish Recovery Board 2010; NMFS 2013).

Limiting Factors include the following (NMFS 2013; NOAA Fisheries 2011):

- Degraded estuarine and nearshore marine habitat resulting from cumulative impacts of land use and flow management by the Columbia River hydropower system.
- Degraded freshwater habitats; including floodplain connectivity and function, channel structure and complexity, riparian areas, recruitment of large wood, stream substrate, stream flow, and water quality. The degradation is mainly the result of cumulative impacts from agriculture, forestry, and development.
- Reduced access to spawning and rearing habitat mainly as a result of tributary hydropower projects and lowland development.
- Avian and marine mammal predation in the lower mainstem Columbia River and estuary.
- Hatchery-related effects.
- Modified flow regimes that have altered the temperature regime, the estuarine food web, and ocean productivity.
- Reduced access to off-channel rearing habitat in the lower Columbia River.
- Reduced productivity resulting from sediment and nutrient-related changes in the estuary.
- Juvenile fish stranding from ship wakes.
- Contaminants in the water that affect fish health and reproduction.

2.2.2. Status of the Critical Habitats

This section describes 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 areas. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (*e.g.*, sites with conditions that support spawning, rearing, migration and foraging).

For salmon and steelhead, the NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support[10]. The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of 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 the fact that it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

[10] 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).

The physical or biological features of freshwater spawning and incubation sites include water flow, quality and temperature conditions and suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring.

The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

Willamette-Lower Columbia Recovery Domain. Critical habitat was designated in the Willamette-Lower Columbia (WLC) rivers recovery domain for LCR Chinook salmon, LCR steelhead, CR chum salmon, and is proposed for LCR coho salmon. Lake River has been identified as critical habitat for CR chum and proposed for LCR coho salmon. The critical habitats for Chinook salmon, steelhead, and eulachon have been designated in the Columbia River mainstem but not in Lake River.

The Columbia River estuary has lost a significant amount of the tidal marsh and tidal swamp habitats that are critical to juvenile salmon and steelhead, particularly small or ocean-type species (Bottom *et al.* 2005; Fresh *et al.* 2005; NMFS 2011b; NMFS 2013). Edges of marsh areas provide sheltered habitats for juvenile salmon and steelhead where food, in the form of amphipods or other small invertebrates that feed on marsh detritus, is plentiful, and larger predatory fish can be avoided. Historically, floodwaters of the Columbia River inundated the margins and floodplains along the estuary, allowing juvenile salmon and steelhead access to a wide expanse of low-velocity marshland and tidal channel habitats. In general, the floodplains became habitat for salmon and steelhead during high river flows or flood tides. Sherwood *et al.* (1990) estimated that the Columbia River estuary lost 20,000 acres of tidal swamps, 10,000 acres of tidal marshes, and 3,000 acres of tidal flats between 1870 and 1970. This study further estimated an 80% reduction in emergent vegetation production and a 15% decline in benthic algal production.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

The current state of the lower Columbia River and the habitat in the action area has been adversely affected by a broad array of human activities including; population growth, urbanization, roads, diking, fishing, flood control, irrigation dams, pollution, municipal and industrial water use, introduced species, and hatchery production (NRC 1996). In addition, salmon populations have been strongly affected by ocean and climate conditions. The quality and

quantity of habitat in many Columbia River basin watersheds has declined dramatically in the last 150 years, especially the loss of floodplain connectivity, and feeding and resting habitat for juvenile salmonids in marshland and tidal channel habitats (Bottom *et al.* 2005).

Water quality throughout the action area is also degraded from commercial and residential contaminants and stormwater pollutants. Urban, industrial, and agricultural practices across the basin contribute multiple pollutants at levels harmful to aquatic life. In general, habitat degradation has reduced the quality of important rearing and migration habitat for salmon and steelhead in the action area. Survival through this reach has declined for both juveniles and adults, resulting in reduced population productivity and abundance. The only populations affected by this proposed action are LCR Chinook salmon, LCR steelhead, and LCR coho salmon, particularly those populations that pass through the action area to spawn in upstream tributaries including Salmon Creek, Whipple Creek, and Burnt Bridge Creek.

The Lake River project action area is located at river mile (RM) 3.5 (approximately RM 90 of the adjacent Columbia River). Individuals of ESA-listed salmon and steelhead migrate through the action area. Adult salmonids will move upstream and through the action area within hours, if not within minutes. Juvenile salmonids, depending on the species and age of the fish, may linger longer within the action area but there is limited habitat to attract and hold them in the area. Thus, the action area primarily serves as a migration corridor for all life stages.

It is unlikely there will be substantial additional development on Lake River. The BNSF rail line occupies nearly the entire right bank of the River, while the Ridgefield Wildlife Refuge is on the left bank.

Lake River originates at the outflow of Lake Vancouver, approximately eight miles above the project action area. Lake Vancouver is less than 15 feet deep and fed by Burnt Bridge Creek, which is controlled by tide gates. Burnt Bridge Creek flows through residential areas in the city of Vancouver and contributes pollutants to Lake Vancouver. Toxic algal blooms caused by pollutants and stagnant water may close recreational use of the Lake during the summer. At times, low water levels in Lake Vancouver may reverse flows from Lake River back into Lake Vancouver.

Lake River is in the Salmon Creek watershed (1708000109). This watershed was rated as having high conservation value for Chum salmon by the CHART (NOAA Fisheries 2005). The CHART for LCR coho salmon rated this watershed as having moderate conservation value.[11]

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR

[11] Draft CHART report available at (accessed 1/16/2015): http://www.westcoast.fisheries.noaa.gov/publications/protected_species/salmon_steelhead/critical_habitat/2013_chartreport2_proposedch_pssteelhead_lcrcoho.pdf

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.

2.4.1 Species Effects

The proposed action will affect LCR Chinook salmon, LCR coho salmon, LCR steelhead, LCR coho salmon CH and CR chum salmon CH. The effects of replacing bridges has been analyzed in detail in SLOPES for Stormwater, Transportation, and utilities and is also summarized below (NMFS 2014).

Construction Noise. Heavy equipment will be operated from shore and a work trestle. Much of the in-water activities will be installing and removing support piles and removing existing creosote-treated piles. Proofing the hollow steel support piles will exceed levels that are likely to injure or kill fish within the action area.

Underwater noise thresholds for fish were developed by the Fisheries Hydroacoustic Work Group (2008) and provide guidance on expected impacts on fish from elevated noise exposure. The current injury thresholds for fish are as follows:

- 206 decibel (dB) peak
- 187 dB cumulative sound exposure level (SEL) for fish > 2 grams
- 183 dB cumulative SEL for fish < 2 grams

Listed fish less than two grams are not likely to occur in the action area. Chinook salmon, coho salmon, and steelhead juveniles, if present, would be larger than two grams as they migrate through the action area. Adult salmonids will not be present during the in-water work because their migration times do not coincide with the proposed work windows.

Using the Practical Spreading Loss calculator, underwater noise will exceed the injury threshold up to 680 feet from the source of pile proofing. Juvenile salmonids within that area will be killed or injured and perhaps die later. However, due to the small amount of habitat affected and the modest condition of this habitat, we expect only a very small number of juveniles will be exposed to this noise.

Water Quality. There is a small potential for short-term water quality degradation but water quality will improve over the long-term. Existing creosote-treated piles will be removed. The wood preservatives in the mud adjacent to the piles will be released into the water column plumes as the piles are extracted. Juvenile salmonids and benthic organisms occurring within the expected turbid plumes will be exposed to contaminants.

The primary effect from removing the piles will be the suspension of sediments, which may result in harmful levels of turbidity and the release of contaminants in the water column. This sediment may also hamper respiratory function, potentially stalling out-migrating salmon while waiting for the water to clear. Increased turbidity may also hinder juvenile foraging ability or affect the distribution of prey species. The effects of increased turbidity on salmonids is analyzed in detail in the SLOPES opinions referenced above.

Conducting work during low flows will reduce the sediment impacts in the project area. However, Lake River has a low gradient and suspended sediments are expected to settle-out within several minutes and up to 300 feet from the source Thus, exposure to turbid plumes will be short-term and limited in area. As with impacts from noise, only a small number of juvenile fish are likely to be exposed to increased turbidity. Removing the existing piles will provide a long-term improvement to water quality by eliminating a source of pollutants from the leaching of creosote-treated wood piles.

Stormwater. All stormwater runoff from the new bridge will be directed landward to infiltrate into forested permeable soils or open grass fields. Stormwater will not directly discharge into Lake River and thus will have no impact on water quality in Lake River.

Predation. Predation has been identified as one of the limiting factors for all salmonid species in the Columbia River basin (NMFS 2008b). Increased predator abundance may increase due to climate change (ISAB 2007). The ISAB recommended reducing predation by introducing piscivorous species to mitigate these anticipated effects. Native predator species such as northern pike minnow (*Ptychocheilus oregonensis*) and introduced predators such as largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), black crappie (*Pomoxis nigromaculatus*), white crappie (*P. annularis*), and walleye (*Stizostedion vitreum*) may use habitat created by overwater structures such as piers (Ward and Nigro 1992, Ward *et al.* 1994, Poe *et al.* 1991, Beamesderfer and Rieman 1991, Rieman and Beamesderfer 1991, and Collis *et al.* 1995).

Phillips (1990) and Carrasquero (2001) report that smallmouth and largemouth bass have a strong affinity to structures and tend to forage and spawn in the vicinity of piers and pilings.

Largemouth and smallmouth bass are common predators of juvenile salmonids. Major habitat types used by largemouth bass include vegetated areas, open water and areas with cover such as docks and submerged trees (Mesing and Wicker 1986). During the summer, bass prefer pilings, rock formations, areas beneath moored boats, and alongside docks. Colle *et. al.* (1989) found that in lakes lacking vegetation, largemouth bass distinctly preferred habitat associated with piers, a situation analogous to slack water areas of the Columbia River. Bevelhimer (1996), in studies on smallmouth bass, indicates that ambush cover and low light intensities create a predation advantage for predators and can also increase foraging efficiency.

Light plays an important role in predation. Prey species are better able to see predators under high light intensity, thus providing the prey species with an advantage (Hobson 1979, Helfman 1981). Petersen and Gadomski (1994) found that predator success was higher at lower light intensities. Prey fish lose their ability to school at low light intensities, making them vulnerable to predation (Petersen and Gadomski 1994). Howick and O'Brien (1983) found that in high light intensities prey species (bluegill) can locate largemouth bass before they are seen by the bass. However, in low light intensities, the bass can locate the prey before they are seen. Walters *et al.* (1991) indicates that high light intensities may result in the increased use of shade-producing structures. Helfman (1981) found that shade, in conjunction with water clarity, sunlight and vision, is a factor in attraction of temperate lake fishes to overhead structure. In the case of the proposed bridge, the increased area of shade from the bridge deck will incrementally increase

habitat for predatory fish that can prey on listed juveniles migrating through the action area. A small portion of the increased area will be offset by increasing the height of the deck above the water by several feet. It is not possible to exactly determine how many predatory fish may reside under the bridge but it is likely a very small increase.

In addition to piscivorous predation, overwater structures (tops of piles and hand rails) provide perching platforms for avian predators, such as double-crested cormorants (*Phalacrocorax auritis*), from which they can launch feeding forays or dry plumage. Krohn *et al.* (1995) indicate that cormorants can reduce fish populations in forage areas, thus possibly affecting adult returns as a result of smolt consumption. Because their plumage becomes wet when diving, cormorants may spend considerable time drying out feathers (Harrison 1983) on pilings and other structures near feeding grounds (Harrison 1984). However, with or without anthropogenic structures to rest on, cormorants would find natural roosting habitat in nearby trees overlooking Lake River. Therefore, it is not possible to exactly discern how much the Lake River Bridge contributes to avian predation on listed fish though the impacts are likely low because juvenile salmon and steelhead are not expected to congregate around the bridge, which limits forage success for the birds.

Summary of Effects on Listed Species. Considering the low abundance and short residence time of juvenile ESA-listed salmonids in the action area, any effects of the continued perpetuation of predation, water quality degradation, and noise and physical disturbance to the growth, survival, and distribution of ESA-listed salmonids in the action area will be small and isolated.

Overall, the potential adverse effects are limited to injurious underwater noise during pile proofing, turbid plumes and the release of contaminates while removing creosote-treated piles, and a low level of fish and avian predation. These effects are unlikely to be significant at the population scale.

The proposed action will have no effect on the long-term abundance trends of any populations addressed by this opinion. In addition, there will be long-term beneficial effects of the proposed action from the removal of creosote-treated wood floats.

2.4.2 Critical Habitat Effects

The proposed action will affect designated and proposed critical habitat for CR chum salmon and LCR coho salmon, respectfully. Identified PCEs for migration and rearing will not significantly change. The proposed action will temporarily increase turbidity up to 300 feet downstream of the source and disturb benthic habitat and rearing space. Turbid plumes and in-water disturbances will be short-lived and will quickly recover to full function in a short time frame.

The PCEs for migration of adult and juvenile salmonids include the following:

- streams free of obstructions,
- containing natural cover,
- with adequate depth and flows, and with
- cool water free of toxic pollutants.

The proposed action will increase turbidity up to 300 feet from the source and underwater noise up to 1,600 feet downstream and 1,900 feet upstream of the bridge. Removing 108 creosote-treated piles from within the OHWM will benefit listed critical habitats by removing a source of pollutants and a cover for predatory species. The support piers will continue to occupy rearing and migratory habitat that might otherwise be used by listed species. The wider bridge deck will cast a larger shade footprint on the River than the existing structure; thus, increasing cover for predators. The features of the new bridge will continue to attract predatory fish and avian species that will kill or injure juvenile listed species.

The proposed project will not decrease stream depth or otherwise effect flows and will not affect the water temperature. The proposed action will not cause significant loss of critical habitat quality in the action area.

Interrelated actions in this project include removing an additional six creosote-treated stub piles in the River near the bridge in addition to those piles supporting the existing bridge. This interrelated action will cause temporary turbid plumes but will have long-term beneficial effects on listed species and habitats.

2.5 Cumulative Effects

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

The BNSF railroad will continue to maintain its infrastructure and operate trains immediately parallel to most of Lake River. Train engines emit exhaust pollutants and rail cars can leak many types of materials, some of which may migrate into Lake River. Derailments could have significant negative effects on the riparian habitat and could also fall directly into Lake River itself. These cumulative effects are likely to cause some habitat quality in the action area to remain static over time.

The Ridgefield Wildlife Refuge is not likely to expand its infrastructure or use characteristics since, by design, it is intended to preserve wildlife habitat. We expect the general habitat characteristics and quality in the action area to remain stable.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed

species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species.

The NMFS analyzed the current status of the species, the condition of the critical habitats, the cumulative effects, and the baseline conditions. We also considered the effects of the proposed action on the species and their habitats, which include the short-term increases in turbidity and underwater noise, and continuation of fish and avian predation. We concluded that the proposed project has the potential to adversely affect ESA-listed fish and their designated critical habitats. However, the effects of the proposed action will not be significant enough to have any impact on the abundance or productivity of the affected populations as explained further below.

For the ESA-listed species:

- Most populations of LCR Chinook salmon, LCR coho salmon, LCR steelhead are at a low level of persistence.
- The current environmental baseline has been degraded by restricted natural flows, reduced water quality from chemical pollution, loss of functioning floodplains and secondary channels, and loss of vegetated riparian areas and associated shoreline cover. The significance of the degradation has resulted in the loss of spawning and rearing habitats, the loss of migratory pathways, and increased predation.
- The proposed action will double the bridge deck width from the existing 16 feet to 32 feet that perpetuates a potential risk of predation of juvenile salmonids. However, the project also reduces predator cover habitat by removing at least 108 piles and replacing them with two, eight-foot diameter drilled shafts within the OHWM. The two new shafts provide less diverse and fewer hiding opportunities for predators. The new bridge will be several feet higher above the water.
- Underwater noise from impact pile proofing the work trestle support piles is expected to exceed the injury threshold for juvenile Chinook salmon, coho salmon, and steelhead that occur in the action area. However, this action will be restricted to June 1- September 15 to avoid and minimize species presence and exposure to sound pressure levels that may harm or kill them.
- Cumulative effects from the BNSF railroad and the Refuge operations will likely have a neutral to slightly negative impact on population abundance trends in the future.

Even with the poor status of the populations and degraded baseline, the proposed action will not affect abundance, distribution, diversity, or productivity of any of the ESA-listed species or further degrade the baseline or their limiting factors. The effects of the action are too minor to have any measureable impact on the affected populations. Therefore, the proposed action will not reduce the productivity or survival of the affected populations even when combined with a degraded environmental baseline and additional pressure from cumulative effects.

For critical habitat:

- The PCEs within the action area are currently in a moderately-functioning state providing passable migratory routes. However, altered flow regimes will reduce habitat access. There will continue to be limited food production and a moderate degradation of water quality from chemical pollution. There will also be reduced cover from the loss of riparian vegetation, and reduced secondary and floodplain habitats.

- The existing baseline conditions include reduced floodplain and secondary channel connectivity and a general degradation of water quality, have affected the capacity of the habitat to support ESA-listed fish, and contributes to the low abundance of ESA-listed fish and their restricted distribution.
- The proposed action will continue perpetuate some level of predation because of the in-water piers and wider bridge deck.
- The project will not adversely affect riparian vegetation, water temperature, or available forage opportunities.
- Cumulative effects from basin-wide activities (such as reduced water quality) are likely to have a neutral to negative impact on the quality of critical habitat PCEs.

As a whole, the critical habitat for migration and rearing is partially functioning under the current baseline in the action area. Given the low potential of the proposed action to affect PCEs for migration and rearing, and the very minor effects to the forage PCE, the proposed action is not likely to reduce the quality or conservation value of designated or proposed critical habitats in the action area.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitats, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of LCR Chinook salmon, and LCR steelhead, or destroy or adversely modify critical habitats for LCR coho salmon and CR chum salmon.

You may ask the NMFS to adopt the conference opinion as a biological opinion when critical habitat for LCR coho salmon is designated. The request must be in writing. If we review the proposed action and find there have been no significant changes to the action that would alter the contents of the opinion and no significant new information has been developed (including during the rulemaking process), we may adopt the conference opinion as the biological opinion on the proposed action and no further consultation will be necessary.

2.8 Incidental Take Statement

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

prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

2.8.1 Amount or Extent of Take

Actions necessary to complete the proposed Lake River Bridge replacement will take place within the OHWM when juvenile individuals of LCR Chinook salmon, LCR coho salmon, and LCR steelhead are likely to be present. Incidental take caused by the adverse effects of the proposed action will include exposure to injurious underwater noise, vulnerability to predatory fish and birds associated with shaded areas under the bridge deck and adjacent to the bridge piers, and avoidance and vulnerability to turbidity and release of pollutants while removing creosote-treated piles.

The NMFS cannot precisely predict the number of fish that are reasonably certain to be injured or killed if their habitat is modified or degraded by the proposed action. In such circumstances, the NMFS cannot provide a number of individuals that would be killed or injured by the proposed action. Here, the best available indicators of take are the amount of habitats affected where the ESA-listed species may occur. Thus, the area of affected habitat is used as a surrogate to define take.

Turbidity from extracting piles may exceed ambient levels up to 300 feet downstream of the source. If increased turbidly is detected above background levels more than 300 feet downstream, the extent of take will be exceeded.

Underwater noise from impact pile-driving will exceed ambient levels across the width of the River and up to 1,600 feet downstream and 1,900 feet upstream covering approximately 12.20 acres of benthic habitat. Impact proofing the piles will be restricted to only occur from June 1 to September 15 and will be completed within 47 total days. Impact proofing is expected to kill or injure fish within 680 feet of the source. Underwater noise will be monitored using a hydrophone, so it will be obvious if these levels are exceeded.

Under the terms and conditions, there is a requirement to monitor and report turbidity and underwater noise with respect to this extent of surrogate take.

Take may also occur because of the increased area of shade from a wider bridge deck and resulting predation. Increased shade positively correlates to increased habitat for predatory fish. The existing bridge shades approximately 4,000 square feet of the Lake River channel. The new bridge deck shades approximately 8,000 square feet: a net increase of 4,000 square feet. The new bridge is at least 15 feet higher above the River, which will incrementally offset the disorienting effects of a sharp line from shading, compared to existing conditions. Additionally, the new bridge is 200 feet longer than the old bridge; thus, increasing perch habitat for avian predators. If any more than 8,000 feet is shaded by the new bridge, the extent of take will be exceeded.

2.8.2 Effect of the Take

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

2.8.3 Reasonable and Prudent Measures

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

1. Minimize incidental take from turbidity.
2. Minimize incidental take from underwater sound effects from pile-driving.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the FHWA or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The FHWA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following term and condition implements reasonable and prudent measure 1 (turbidity): Monitor turbidity levels in a line downstream (depending on tidal direction) of in-water work to ensure that the turbidity does not exceed five nephelometric turbidity units above background at 300 feet from the source. The FHWA shall report the results of the turbidity monitoring to the NMFS within 60 days of the completion of each in-water work season.

2. The following term and condition implements reasonable and prudent measure 2 (underwater noise):
   a) Use a vibratory hammer to drive piles to the maximum extent practicable before completing the task with an impact hammer;
   b) Impact proofing is restricted to only occur June 1 to September 15.
   c) Have a minimum 12-hour rest period between daily limits of impact pile driving;
   d) Immediately stop impact pile-driving if distressed fish are observed. Contact the NMFS immediately to discuss additional protective measures.
   e) Monitor underwater noise with standard protocol methods to identify the levels of sound propagation
   f) Submit a hydroacoustic monitoring plan to the NMFS for review a minimum of 45 days before impact pile-driving. The hydroacoustic monitoring plan must be prepared and implemented by a proven expert in the field of underwater acoustics and data collection and shall include the name and qualifications of the biologist to be present during impact pile-driving.

g) Provide the results of the hydroacoustic monitoring to the NMFS within 60 days of the completion of each season of construction.

2.9 Conservation Recommendations

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

The NMFS recommends that the FHWA seek opportunities to restore riparian habitats and increase channel complexity along Lake River and its tributaries to enhance juvenile rearing habitat.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Lake River Bridge replacement project.

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

2.11 "Not Likely to Adversely Affect" Determinations

The NMFS does not anticipate the proposed action will adversely affect CR chum salmon or eulachon. These species are not documented to occur in the action area or upstream tributaries to Lake River. There are no physical barriers to chum salmon and eulachon straying into the action area; however, there is no established populations and minimal quality habitat to attract them. Impact pile-driving will occur from June 1 to September 15 when adult chum salmon and eulachon have not yet entered the Columbia River and juveniles have already out-migrated. Therefore, we conclude that any effects to these species will be discountable.

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

Section 305(b) of the MSA directs Federal agencies to consult with the NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct

or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires the NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the FHWA and descriptions of EFH for Pacific coast salmon (PFMC 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

As part of the information provided in the request for ESA concurrence, the FHWA determined that the proposed action may have an adverse effect on EFH designated for Chinook salmon and coho salmon. The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document and the NMFS concurs with the findings in the EFH assessment.

3.2 Adverse Effects on Essential Fish Habitat

Based on information provided by the action agency and the analysis of effects presented in the ESA portion of this document, the NMFS concludes that the proposed action will have adverse effects on EFH designated for Chinook salmon and coho salmon. The effects of the proposed action on EFH are the same as those described above in the ESA portion of this document and the NMFS concurs with the findings in the EFH assessment.

3.3 Essential Fish Habitat Conservation Recommendations

The NMFS recommends that the FHWA seek opportunities to restore riparian habitats and increase channel complexity along Lake River and its tributaries to enhance juvenile rearing habitat.

Fully implementing this EFH conservation recommendation would protect, by avoiding or minimizing the adverse effects described in Section 3.2, above, approximately 20 acres of designated EFH for Pacific coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, FHWA must provide a detailed response in writing to the NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless the NMFS and the federal agency have agreed to use alternative time frames for the federal agency

response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with the NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

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

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the FHWA-Western Federal Lands division. An individual copy of this opinion was provided to the FHWA. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Beamesderfer, R.C., and B.E. Rieman. 1991. Abundance and Distribution of Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:439-447.

Bevelhimer, M.S. 1996. Relative importance of temperature, food, and physical structure to habitat choice by smallmouth bass in laboratory experiments. Transactions of the American Fisheries Society 125:274-283.

Bindoff, N.L., J. Willebrand, V. Artale, A, Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quere, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan. 2007. Observations: Oceanic Climate Change and Sea Level. P. 385-432 in: Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H. L. Miller (eds.). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Bottom, D.L., C.A. Simenstad, J. Burke, A.M. Baptista, D.A. Jay, K.K. Jones, E. Casillas, and M.H. Schiewe. 2005. Salmon at river's end: The role of the estuary in the decline and recovery of Columbia River salmon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-68. 246 p.

Busch, S., P. McElhany, and M. Ruckelshaus. 2008. A comparison of the viability criteria developed for management of ESA listed Pacific salmon and steelhead. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle. http://www.nwfsc.noaa.gov/trt/trt_documents/viability_criteria_comparison_essay_oct_10.pdf

Carrasquero, J. 2001. Overwater structures: Freshwater issues. White paper submitted to Washington Department of Fish and Wildlife, Washington Department of Ecology and Washington Department of Transportation. Olympia, Washington.

Colle, D.E., R.L. Cailteux, and J.V. Shireman. 1989. Distribution of Florida largemouth bass in a lake after elimination of all submersed aquatic vegetation. North American Journal of Fisheries Management 9:213-218.

Collis, K., R.E. Beaty, and B.R. Crain. 1995. Changes in Catch Rate and Diet of Northern Squawfish Associated With the Release of Hatchery-Reared Juvenile Salmonids in a Columbia River Reservoir. North American Journal of Fisheries Management 15:346-357.

Fisheries Habitat Working Group. 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities. Memorandum of Agreement between NOAA Fisheries' Northwest and Southwest Regions; USFWS Regions 1 and 8; California, Washington, and Oregon Departments of Transportation; California Department of Fish and Game; and Federal Highways Administration. June 12, 2008.

Ford, M.J., (editor). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-113. 281 p.

Fresh, K.L., E. Casillas, L.L. Johnson, and D.L. Bottom. 2005. Role of the estuary in the recovery of Columbia River Basin salmon and steelhead: An evaluation of the effects of selected factors on salmonid population viability. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-69. 105 p.

Harrison, P. 1983. Seabirds: an Identification Guide. Houghton Mifflin Company. Boston. 448 p.

Harrison, C.S. 1984. Terns Family Laridae Pages 146-160 in D. Haley, D. editor. Seabirds of eastern North Pacific and Arctic waters. Pacific Search Press. Seattle. 214 p.

Helfman, G.S. 1981. The advantage to fishes of hovering in shade. Copeia. 1981(2):392-400.

Hobson, E.S. 1979. Interactions between piscivorous fishes and their prey. Pages 231-242 in R. H. Stroud and H. Clepper, editors. Predator-Prey Systems in Fisheries Management. Sport Fishing Institute, Washington, D.C.

Howick, G.L., and W.J. O'Brien. 1983. Piscivorous feeding behavior of largemouth bass: an experimental analysis. Transactions of the American Fisheries Society 112:508-516.

ISAB (Independent Scientific Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. ISAB Climate Change Report, ISAB 2007-2, Northwest Power and Conservation Council, Portland, Oregon.

Krohn, W.B., R.B. Allen, J.R. Moring, and A.E. Hutchinson. 1995. Double-crested cormorants in New England; population and management histories. Pages 99-109 in The Double-crested Cormorant: biology, conservation and management (D.N. Nettleship and D.C. Duffy, editors) Colonial Waterbirds 18 (Special Publication 1).

Lower Columbia Fish Recovery Board. 2010. Washington lower Columbia salmon recovery & fish and wildlife subbasin plan. Olympia, Washington. May 28. http://www.lcfrb.gen.wa.us/Recovery%20Plans/RP%20Frontpage.htm.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability status of Oregon salmon and steelhead populations in the Willamette and Lower Columbia Basins. Prepared for Oregon Department of Fish and Wildlife and National Marine Fisheries Service, Portland, Oregon.

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

Mesing, C.L., and A.M. Wicker. 1986. Home range, spawning migrations, and homing of radio-tagged Florida largemouth bass in two central Florida lakes. Transactions of the American Fisheries Society 115:286-295.

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

NMFS. 2009. Middle Columbia River steelhead distinct population segment ESA recovery plan. November 30. http://www.nwr.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/interior_columbia/middle_columbia/mid-c-plan.pdf.

NMFS. 2011a. 5-year review: summary and evaluation of Lower Columbia River Chinook, Columbia River chum, Lower Columbia River coho, and Lower Columbia River steelhead. National Marine Fisheries Service. Portland, Oregon.

NMFS. 2011b. Columbia River estuary ESA recovery plan module for salmon and steelhead.Prepared for NMFS by the Lower Columbia River Estuary Partnership (contractor) and PC Trask & Associates, Inc. (subcontractor). National Marine Fisheries Service, Northwest Region. Portland, Oregon. January. http://www.nwr.noaa.gov/publications/recovery_planning/salmon_steelhead/domains/willamette_lowercol/lower_columbia/estuary-mod.pdf.

NMFS. 2013. ESA Recovery Plan for Lower Columbia River Coho Salmon, Lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and Lower Columbia River Steelhead. National Marine Fisheries Service, Northwest Region. June.

NMFS. 2014. Reinitiation of the Endangered Species Act Section 7 Programmatic Conference and Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for Revisions to Standard Local Operating Procedures for Endangered Species to Administer Maintenance or Improvement of Stormwater, Transportation or Utility Actions Authorized or Carried Out by the U.S. Army Corps of Engineers in Oregon (SLOPES for Stormwater, Transportation or Utilities). Portland OR, 191 p.

NOAA Fisheries. 2005. Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Oceanic and Atmospheric Administration, NMFS-Protected Resources Division. Portland, Oregon.

NOAA Fisheries. 2011. Biennial report to Congress on the recovery program for threatened and endangered species October 1, 2008 – September 30, 2010. NOAA-National Marine Fisheries Service. Washington, D.C.

NRC. 1995. Science and the Endangered Species Act. Committee on Scientific Issues in the Endangered Species Act, Board on Environmental Studies and Toxicology, Commission on Life Sciences. National Research Council, National Academy Press. Washington, D.C.

ODFW. 2010. Lower Columbia River conservation and recovery plan for Oregon populations of salmon and steelhead. Oregon Department of Fish and Wildlife. Salem, Oregon.

Petersen, J.M., and D.M. Gadomski. 1994. Light-Mediated Predation by Northern Squawfish on Juvenile Chinook Salmon. Journal of Fish Biology 45 (supplement A), 227-242.

Pflug, D.E., and G.B. Pauley. 1984. Biology of Smallmouth Bass (Micropterus dolomieui) in Lake Sammamish, Washington. Northwest Science 58(2):119-130.

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

PFMC. 1999. Description and identification of essential fish habitat, adverse impacts and recommended conservation measures for salmon. Appendix A to Amendment 14 to the Pacific Coast Salmon Plan. Pacific Fishery Management Council, Portland, Oregon. March.

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

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

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

Phillips, S.H. 1990. A guide to the construction of freshwater artificial reefs. Sportfishing Institute. Washington D.C. 24 p.

Poe, T.P, H.C. Hansel, S. Vigg, D.E. Palmer, and L.A. Prendergast. 1991. Feeding of Predaceous Fishes on Out-Migrating Juvenile Salmonids in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:405-420.

Rieman, B.E., and R.C. Beamesderfer. 1991. Estimated Loss of Juvenile Salmonids to Predation by Northern Squawfish, Walleyes, and Smallmouth Bass in John Day Reservoir, Columbia River. Transactions of the American Fisheries Society 120:448-458.

Scheuerell, M.D., and J.G. Williams. 2005. Forecasting climate-induced changes in the survival of Snake River spring/summer Chinook salmon (*Oncorhynchus tshawytscha*). Fisheries Oceanography 14:448-457.

Sherwood, C.R., D.A. Jay, R.B. Harvey, P. Hamilton, and C.A. Simenstad. 1990. Historical changes in the Columbia River estuary. Progress in Oceanography 25(1-4):299-352.

USGCRP. 2009. Global climate change impacts in the United States. U.S. Global Change Research Program. Washington, D.C. 188 p. http://waterwebster.org/documents/climateimpacts- report.pdf.

Wainwright, T.C., M.W. Chilcote, P.W. Lawson, T.E. Nickelson, C.W. Huntington, J.S. Mills, K.M.S. Moore, G.H. Reeves, H.A. Stout, and L.A. Weitkamp. 2008. Biological recovery criteria for the Oregon Coast coho salmon evolutionary significant unit.

Walters, D.A., W.E. Lynch Jr., and D.L. Johnson. 1991. How depth and interstice size of artificial structures influence fish attraction. North American Journal of Fisheries Management 11:319-329.

Ward, D.L., and A.A. Nigro. 1992. Differences in Fish Assemblages Among Habitats Found in the Lower Willamette River, Oregon: Application of and Problems With Multivariate Analysis. Fisheries Research 13:119-132.

Ward, D.L., A.A. Nigro, R.A. Farr, and C.J. Knutsen. 1994. Influence of Waterway Development on Migrational Characteristics of Juvenile Salmonids in the Lower Willamette River, Oregon. North American Journal of Fisheries Management 14:362-371.

Zabel, R.W., M.D. Scheuerell, M.M. McClure, and J.G. Williams. 2006. The interplay between climate variability and density dependence in the population viability of Chinook salmon. Conservation Biology 20(1):190-200.