



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

Refer to NMFS No.:
WCR-2018-10298

March 14, 2019

Daniel M. Mathis
Federal Highway Administration
Suite 501 Evergreen Plaza
711 South Capital Way
Olympia, Washington 98501-1284

Re: Endangered Species Act Section 7 Formal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the City of Kenmore West Sammamish Bridge Replacement Project, King County, Washington, Federal Aid #: BRM-2411 (003), Sixth Field HUC: 171100120304 – Bear Creek-Sammamish River.

Dear Mr. Mathis:

Thank you for your letter of July 12, 2018, requesting reinitiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for Federal Highway Administration (FHWA) funding to the City of Kenmore, Washington for the replacement of the West Sammamish Bridge.

The enclosed document contains the biological opinion (Opinion) prepared by NMFS pursuant to section 7(a)(2) of the ESA to assess the effects of the proposed action. In the Opinion, NMFS concluded that the proposed action is likely to adversely affect but not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon and PS Sound steelhead. NMFS also concluded that the proposed action is likely to adversely affect, but is not likely to result in the destruction or adverse modification of designated critical habitat for PS Chinook salmon.

As required by section 7 of the ESA, NMFS has provided an incidental take statement (ITS) with the Opinion. The ITS describes reasonable and prudent measures (RPM) NMFS considers necessary or appropriate to minimize the impact of incidental take associated with this action, and sets forth nondiscretionary terms and conditions that the COE must comply with to meet those measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of listed species.

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NMFS also reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast Salmon. Therefore, we have included the results of that review in Section 3 of this document.

Please contact Donald Hubner in the North Puget Sound Branch of the Oregon/Washington Coastal Office at (206) 526-4359, or by electronic mail at Donald.Hubner@noaa.gov if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

A handwritten signature in blue ink, appearing to read "Kim W. Kratz".

Kim W. Kratz, Ph.D.
Assistant Regional Administrator
Oregon Washington Coastal Office

cc: Lindsey L. Handel, FHWA
Melanie Vance, WSDOT
Karen Walter, Muckleshoot Indian Tribe
Matthew J. Baerwalde, Snoqualmie Indian Tribe

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

for the

City of Kenmore West Sammamish Bridge Replacement Project
King County, Washington
(Sixth Field HUC: 171100120304)

NMFS Consultation Numbers: WCR-2018-10298

Action Agency: Federal Highway Administration

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Chinook salmon (<i>Oncorhynchus tshawytscha</i>) Puget Sound (PS)	Threatened	Yes	No	Yes	No
steelhead (<i>O. mykiss</i>) PS	Threatened	Yes	No	N/A	N/A


N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

Affected Essential Fish Habitat (EFH) and NMFS' Determinations:

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	No

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:



 Kim W. Kratz, Ph.D
 Assistant Regional Administrator
 Oregon Washington Coastal Office

Date: March 14, 2019

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LIST OF ACRONYMS and ABBREVIATIONS

ADA – Americans with Disabilities Act
BA – Biological Assessment
BMP – Best Management Practices
CFR – Code of Federal Regulations
cfs – Cubic Feet per Second
dB – Decibel
DIP – Demographically Independent Population
DO – Dissolved Oxygen
DPS – Distinct Population Segment
DQA – Data Quality Act
EFH – Essential Fish Habitat
ESA – Endangered Species Act
ESU – Evolutionarily Significant Unit
fc – Foot-Candles
FHWA – Federal Highway Administration
HPA – Hydraulic Project Approval
HRM – Highway Runoff Manual
HUC – Hydrologic Unit Code
IESNA – Illuminating Engineering Society of North America
ITS – Incidental Take Statement
LWD – Large Woody Debris
LOC – Letter of Concurrence
mg/L – Milligrams per Liter
MPG – Major Population Group
MSA – Magnuson-Stevens Fishery Conservation and Management Act
NLAA – Not Likely to Adversely Affect
NMFS – National Marine Fisheries Service
NTU – Nephelometric Turbidity Units
OHWM – Ordinary High Water Mark
Opinion – Biological Opinion
OWCO – Oregon Washington Coastal Office
OWS – Over-Water Structure
PAH – Polycyclic Aromatic Hydrocarbons
PBF – Physical or Biological Feature
PCB – Polychlorinated Biphenyl
PCE – Primary Constituent Element
PFMC – Pacific Fishery Management Council
PS – Puget Sound
PSSTRT – Puget Sound Steelhead Technical Recovery Team
PSTRT – Puget Sound Technical Recovery Team
RL – Received Level
RM – River Mile
RPA – Reasonable and Prudent Alternative
RPM – Reasonable and Prudent Measure

SAV – Submerged Aquatic Vegetation
SEL – Sound Exposure Level
SL – Source Level
SPCC – Spill Prevention, Control, and Countermeasure
TSS – Total Suspended Sediment
VSP – Viable Salmonid Population
WCR – Westcoast Region (NMFS)
WDFW – Washington State Department of Fish and Wildlife
WSDOT – Washington State Department of Transportation

1. INTRODUCTION

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

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (Opinion) and incidental take statement 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). A complete record of this consultation is on file at the Oregon Washington Coastal Office (OWCO) in Lacey, Washington.

1.2 Consultation History

On April 14, 2016, NMFS received a letter from the Federal Highway Administration (FHWA) that requested formal consultation for the proposed action. That consultation was assigned the tracking number WCR-2016-4525. On May 9, 2016, NMFS issued an informal consultation letter of concurrence (LOC) to the FHWA with our determination that the proposed action is not likely to adversely affect (NLAA) ESA-listed species and critical habitats, and that the proposed action would not adversely affect essential fish habitat (EFH) that was designated under the MSA. The NMFS NLAA determination was based largely on the expectation that it would be extremely unlikely that PS Chinook salmon and PS steelhead would be present within the action area during the proposed in-water work window.

During an interagency meeting on April 10, 2018, the FHWA received information that reinforced their expectation that PS Chinook salmon were likely to be adversely affected by their proposed action, which triggered the need to reinitiate consultation. On July 12, 2018, the FHWA requested to reinitiate formal consultation with NMFS for the proposed action. However, the consultation request was submitted while important project details were still in flux, and numerous phone calls and e-mails were exchanged between NMFS and FHWA's representative at Washington State Department of Transportation (WSDOT) to share project details.

The final plans for the bridge stormwater drainage plan were completed on November 13, 2018 (Perteet 2018). Although several information requests were made and responded to following that date, NMFS considers November 13, 2018 to be the date when all of the project information required for consultation was available, and that formal consultation was initiated on that date.

This Opinion is based on the review of the information and project drawings in the Biological Assessment (BA) for the project (Jacobs 2016); supplemental materials and responses to NMFS questions (Jacobs 2018; Perteet 2018; WSDOT 2019a-g); recovery plans, status reviews, and critical habitat designations for ESA-listed PS Chinook salmon and PS steelhead; published and unpublished scientific information on the biology and ecology of those species; and relevant scientific and gray literature (see Literature Cited).

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). “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).

The FHWA proposes to fund the City of Kenmore to replace an old two-lane bridge across the Sammamish River at about river mile 0.35 (Figure 1). The FHWA identified no actions that would be interrelated or interdependent with the proposed action. However, the new bridge would remain on the landscape for decades.



Figure 1. Google satellite photographs of the City of Kenmore West Sammamish Bridge Replacement Project site in King County, Washington. The left image shows the project site relative to Lake Washington and Puget Sound. The City of Seattle is visible to the southwest of the site. The right image shows the bridge and the Sammamish River where it enters the north end of Lake Washington.

Overview: The existing river crossing consists of two 2-lane pier-supported bridges. Southbound traffic uses the western bridge, which was built in 1938. Northbound traffic uses the eastern bridge, which was built in the 1970s. Under the proposed action, the City of Kenmore would replace the western bridge, conduct minor upper-structure work along the entire length of the eastern bridge, and preform upland road work along the entire length of 68th Avenue NE north and south of the bridge to and including the intersections at NE 170th Street and NE 175th Street (Jacobs 2016 and 2018).

Construction would include the use of heavy equipment and various handheld power tools, standard construction practices, and required compliance with appropriate best management practices (BMP). The project also includes mitigation work along both river banks near both ends of the bridge.

The existing west bridge is about 600 feet long and 30 feet wide, and is supported by 11 dual-column concrete piers. It has two car lanes that are each about 12.5 feet wide and a 5-foot wide sidewalk. The new bridge would be about 600 feet long and 50 feet wide, and be supported by 6 2-pile piers. It would have two car lanes that are about 17 feet wide, and a 16-foot wide bicycle and pedestrian path to meet current standards under the Americans with Disabilities Act (ADA).

The new bridge would include a stormwater treatment system with a filter media treatment module (modular wetland) installed under each end of the bridge. Stormwater runoff from the bridge would be collected and piped to the modules where it would pass through filter media, then be discharged through T-shaped diffusers installed 150 and 180 feet upland from the OHWM of the river for the northern and southern diffusers, respectively (Perteet 2018; WSDOT 2019a and d). The system is reportedly designed to remove 80% of TSS, 50% of total phosphorous, 30% of dissolved copper, 60% of dissolved zinc, and petroleum-based chemicals to satisfy state standards from runoff within design flows of 0.113 and 0.060 cubic feet per second (cfs), for the north and south modules respectively. However, runoff would bypass the filter media if it exceeds the design flow rates (WSDOT 2019d and e). The City has an annual storm water maintenance program that includes annual inspections, testing of the outfalls after the first year of the system goes on line, and adjustment, repair, or replacement as needed if the system is damaged or otherwise not performing as expected (WSDOT 2019d).

Construction would occur over 3 consecutive years (Jacobs 2016; WSDOT 2019a). Work would be done from shore, temporary trestles, and barges. During Year-1, the western half of the new bridge would be constructed along the west side of the existing west bridge. During Year-2, the existing west bridge would be demolished and replaced. During Year-3, minor superstructure work and upland roadwork would be done, and demobilization and mitigation work would be completed. The sequence of work is listed in more detail below.

A typical work week would run Monday through Friday, 7 am to 5 pm, but night work is highly likely, and could occur at any time over the life of the project. Construction lighting must comply with strict requirements for worker and work zone safety, but will be shielded and limited to the extent practicable. Also, the City has committed to coordinate with the Muckleshoot Indian Tribe to limit or halt nighttime construction during salmon migration seasons (WSDOT 2019a).

To reduce the potential for, and intensity of impacts on listed species and their habitat resources, the city's contractors would be required to comply with the Impact Avoidance and Minimization Measures, EFH Conservation Measures, and Fish Removal Protocol and Standards that are identified in the project BA (Jacobs 2016). Those measures include required use of an enclosed bubble curtain for impact driving of piles, and compliance with a Spill Prevention, Control, and Countermeasure (SPCC) plan. They also include work area isolation and fish salvage for in-water demolition and construction work. As described in more detail in the sequence of work below, workers would install a temporary isolation barrier east and south of the existing bridge

piers 6 through 11 on the north bank. They would also install temporary cofferdams around bridge piers that are within the main river channel. This work would be done in compliance with the WSDOT Fish Removal Protocol and Standards as identified in Appendix A of the applicant's BA. Further, they must also comply with the provisions identified in the project's Hydraulic Project Approval (HPA, WDFW 2018), and in-water work would be limited to July 1 through August 31 for the first two years, and July 16 through August 31 for the third year.

As compensation for some of the expected impacts of this project, the city would remove debris, install large woody debris (LWD), and plant native vegetation at the project site. During construction, the City would remove about 190 derelict timber piles, derelict timber cofferdams from around 6 pier columns, and about 9 pieces of concrete debris from the river and from the wetland beneath and east of the north end of the bridge (Wetland A). All derelict timber is believed to be creosote-treated. After project construction is complete, the City would install large woody debris (LWD), and plant native vegetation. They would install five pieces of LWD in Wetland A. They would install three pieces of LWD and plant 14 native trees near the riverbank within the wetland west of the boat launch parking area (Wetland B) west of the southern end of the bridge. They would also remove invasive species and plant native shrubs. Southeast of the bridge, they would plant 114 native trees in Rhododendron Park, with 100 of those trees planted close to the riverbank. All LWD will be installed in the dry. Two access routes would be constructed to aid wheelbarrow-transportation and hand-planting of the trees and shrubs. Following completion of the project, the City of Kenmore plans a separate project to stabilize the access routes for use as walking and maintenance trails (Jacobs 2018a).

Year-1

March through January, workers would conduct upland road work on 68th Avenue NE north and south of the bridge. The work would include construction of bridge approaches, widening of the road, improvement of the road surface, installation of barrier walls and signage, and stripe painting.

March through April, workers would conduct upland work to remove vegetation and build access paths to the north and south riverbanks along the west side of the existing bridge.

July through August, workers would conduct in-water work to install a temporary isolation barrier along the north riverbank, east of bridge piers 6 through 9 of the existing west bridge. Sections of the barrier that are in the dry may be installed prior to July. Barrier materials are expected to include some combination of steel sheet piles, sandbags and/or concrete blocks with a plastic liner, or water-filled bladders. Should sheet piles be used, they would be installed and removed with vibratory equipment. Other barrier materials would likely be installed and removed with heavy equipment with a lifting arm and hand tools. The barrier would be removed during the Year-3 in-water work window.

During the same time, workers would conduct in- and over-water work to install temporary pile-supported trestles west of the new bridge's planned location. The north trestle would extend from the north bank to about mid-river (Figure 2). It would be supported by about 36 12-inch diameter steel pipe piles. An optional south trestle, if installed, would extend about a third of the way across the river from the south bank. It would be supported by about 24 12-inch steel pipe piles.

The piles would be installed with a vibratory driver, then proofed with an impact hammer. All impact driving would be limited to daylight hours. Also, the City’s contractors would be required to use wood blocks in addition to the enclosed bubble curtains identified in the BA for all impact driving (WSDOT 2019e). About 8 and 5 days of pile installation are expected for the respective trestles, with about 5 piles installed per day (WSDOT 2019a). The trestles would remain in place until the Year-3 in-water work window.

The workers would also use a vibratory driver to install about 24-inch steel sheet piles to create cofferdams around the western column locations for piers 2 and 3 of the new bridge, and around the western sides of piers 3 through 6 of the old bridge (Figure 2). Within the new pier 2 and 3 sites, temporary casings would vibrated or rotated into the substrate, with about 2 to 3 days of “drilling” done for each. The sediment and water within the casings would be removed by auger and/or pump. A rebar frame would be inserted into the casing, then concrete would be poured in. After the concrete sets, the casings would be removed. The columns would be completed with 4-foot by 5-foot cast-in-place concrete that would be poured into temporary forms set onto the drilled shafts. The cofferdams for the new pier columns would be remove after the work is done. The partial cofferdams for existing piers 3 through 6 would remain in place until the end of Year-2 in-water work.

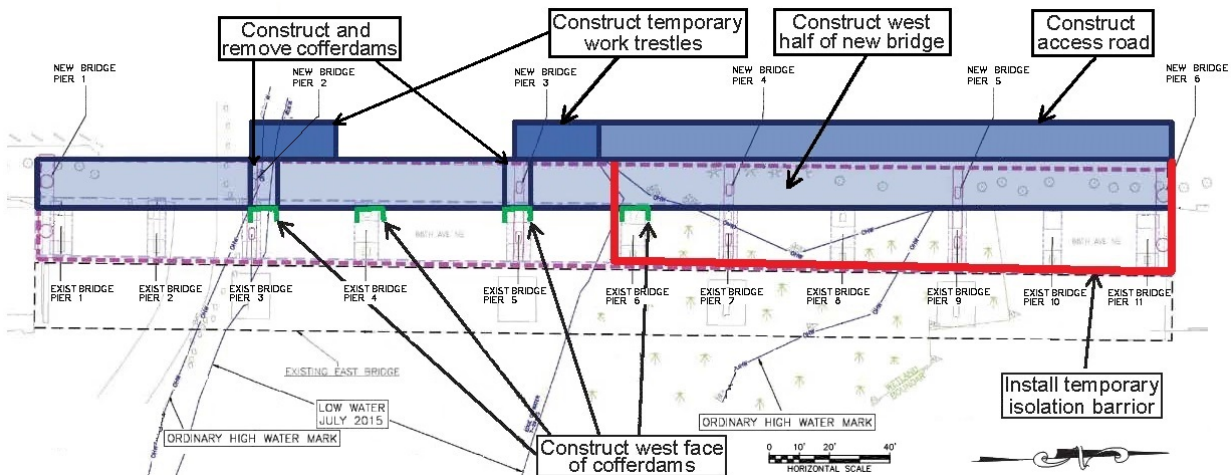


Figure 2. Overhead drawing of the Sammamish Bridges relative to the ordinary high water line and the 2015 low water line, showing planned Year-1 construction. The dashed magenta outline shows the footprint of the new West Bridge. The light blue rectangle indicates the western half of the new bridge. The darker blue rectangles indicate the temporary access road and trestles. The 3-sided red line indicates the temporary isolation barrier. (Adapted from Figure 4 in Jacobs 2016).

August through October, workers would conduct upland work and/or work behind the temporary isolation barrier to install drilled shaft columns for the western pier columns for piers 4 through 6 of the new bridge. That work would be virtually identical to that described above.

September through December, workers would conduct over-water and upland work to build the west half of the bridge on the new piers. The work would include installation of superstructure

beams, construction of bridge deck formwork, installation of reinforcing steel, and pouring the concrete bridge deck.

Year-2

January, the recently completed west half of new bridge would be opened to traffic, then workers would conduct upland work to clear and grub 68th Avenue NE roadway and the approach slabs to old west bridge. They would also install demolition supports and debris containment systems in preparation for demolition and removal of the old bridge superstructure.

January through May, workers would conduct over-water work with concrete saws and other equipment to demolish and remove the old bridge deck and beams (superstructure). They would also demolish the substructure and foundations of bridge piers 1 and 2, and piers 6 through 11, which are all upland or behind the isolation barrier. They would also demolish the above-water substructure of piers 3 through 5. As part of this work, workers would install a temporary pile-supported trestle within footprint of old bridge from the north bank out to pier 6 (Figure 3). The trestle would be supported by about 80 12-inch piles that would be installed with a combination vibratory driving and impact hammer proofing. As necessary, workers may install cofferdams around old piers 6 through 8 (behind the barrier), then remove those cofferdams after demolition is complete (WSDOT 2019a and d).

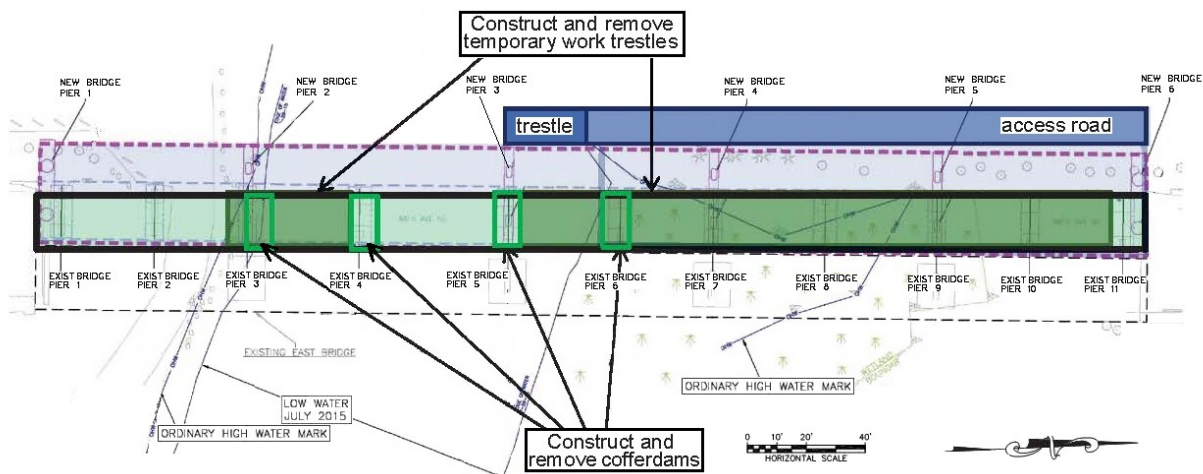


Figure 3. Overhead drawing of the Sammamish Bridges relative to the ordinary high water line and the 2015 low water line, showing planned Year-2 construction. The dashed magenta outline shows the footprint of the new West Bridge. The light and dark green rectangles outlined in black indicates the eastern half of the new bridge. The darker green rectangles indicate the locations of temporary trestles. (Adapted from Figure 5 in Jacobs 2016).

July through August, workers would install a temporary pile-supported trestle from the south bank to pier 4, and extend the northern trestle to pier 5. Both would remain within the footprint of the old bridge. About 40 12-inch steel piles would be installed for the south trestle, and about 20 additional 12-inch steel piles would be installed to extend the northern trestle (WSDOT 2019a and d). Those piles would also be installed with a combination vibratory and impact driving.

From the trestles, workers would use a vibratory driver to install steel sheet pile cofferdams around the old wood cofferdams that surround the pier columns for existing piers 4 through 6 (Figure 4), and to complete the cofferdams around the foundations of old piers 3 through 5 (Figures 2 and 3). Up to about 60 sheet piles would be used for each cofferdam. They would use a vibratory extractor and/or a claw bucket to remove about 192 derelict creosote-treated timber piles, the timber cofferdams, and debris from the area under and east of the existing bridges (Figure 4). Any piles that break during extraction would be cut-off about 2 feet below the mudline and left in the ground. They will not be dug out (WSDOT 2019a).

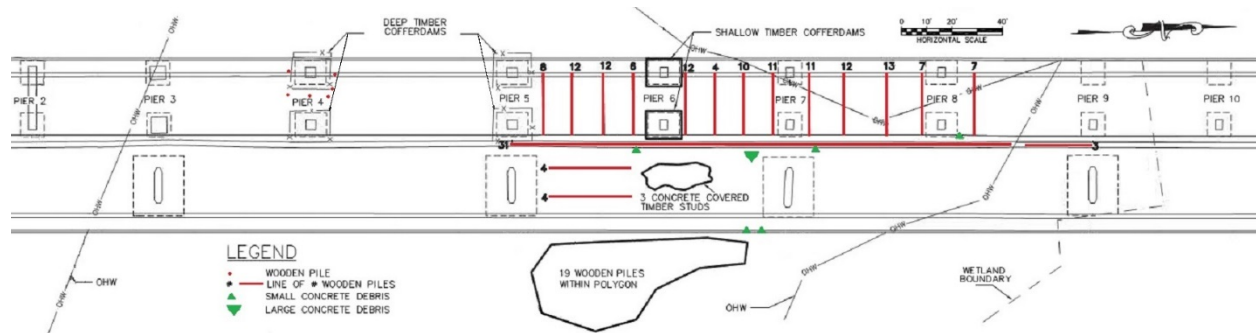


Figure 4. Overhead drawing of the existing Sammamish Bridges showing the locations of derelict timber piles and cofferdams and concrete debris that would be removed during Year-2 work. The red lines indicate lines of piles to be removed. The number at the end of each line indicates the number of piles in the line. The green triangles indicate areas of concrete debris. The 6 red dots at pier 4 indicate individual piles (Adapted from Figure 5 in Jacobs 2018b).

The timber cofferdams and concrete pier foundations 3 through 5 would be removed using vibratory extractors, excavators, clam buckets, and hand work. After old piers 3 and 5 are removed, the drilled shaft columns for the eastern columns for new piers 2 and 3 would be installed within the cofferdams (Figures 2 and 3).

Workers would remove the cofferdams from old pier locations 3 through 5. They would pull the sheet piles from the east faces, and about half of the north and south faces. Due to vertical limitations imposed by new structures, the remaining cofferdam faces may need to be cut off 3 feet below mudline instead of being pulled out.

July through September, workers would install the drilled shaft columns and pier caps for eastern pier 1 and piers 4 through 6 (upland or behind isolation barrier). They would also install the pier caps for eastern piers 2 and 3. They would remove the temporary trestles as work progresses.

September through December, workers would conduct over-water and upland work to build the east half of the bridge on the new piers. The work would include installation of superstructure beams, construction of bridge deck formwork, installation of reinforcing steel, and pouring the concrete bridge deck. They would also do upland work to install bridge approach slabs.

Year-3

January through March, workers would conduct upland road work to construct bridge approaches, install barrier walls and signage, and paint striping.

March through April, workers would construct multi-use barrier walls along the new bridge.

July 16 through August, workers would remove the isolation barrier and the temporary trestles from the west side of the bridge. Work to remove the barrier would include lifting and hauling away of barrier components, and may include vibratory extraction of sheet piles if they were included in the barrier. Work to remove the trestle would include cutting and deconstruction of the trestle superstructure, and pulling of the piles, possibly with a vibratory extractor. They would also return the temporary access road to preconstruction conditions, including planting native vegetation. Once other work is complete, the LWD would be installed and native trees and shrubs would be planted. This upland work may extend beyond the in-water work window.

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

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

2.1 Analytical Approach

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

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

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

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or to cause the destruction or adverse modification of designated critical habitat:

- Identify the range-wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a reasonable and prudent alternative (RPA) 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 PBFs that help to form that conservation value.

The project site is located on the Sammamish River, which is occupied by the Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*) Evolutionarily Significant Unit (ESU) and the PS steelhead (*O. mykiss*) Distinct Population Segment (DPS). Both species are currently listed as threatened under the ESA, and the river reach within the action area has been designated as critical habitat for PS Chinook salmon (70 FR 52630; September 2, 2005) (Table 1).

Table 1. ESA-listed marine species that may be affected by the proposed action.

ESA-listed marine species and critical habitat likely to be adversely affected (LAA)				
Species	Status	Species	Critical Habitat	Listed / CH Designated
Chinook salmon (<i>Oncorhynchus tshawytscha</i>) Puget Sound	Threatened	LAA	LAA	06/28/05 (70 FR 37160) / 09/02/05 (70 FR 52630)
steelhead (<i>O. mykiss</i>) Puget Sound	Threatened	LAA	NA	05/11/07 (72 FR 26722) / 02/24/16 (81 FR 9252)

N/A = not applicable. The action area is outside designated critical habitat, or critical habitat has not been designated.

The summaries that follow describe the status of the ESA-listed species, and their designated critical habitats, that occur within the action area and are considered in this opinion. More detailed information on the biology, habitat, and conservation status and trend of these listed resources can be found in the recovery plans and other sources at: <http://www.nmfs.noaa.gov/pr/species/fish/> and, and in the listing regulations and critical habitat designations published in the Federal Register and are incorporated here by reference.

Listed Species

Viable Salmonid Population (VSP) Criteria: For Pacific salmonids, we commonly use four VSP criteria (McElhany *et al.* 2000) to assess the viability of the populations that constitute the species. These four criteria (spatial structure, diversity, abundance, and productivity) 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.

“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 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 in single genes to complex life history traits.

“Abundance” generally refers to the number of naturally-produced adults that return to their natal spawning grounds.

“Productivity” refers to 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 in decline.

For species with multiple populations, we assess the status of the entire species based on the biological status of the constituent populations, 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 ESA-listed species, and their designated critical habitats, that occur within the geographic area of this proposed action and are considered in this opinion. 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.

Puget Sound (PS) Chinook Salmon

The PS Chinook salmon evolutionarily significant unit (ESU) was listed as threatened on June 28, 2005 (70 FR 37160). We adopted the recovery plan for this ESU in January 2007. The recovery plan consists of two documents: the Puget Sound salmon recovery plan (SSPS 2007) and a supplement by NMFS (2006). The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus *et al.* 2002). The PSTRT's biological recovery criteria will be met when all of the following conditions are achieved:

- The viability status of all populations in the ESU is improved from current conditions, and when considered in the aggregate, persistence of the ESU is assured;
- Two to four Chinook salmon populations in each of the five biogeographical regions of the ESU (Table 1) achieve viability, depending on the historical biological characteristics and acceptable risk levels for populations within each region;
- At least one population from each major genetic and life history group historically present within each of the five biogeographical regions is viable;
- Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario; Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery; and
- Populations that do not meet all the Viable Salmon Population (VSP) parameters are sustained to provide ecological functions and preserve options for ESU recovery.

General Life History: Adult Chinook salmon spawn in freshwater streams, depositing fertilized eggs in gravel "nests" called redds. The eggs incubate for three to five months before juveniles hatch and emerge from the gravel. Juveniles spend from three months to two years in freshwater before migrating to the ocean to feed and mature. Chinook salmon spend from one to six years in the ocean before returning to their natal freshwater streams where they spawn and then die.

Chinook salmon are divided into two races, stream-types and ocean-types, based on the major juvenile development strategies. Stream-type juveniles rear in freshwater for a year or more before entering marine waters. Conversely, ocean-type juveniles tend to leave their natal streams early during their first year of life, and rear in estuarine waters as they transition into their marine life stage.

Chinook salmon are further grouped into "runs" that are based on the timing of adults that return to freshwater. Early- or spring-run chinook salmon tend to enter freshwater as immature fish,

migrate far upriver, and finally spawn in the late summer and early autumn. Late- or fall-run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas, and spawn within a few days or weeks. Summer-run fish show intermediate characteristics of spring and fall runs, without the extensive delay in maturation exhibited by spring-run Chinook salmon.

Spatial Structure and Diversity: The PS Sound Chinook salmon ESU includes all naturally spawning populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington. The ESU also includes the progeny of numerous artificial propagation programs (NWFSC 2015). The PSTRT identified 22 extant populations, grouped into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity. The PSTRT distributed the 22 populations among five major biogeographical regions, or major population groups (MPGs), that are based on similarities in hydrographic, biogeographic, and geologic characteristics (Table 2).

Table 2. Extant PS Chinook salmon populations in each biogeographic region (Ruckelshaus *et al.* 2002, NWFSC 2015).

Biogeographic Region	Population (Watershed)
Strait of Georgia	North Fork Nooksack River
	South Fork Nooksack River
Strait of Juan de Fuca	Elwha River
	Dungeness River
Hood Canal	Skokomish River
	Mid Hood Canal River
Whidbey Basin	Skykomish River
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
Nisqually River	

Hatchery-origin spawners are present in high fractions in most populations within the ESU, with the Whidbey Basin the only MPG with consistently high fractions of natural-origin spawners.

Between 1990 and 2014, the fraction of natural-origin spawners has declined in many of the populations outside of the Skagit watershed (NWFSC 2015).

Abundance and Productivity: Available data on total abundance since 1980 indicate that abundance trends have fluctuated between positive and negative for individual populations, but productivity remains low in most populations, and hatchery-origin spawners are present in high fractions in most populations outside of the Skagit watershed. Available data now show that most populations have declined in abundance over the past 7 to 10 years. Further, escapement levels for all populations remain well below the PSTRT planning ranges for recovery, and most populations are consistently below the spawner-recruit levels identified by the PSTRT as consistent with recovery (NWFSC 2015). The current information on abundance, productivity, spatial structure and diversity suggest that the Whidbey Basin MPG is at relatively low risk of extinction. The other four MPGs are considered to be at high risk of extinction due to low abundance and productivity (NWFSC 2015). The most recent 5-year status review concluded that the ESU should remain listed as threatened (NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS Chinook salmon include:

- Degraded floodplain and in-river channel structure
- Degraded estuarine conditions and loss of estuarine habitat
- Riparian area degradation and loss of in-river large woody debris
- Excessive fine-grained sediment in spawning gravel
- Degraded water quality and temperature
- Degraded nearshore conditions
- Impaired passage for migrating fish
- Severely altered flow regime

PS Chinook Salmon within the Action Area: The PS Chinook salmon population that occurs in the action area consists of fall-run Chinook salmon from the North Lake Washington / Sammamish River population (NWFSC 2015; WDFW 2019a). This population is small, with a total abundance that has fluctuated between about 33 and 2,223 individuals from 1983 through 2017. Natural-origin spawners comprise a small proportion of the total population, and the trend in natural-origin spawners is negative (NWFSC 2015; WDFW 2019b). Natural-origin spawners accounted for only about 13% of the 1,524 total return in 2017 (WDFW 2019b).

The project reach provides migratory habitat for juvenile and adult life stages, as well as documented rearing habitat for juveniles (WDFW 2019a). The population spawns primarily in Issaquah Creek, Bear Creek, and Cottage Lake Creek. Spawning also occurs in larger tributaries of the Sammamish River such as North, Swamp, and Little Bear Creeks, and in the main stem of the Sammamish River as close as about 540 yards upstream of the project site. Juvenile rearing is documented in the Sammamish River from about 80 yards downstream of the project site to the start of documented spawning habitat 540 yards upstream (WDFW 2019a).

Returning adults and out-migrating juveniles from all of these areas must pass the action area to complete their life cycles. Adult Chinook salmon pass through Chittenden Locks (aka Ballard Locks) mid-June through September. Peak migration occurs in mid-August (City of Seattle 2008). They then swim through the ship canal, Lake Washington, and into the Sammamish River

to reach their natal streams. Spawning occurs between early August and late October. Both stream- and ocean-type Chinook salmon are present in the basin, but the majority are ocean-types. Juvenile Chinook salmon are found in Lake Washington and Lake Sammamish between January and July, primarily in the littoral zone (Tabor *et al.* 2006). They migrate through the ship canal and past the locks from late-May to early-July (City of Seattle 2008).

Puget Sound (PS) Steelhead

The PS steelhead distinct population segment (DPS) was listed as threatened on May 11, 2007 (72 FR 26722). The recovery plan for this DPS is under development. In 2013, the Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified 32 demographically independent populations (DIPs) within the DPS, based on genetic, environmental, and life history characteristics. Those DIPs are distributed among three geographically-based major population groups (MPGs); Northern Cascades, Central and South Puget Sound; and Hood Canal and Strait de Fuca (Myers *et al.* 2015) (Table 3).

Table 3. PS steelhead Major Population Groups (MPGs), Demographically Independent Populations (DIPs), and DIP Viability Estimates (Modified from Figure 58 in Hard *et al.* 2015).

Geographic Region (MPG)	Demographically Independent Population (DIP)	Viability
Northern Cascades	Drayton Harbor Tributaries Winter Run	Moderate
	Nooksack River Winter Run	Moderate
	South Fork Nooksack River Summer Run	Moderate
	Samish River/Bellingham Bay Tributaries Winter Run	Moderate
	Skagit River Summer Run and Winter Run	Moderate
	Nookachamps River Winter Run	Moderate
	Baker River Summer Run and Winter Run	Moderate
	Sauk River Summer Run and Winter Run	Moderate
	Stillaguamish River Winter Run	Low
	Deer Creek Summer Run	Moderate
	Canyon Creek Summer Run	Moderate
	Snohomish/Skykomish Rivers Winter Run	Moderate
	Pilchuck River Winter Run	Low
	North Fork Skykomish River Summer Run	Moderate
	Snoqualmie River Winter Run	Moderate
	Tolt River Summer Run	Moderate
Central and South Puget Sound	Cedar River Summer Run and Winter Run	Low
	North Lake Washington and Lake Sammamish Winter Run	Moderate
	Green River Winter Run	Low
	Puyallup River Winter Run	Low
	White River Winter Run	Low
	Nisqually River Winter Run	Low
	South Sound Tributaries Winter Run	Moderate
	East Kitsap Peninsula Tributaries Winter Run	Moderate
Hood Canal and Strait de Fuca	East Hood Canal Winter Run	Low
	South Hood Canal Tributaries Winter Run	Low
	Skokomish River Winter Run	Low
	West Hood Canal Tributaries Winter Run	Moderate
	Sequim/Discovery Bay Tributaries Winter Run	Low
	Dungeness River Summer Run and Winter Run	Moderate
	Strait of Juan de Fuca Tributaries Winter Run	Low
	Elwha River Summer Run and Winter Run	Low

In 2015, the PSSTRT concluded that the DPS is at “very low” viability; with most of the 32 DIPs and all three MPGs at “low” viability based on widespread diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence (Hard *et al.* 2015). Based on the PSSTRT viability criteria, the DPS would be considered viable when all three component MPG are considered viable. A given MPG would be considered viable when: 1) 40 percent or more of its component DIP are viable; 2) mean DIP viability within the MPG exceeds the threshold for viability; and 3) 40 percent or more of the historic life history strategies (i.e., summer runs and winter runs) within the MPG are viable. For a given DIP to be considered viable, its probability of persistence must exceed 85 percent, as calculated by Hard *et al.* (2015), based on abundance, productivity, diversity, and spatial structure within the DIP.

General Life History: PS steelhead exhibit two major life history strategies. Ocean-maturing, or winter-run fish typically enter freshwater from November to April at an advanced stage of maturation, and then spawn from February through June. Stream-maturing, or summer-run fish typically enter freshwater from May to October at an early stage of maturation, migrate to headwater areas, and hold for several months prior to spawning in the following spring. After hatching, juveniles rear in freshwater from one to three years prior to migrating to marine habitats (two years is typical). Smoltification and seaward migration typically occurs from April to mid-May. Smolt lengths vary between watersheds, but typically range from 4.3 to 9.2 inches (109 to 235 mm) (Myers *et al.* 2015). Juvenile steelhead are generally independent of shallow nearshore areas soon after entering marine water (Bax *et al.* 1978, Brennan *et al.* 2004, Schreiner *et al.* 1977), and are not commonly caught in beach seine surveys. Recent acoustic tagging studies (Moore *et al.* 2010) have shown that smolts migrate from rivers to the Strait of Juan de Fuca from one to three weeks. PS steelhead feed in the ocean waters for one to three years (two years is again typical), before returning to their natal streams to spawn. Unlike Chinook salmon, most female steelhead, and some males, return to marine waters following spawning (Myers *et al.* 2015).

Spatial Structure and Diversity: The PS steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). The DPS also includes six hatchery stocks that are considered no more than moderately diverged from their associated natural-origin counterparts (USDC 2014). PS steelhead are the anadromous form of *O. mykiss* that occur below natural barriers to migration in northwestern Washington State (NWFSC 2015). Non-anadromous “resident” *O. mykiss* (a.k.a. rainbow trout) occur within the range of PS steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard *et al.* 2015). As stated above, the DPS consists of 32 DIP that are distributed among three geographically-based MPG. An individual DIP may consist of winter-run only, summer-run only, or a combination of both life history types. Winter-run is the predominant life history type in the DPS (Hard *et al.* 2015).

Abundance and Productivity: Available data on total abundance since the late 1970s and early 1980s indicate that abundance trends have fluctuated between positive and negative for individual DIP. However, low productivity persists throughout the 32 DIP, with most showing downward trends, and a few showing sharply downward trends (Hard *et al.* 2015, NWFSC 2015). Since the mid-1980s, trends in natural spawning abundance have also been temporally variable for most DIP but remain predominantly negative, and well below replacement for at least 8 of the DIP (NWFSC 2015). Smoothed abundance trends since 2009 show modest increases for 13 DIP. However, those trends are similar to variability seen across the DPS, where brief periods of increase are followed by decades of decline. Further, several of the upward trends are not statistically different from neutral, and most populations remain small. Nine of the evaluated DIP had geometric mean abundances of fewer than 250 adults, and 12 had fewer than 500 adults (NWFSC 2015). Over the time series examined, the over-all abundance trends, especially for natural spawners, remain predominantly negative or flat across the DPS, and general steelhead abundance across the DPS remains well below the level needed to sustain natural production into the future (NWFSC 2015). The PSSTRT recently concluded that the PS

steelhead DPS is currently not viable (Hard *et al.* 2015). The DPS's current abundance and productivity are considered to be well below the targets needed to achieve delisting and recovery. Growth rates are currently declining at 3 to 10% annually for all but a few DIPs, and the extinction risk for most populations is estimated to be moderate to high. The most recent 5-year status review concluded that the DPS should remain listed as threatened (NMFS 2017a).

Limiting Factors: Factors limiting recovery for PS steelhead include:

- The continued destruction and modification of steelhead habitat
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania)
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish
- A reduction in spatial structure
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, increased flood frequency and peak flows during storms and reduced groundwater-driven summer flows, with resultant gravel scour, bank erosion, and sediment deposition
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, increasing the likelihood of gravel scour and dislocation of rearing juveniles

PS Steelhead within the Action Area: The PS steelhead that occur in the action area are winter-run fish from the North Lake Washington / Lake Sammamish population, which is among the smallest populations of the DPS (NWFSC 2015; WDFW 2019c). The North Lake Washington / Lake Sammamish population is very small. WDFW reports that the total abundance for PS steelhead in this basin fluctuated between 0 and 916 individuals between 1984 and the last survey in 1999, with a strong negative trend. Abundance never exceeded 45 fish after 1992 (WDFW 2019c). NWFSC (2015) disagrees with WDFW in that returns may have been above 1,500 individuals during the mid-1980s, but NWFSC agrees with the steep decline to virtually no steelhead in the basin since 2000.

The project reach primarily provides migratory habitat for juvenile and adult life stages (WDFW 2019a). The population spawns upstream of the project reach in Issaquah Creek. Therefore, returning adults and out-migrating juveniles must pass the action area to complete their life cycles. Adult steelhead pass through Chittenden Locks (aka Ballard Locks) and the Lake Washington Ship Canal between January and May, and may remain in Lake Washington through June before migrating through the Sammamish River to reach their natal streams (City of Seattle 2008). The timing of steelhead spawning in the basin is uncertain, but occurs well upstream of the action area. Juvenile steelhead pass through the Sammamish River before entering Lake Washington in April, and typically migrate through the ship canal and the locks between April and May (City of Seattle 2008).

Critical Habitat

This section describes the status of designated critical habitat that would be affected by the proposed action by examining the condition and trends of physical or biological features (PBFs) that are essential to the conservation of the listed species throughout the designated areas. The PBFs are essential because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration and foraging). The proposed project would affect critical habitat for PS Chinook salmon.

Puget Sound Chinook Salmon Critical Habitat: NMFS designated critical habitat for PS Chinook salmon on September 2, 2005 (70 FR 52630). That critical habitat is located in 16 freshwater subbasins and watersheds between the Dungeness/Elwha Watershed and the Nooksack Subbasin, inclusively, as well as in nearshore marine waters of the Puget Sound that are south of the US-Canada border and east of the Elwha River, and out to a depth of 30 meters. Although offshore marine is an area type identified in the final rule, it was not designated as critical habitat for PS Chinook salmon.

The PBFs of salmonid critical habitat include: (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development; (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks; (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival; (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation; (5) Nearshore marine areas free of obstruction and excessive predation with: (i) Water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and (6) Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation. The PBF for PS Chinook salmon critical habitat are listed in Table 4.

Major tributary river basins in the Puget Sound basin include the Nooksack, Samish, Skagit, Sauk, Stillaguamish, Snohomish, Lake Washington, Cedar, Sammamish, Green, Duwamish, Puyallup, White, Carbon, Nisqually, Deschutes, Skokomish, Duckabush, Dosewallips, Big Quilcene, Elwha, and Dungeness rivers and Soos Creek. Critical habitat throughout the Puget Sound basin has been degraded by numerous activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large woody debris (LWD) from the waterways, intense urbanization, agriculture, alteration of floodplain and stream

morphology (*i.e.*, channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors of critical habitat throughout the basin.

Table 4. Physical or biological features (PBFs) of designated critical habitat for PS Chinook salmon, and the corresponding life history events. Although offshore marine areas were identified in the FR, no offshore marine areas were designated as critical habitat for PS Chinook salmon.

Physical or Biological Features		Life History Event
Site Type	Site Attribute	
Freshwater spawning	Water quantity Water quality Substrate	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Water quantity and Floodplain connectivity Water quality and Forage Natural cover	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	(Free of obstruction and excessive predation) Water quantity and quality Natural cover	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine	(Free of obstruction and excessive predation) Water quality, quantity, and salinity Natural cover Forage	Adult sexual maturation and “reverse smoltification” Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Nearshore marine	(Free of obstruction and excessive predation) Water quality, quantity, and forage Natural cover	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing
Offshore marine	Water quality and forage	Adult growth and sexual maturation Adult spawning migration Subadult rearing

Land use practices have likely accelerated the frequency of landslides delivering sediment to streams. Fine sediment from unpaved roads also contributes to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and LW recruitment (SSPS 2007).

Diking, agriculture, revetments, railroads and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and LWD. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat.

Wetlands play an important role in hydrologic processes, as they store water which ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Thousands of acres of lowland wetlands across the region have been drained and converted to agricultural and urban uses, and forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence *et al.* 1996; SSPS 2007).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of suspended sediment, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2007).

Peak stream flows have increased over time due to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2007). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist *et al.* 2011).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected PS Chinook salmon populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat (*e.g.*, Elwha River dams block anadromous fish access to 70 miles of potential habitat) changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and LW to downstream areas (SSPS 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins (SSPS 2007).

The nearshore marine habitat has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2007).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2007).

Critical Habitat within the Action Area: Critical habitat has been designated for PS Chinook salmon in the Sammamish River to a point about 950 yards upstream from its entry into Lake Washington; about 280 yards upstream from the project site. The critical habitat along the reach provides the Freshwater Rearing and Migration PBFs for PS Chinook (WDFW 2019a).

2.3 Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). As described in Section 1.3, the project would occur on the Sammamish River at about RM 0.35, upstream from Lake Washington, at the City of Kenmore. As described in the Effects of the Action Section (2.5), construction related effects would be limited to the in-water area within 446 feet of the project site. However, hydrological impacts may extend to the nearest bends in the river from the bridge. The longest distance to the nearest river bend is about 300 yards upstream from the bridge. To be conservative, the action area for this project is considered to be the waters and substrates of the Sammamish River within 300 yards either side of the west bridge.

2.4 Environmental Baseline

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

Environmental conditions in the Sammamish River watershed: The project is located on the Sammamish River about 0.35 mile upstream from Lake Washington (Figure 1). The river is about 14 miles long, and drains several tributary creeks and Lake Sammamish into the north end of Lake Washington. The Sammamish River drainage area is about 242 square miles, including the surface of Lake Sammamish (King County 2009).

The geography and ecosystems within the Sammamish River watershed have been dramatically altered by human activity since European settlers first arrived in the 1800s. Heavy timber harvests from the 1870s through the early twentieth century removed almost all of the area's forests. Development since then has converted most of the lowland areas to urban, agricultural, and industrial uses, and forestry and agricultural practices continue to impact the upper portions of the watershed (WRIA 8).

Completion of the Lake Washington Ship Canal in 1916 dried the Sammamish River marshes and lowered the water level in Lake Sammamish (WRIA 8 2005). Between 1962 and 1964, COE dredging channelized the Sammamish River into its current configuration. This deepened the river by five feet, hardened its banks, and dramatically reduced floodplain connectivity along most of its length (Martz *et al.* 1999).

Urban and residential runoff and sewage discharges have reduced water quality across the watershed. The project site is located near the center of a stream reach that is identified on the State's 303D list for exceedance of water quality thresholds for dissolved oxygen, bacteria, and temperature (WDOE 2019).

Riparian vegetation along the river banks is limited to narrow bands of trees and shrubs that are scattered along the length of the river, with riparian vegetation being completely absent along much the river's length. Along its length, about 26 bridges cross the river, and many docks and piers line its banks, creating harsh over-water shadows that limit aquatic productivity and reduce the river's value as rearing and migration habitat for juvenile salmonids. Additionally, those over-water structures (OWSs) provide habitat conditions that favor fish species that prey on juvenile salmonids, especially the non-native smallmouth bass. Other predators in the lake include the native northern pikeminnow and the non-native largemouth bass (Celedonia *et al.* 2008a & b; Tabor *et al.* 2010).

At the project site, the river is about 180 feet wide. Two 2-lane automobile bridges, set side by side, with a combined width of about 70 feet cross the river. The crossing has been in place since at least 1938 when the west bridge was built. The east bridge was built or replaced in the 1970s. Along the south bank, a small public boat launch with a paved parking lot and a small pier is located west and under the bridge landing. A small wooded wetland area is located along the west side of the parking area, and a wooded park (Rhododendron Park) is located east of the bridge. The upland area north of the river supports mostly commercial and light industrial activity. A gravel yard is located east of the bridge and 68th Avenue NE, behind a 50- to 100 foot deep strip of riparian trees and shrubs. A large paved storage area is located east of the bridge and road, behind a similar riparian strip (Figure 1). North and south from the project site, the upland areas consists of nearly unbroken residential and commercial development, with a golf course to the south east.

The past and ongoing anthropogenic impacts described above have reduced the Sammamish River's ability to support PS Chinook salmon PS steelhead within the action area. However, the action area continues to provide rearing and migratory habitat for both of these species.

Climate Change: Climate change has affected the environmental baseline of aquatic habitats across the region and within the action area. However, the effects of climate change have not been homogeneous across the region, nor are they likely to be in the future. During the last century, average air temperatures in the Pacific Northwest have increased by 1 to 1.4° F (0.6 to 0.8° C), and up to 2° F (1.1° C) in some seasons (based on average linear increase per decade; Abatzoglou *et al.* 2014; Kunkel *et al.* 2013). Recent temperatures in all but two years since 1998 ranked above the 20th century average (Mote *et al.* 2013). Warming is likely to continue during the next century as average temperatures are projected to increase another 3 to 10° F (1.7 to 5.6° C), with the largest increases predicted to occur in the summer (Mote *et al.* 2014).

Decreases in summer precipitation of as much as 30% by the end of the century are consistently predicted across climate models (Mote *et al.* 2014). Precipitation is more likely to occur during October through March, less during summer months, and more winter precipitation will be rain than snow (ISAB 2007; Mote *et al.* 2013 and 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote *et al.* 2014). Models consistently predict increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez *et al.* 2012). The largest increases in winter flood frequency and magnitude are predicted in mixed rain-snow watersheds (Mote *et al.* 2014).

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures; in 2015 this resulted in 3.5-5.3°C increases in Columbia Basin streams and a peak temperature of 26°C in the Willamette (NWFSC 2015). Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua *et al.* 2009).

Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Isaak *et al.* 2012; Mantua *et al.* 2010). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier *et al.* 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer *et al.* 1999; Raymondi *et al.* 2013; Winder and Schindler 2004). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier *et al.* 2008; Raymondi *et al.* 2013; Wainwright and Weitkamp 2013).

As more basins become rain-dominated and prone to more severe winter storms, higher winter stream flows may increase the risk that winter or spring floods in sensitive watersheds will damage spawning redds and wash away incubating eggs (Goode *et al.* 2013). Earlier peak stream flows will also alter migration timing for salmon smolts, and may flush some young salmon and steelhead from rivers to estuaries before they are physically mature, increasing stress and reducing smolt survival (Lawson *et al.* 2004; McMahon and Hartman 1989).

The adaptive ability of these threatened and endangered species is depressed due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. Without these natural sources of resilience, systematic changes in local and regional climatic conditions due to anthropogenic global climate change will likely reduce long-term viability and sustainability of populations in many of these ESUs (NWFSC 2015). New stressors generated by climate change, or existing stressors with effects that have been amplified by climate change, may also have synergistic impacts on species and ecosystems (Doney *et al.* 2012). These conditions will possibly intensify the climate change stressors inhibiting recovery of ESA-listed species in the future.

2.5 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, “effects of the action” means the direct and indirect effects of an action on the species, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Direct effects are caused by exposure to action-related stressors that occur at the time of the action. Indirect effects are effects caused by the proposed action that occur later in time but are still reasonably certain to occur.

As described in Section 1.3, the City’s bridge replacement project would involve work in, over, and adjacent to the Sammamish River for about three years (2019 through 2021). In-water work would be limited to July through August each year, whereas nearby upland and over-water work is expected to occur year-round. Work would include the use of heavy equipment such as impact and vibratory pile driver/extractors, excavators, roadwork equipment, and tools such as concrete saws and jackhammers. The equipment would be operated from the existing bridge and road, as well as from temporary work trestles that would be installed and removed as part of this project. The City’s contractors would be required to comply with the Impact Avoidance and Minimization Measures, EFH Conservation Measures, and Fish Removal Protocol and Standards that are identified in the project BA. They must also comply with the provisions identified in the project’s WDFW HPA.

As described in Section 2.2, PS Chinook salmon and PS steelhead inhabit the action area. Additionally, critical habitat has been designated for PS Chinook salmon within the action area. The planned in-water work window overlaps with the return of adults of both species. It also overlaps with the early part of Chinook salmon spawning that could occur as close as 540 yards upstream of the project site. Over-water work and work behind the isolation barrier and other areas close to the riverbank would overlap with Chinook salmon spawning, rearing, and outmigration.

Construction is likely to cause direct effects through fish removal activities, construction-related noise and activity, and water quality impacts. It may also cause indirect effects through exposure to contaminated forage and impacts on riparian vegetation. The new bridge would remain on the landscape for many decades where it is reasonably certain to cause effects on the species and critical habitats identified above through structure-related altered riverine processes, altered lighting, water quality impacts, and traffic noise.

2.5.1 Effects on Listed Species

Construction-related Fish Removal: Fish salvage coincident with the Year-1 installation of the work area isolation barrier around piers 6 through 9 is likely to adversely affect juvenile PS Chinook salmon and PS steelhead, but would cause minor effects on adults of both species. Implementation of the work area isolation and fish removal shall be planned and directed by a qualified biologist. The directing biologist shall coordinate with construction and environmental staff to plan the sequence and methods for work area isolation, fish removal, and dewatering to provide the best conditions for safe capture and removal of fish. This work would be done in compliance with the WSDOT Fish Removal Protocol and Standards identified in Appendix A of the applicant's BA.

Fish removal would likely begin with the use of a fine-mesh herding net to drive fish out from behind the isolation barrier before it is closed off. Any adult fish that may be present are extremely likely to leave the area during herding, as are most juvenile fish that may be present. Exposure to herding may cause short-term minor effects on the normal behaviors of exposed fish, but it is extremely unlikely to cause detectable effects on their fitness. Small fish that remain within the isolation barrier after multiple passes with the herding net would likely be exposed to electrofishing, capture with dip nets or traps, and possible entrainment or impingement from dewatering pumps.

Fish exposed to electrofishing and capture would experience stress and may experience trauma and mortality. Electrofishing causes effects that range from increased respiratory action to mortality under certain conditions Dalbey *et al.* (1996), Emery (1984), and Snyder (2003) describe responses that range from muscular contractions to mortality from exposure to electrofishing. Depending on the pulse train used, and the intensity and duration of exposure, muscular contractions may cause a lactic acid load and oxygen debt in muscle tissues (Emery 1984), it can cause internal hemorrhage and spinal fractures in 12 to 54% of the exposed fish, and acute mortality in about 2% (Dalbey *et al.* 1996). Severe interruption of motor function can stop respiration, and combinations of lactic acid load and oxygen debt may be irreversible, causing delayed mortality in apparently healthy fish. Obvious physical injuries often lead to reduced long-term growth and survival, whereas uninjured to slightly injured fish showed long-term growth and survival rates similar to unexposed fish of similar age (Dalbey *et al.* 1996). To reduce the effects of electrofishing, it would be used only after multiple net passes within the isolation area yield no fish. Further, the biologist and environmental staff would adhere to the guidelines for initial and maximum power settings for backpack electrofishing identified in the WSDOT Fish Removal Protocol and Standards.

Small fish can also experience physical trauma and physiological stress responses if care is not taken during the various handling and transfer processes (Moberg 2000; Shreck 2000). Contact with nets may cause scale and skin damage, and overcrowding in traps can cause stress and injury. The primary contributing factors to stress and mortality from handling are: (1) Difference in water temperatures between the river and the holding buckets; (2) dissolved oxygen levels; (3) the amount of time that fish are held out of the water; and (4) physical trauma. Stress from handling increases rapidly if water temperature exceeds 18°C (64°F), or if dissolved oxygen is below saturation. Debris buildup in traps can also injure or kill fish. Compliance with the

WSDOT Fish Removal Protocol and Standards would reduce the potential for and the intensity of most or all these factors. The risk of entrainment or impingement during the de-watering of the isolation area is considered extremely unlikely because very few, if any, fish would remain in the affected area, and the pump intakes would be isolated and screened in compliance with the WSDOT Fish Removal Protocol and Standards.

The City gave no estimate of the number juvenile Chinook salmon and steelhead that may be exposed to fish salvage activities. Therefore, the estimate of exposed individuals used in this analysis is based on the regional average, and on the location and timing of the proposed action. A recent Opinion completed for restoration activities in the Pacific Northwest Region estimated that an average of 132 ESA-listed salmon and steelhead are captured per stream restoration project that includes fish salvage, and that up to 5% of the captured fish would be seriously injured or killed by the activity (NMFS 2013).

Because the PS Chinook salmon and PS steelhead populations within the action area for this project are both very small, and because the in-water work window begins after the end of the juvenile out-migration season in this river, the regional average likely well exceeds any reasonable expectations for the number of juvenile Chinook salmon and steelhead that may be captured during this project's fish salvage activities. Based on the best available information, NMFS estimates that up to half of the regional average could be captured during work area isolation for this project, and that up to 5% of those fish would be seriously injured or killed (NMFS 2013). In short, up to 66 juvenile Chinook salmon and/or steelhead may be captured, with up to 4 individuals being seriously injured or killed. The remaining fish would likely experience sub-lethal effects that are unlikely to affect their fitness or survival. Because the fish that may be injured or killed by this stressor would comprise such small subsets of their respective cohorts, their loss would cause no detectable population-level effects.

Construction-related Noise and Activity: Exposure to construction-related noise is likely to adversely affect PS Chinook salmon and PS steelhead. The planned bridge replacement would include 3 years of construction work. In-water work would be limited to July through August. However, some of the over-water and near-water upland work that would occur year-round is also likely to cause elevated in-water noise levels. For example, jackhammer and concrete saw noise is commonly transmitted to the water when the work is done on structures that are in direct contact with the water. Similarly, noise from near-water upland excavation and pile installation is commonly transmitted to the water via the substrate.

The effects of a fishes' exposure to noise vary with the hearing characteristics of the exposed fish, the frequency, intensity, and duration of the exposure, and the context under which the exposure occurs. At low levels, effects may include the onset of behavioral disturbances such as acoustic masking (Codarin *et al.* 2009), startle responses and altered swimming (Neo *et al.* 2014), abandonment or avoidance of the area of acoustic effect (Mueller 1980; Picciulin *et al.* 2010; Sebastianutto *et al.* 2011; Xie *et al.* 2008) and increased vulnerability to predators (Simpson *et al.* 2016). At higher intensities and/or longer exposure durations, the effects may rise to include temporary hearing damage (a.k.a. temporary threshold shift or TTS, Scholik and Yan 2002) and increased stress (Graham and Cooke 2008). At even higher levels, exposure may

lead to physical injury that can range from the onset of permanent hearing damage (a.k.a. permanent threshold shift or PTS) and mortality.

The best available information about the auditory capabilities of the fish considered in this Opinion suggest that their hearing capabilities are limited to frequencies below 1,500 Hz, with peak sensitivity between about 200 and 300 Hz (Hastings and Popper 2005; Picciulin *et al.* 2010; Scholik and Yan 2002; Xie *et al.* 2008).

The NMFS uses two metrics to estimate the onset of injury for fish exposed to high intensity impulsive sounds. The metrics are based on exposure to peak sound level and sound exposure level (SEL), respectively. Both are expressed in decibels (dB). The metrics are: 1) exposure to 206 dB_{peak}; and 2) exposure to 187 dB SEL_{cum} for fish 2 grams or larger, or 183 dB SEL_{cum} for fish under 2 grams; or exposure above 150 dB_{SEL}. Any received level (RL) below 150 dB_{SEL} is considered “Effective Quiet”. The distance from a source where the RL drops to 150 dB_{SEL} is considered the maximum distance from that source where fishes can be affected by the noise, regardless of accumulation of the sound energy (Stadler and Woodbury 2009). Therefore, when there is a difference between the ranges to the isopleths for effective quiet and SEL_{cum}, the shorter range shall apply.

The discussion in Stadler and Woodbury (2009) makes it clear that the thresholds likely overestimate the potential effects of exposure to impulsive sounds. Further, the assessment did not consider non-impulsive sound because it is believed to be less injurious to fish than impulsive sound. Therefore, any application of the criteria to non-impulsive sounds is also likely to overestimate the potential effects in fish. However, this assessment applies the criteria to both impulsive and non-impulsive sounds for continuity, and as a tool to gain a conservative idea of the sound energies that fish may be exposed to during the majority of this project.

Based on the best available information, as described in reports on pile driving noise (CalTrans 2009; Laughlin 2006), reports on various construction-related noises (CDC 2007; FHWA 2017; Reine *et al.* 2012), and in recent acoustic assessments for similar projects (NMFS 2017b and 2018), unattenuated impulsive noise from impact proofing 12-inch steel pipe piles would be the loudest construction-related source, with a source level (SL; noise level at 1 meter) of up to 223 dB_{peak} and 190 dB_{SEL}. However, because the project includes the requirement to utilize wood blocks and an enclosed bubble curtain during impact proofing, the SL would be reduced to about 193 dB_{peak} and 182 dB_{SEL} (CalTrans 2009; Laughlin 2006). Other significant noise sources include excavation, vibratory installation and extraction of 24-inch steel sheet piles and 12-inch steel pipe piles, jackhammers, and concrete saws. Most of the acoustic energy from these sources would be under 2,500 Hz. The peak source levels (SLs) for all construction-related equipment are below the 206 dB_{peak} threshold. They and the dB_{SEL} SLs are listed in Table 5.

Table 5. Estimated in-water dB_{peak} and dB_{SEL} Source Levels for construction-related sound sources in descending order based on expected range of effects. The ranges to the applicable source-specific effects thresholds for fish are highlighted in grey.

Source	Acoustic Signature	Source Level	Threshold Range
Impact 12-inch Steel Pipe Piles	< 1,600 Hz Impulsive	193 dB_{peak}	206 @ N/A
SL after attenuation for wood blocks and enclosed bubble curtain		182 dB_{SEL}	150 @ 136 m
Vib. 24-inch Steel Sheet Piles	< 2.5 kHz Non-Impulsive	190 dB_{peak}	206 @ N/A
		175 dB_{SEL}	150 @ 46 m
Vib. 12-inch Steel Pipe Piles	< 2.5 kHz Non-Impulsive	186 dB_{peak}	206 @ N/A
		170 dB_{SEL}	150 @ 22 m
Vib. Extract 14-inch Timber Pile	< 2.5 kHz Non-Impulsive	181 dB_{peak}	206 @ N/A
		171 dB_{SEL}	150 @ 22 m
Excavator breaking/scooping conc.	< 2.5 kHz Impulsive	194 dB_{peak}	206 @ N/A
Upland work		169 dB_{SEL}	150 @ 18 m
Jackhammer	< 1 kHz Impulsive	188 dB_{peak}	206 @ N/A
Over-water work		168 dB_{SEL}	150 @ 16 m
Drilling	< 5.7* kHz Non-Impulsive	177 dB_{peak}	206 @ N/A
* Typical, auger drills can be up to 24 kHz. Upland or in cofferdam		162 dB_{SEL}	150 @ 6 m
Concrete Saw	0.1 - 4 kHz Non-Impulsive	145 dB_{peak}	206 @ N/A
Over-water work		135 dB_{SEL}	150 @ N/A

Due to the combination of spreading, scattering, and absorption, the sound levels from those sources would attenuate with increasing distance from the source. A commonly used formula to estimate attenuation is: $\text{RL} = \text{SL} - \# \text{Log}(\text{R})$, where RL = received level (dB), SL = source level (dB), $\#$ = spreading coefficient (typically between 10 and 20), and R = range in meters. In the absence of site-specific information, NMFS typically uses the practical spreading loss coefficient of -15 for work in shallow water with relatively low spreading loss, but higher rates of scattering and absorption. Use of that spreading coefficient is supported by CalTrans (2009) and other sources. Attenuation due to propagation through a structure in direct contact with the water or through the substrate is highly variable. In some cases, in-water RL s from an upland source are lower than an identical in-water source at the same range. In other cases, there is little to no difference between the two (CalTrans 2009). Additionally, the denser the medium the better the sound propagates, and transmission through concrete is typically very good. To be protective of listed fish, given the uncertainty of sound attenuation through concrete and the substrate, NMFS used the same spreading coefficient (-15) in the attenuation formula to estimate the range of effects for over-water and upland sources.

The number of impulsive events that may occur during the installation of 12-inch steel piles for this project is unknown, as is the duration of the other sound sources. To be protective of listed fish, given the uncertainty of the number of pile strikes, and the duration of other sound sources, the effective quiet threshold is used here to estimate the area of acoustic affect for all project related noise sources. Based on the exposure guidelines, if the number of pile strikes or duration of sound is very large such that the range to the SEL_{cum} threshold would exceed that of effective quiet threshold, then the effective quiet threshold would apply. If the number of pile strikes is small and the range to the SEL_{cum} threshold is less than that of effective quiet, then use of effective quiet would over-estimate the area of effect. Therefore, use of the effective quiet threshold for this action would be both reasonable and protective of listed fish. The ranges to the

150 dB_{SEL} threshold for all construction-related equipment, based on the application of the practical spreading loss equation to their respective dB_{SEL} SLs are given in Table 5.

The Sammamish River is about 200 feet wide at the project site. For all impact pile driving of 12-inch pipe piles, levels above the 150 dB_{SEL} threshold for the onset of effects in fish would be present across the entire width of the river. Sound levels above that threshold would extend about 446 feet (136 m) either side of the bridge during in-water impact pile driving, but may extend less far during upland impact driving. Other, less intense noise sources would also cause in-water sound levels above 150 dB_{SEL}, but at shorter ranges from the source. In-water and/or upland vibratory driving of sheet piles would cause in-water sound levels above 150 dB_{SEL} out to about 151 feet (46 m) from the work. Vibratory extraction of derelict timber piles would cause in-water sound levels above 150 dB_{SEL} out to about 72 feet (22 m). Upland and/or in-water pier demolition within cofferdams, and over-water demolition work may cause in-water sound levels above the 150 dB_{SEL} threshold more than 50 feet (16 to 18 m) from the work. Upland and/or in-water pier column drilling within cofferdams could cause in-water sound levels above the 150 dB_{SEL} up to about 20 feet around the work.

Thirteen days of daytime impact pile driving would occur July through August in Year-1 and Year-2. Some combination of in-water and/or upland vibratory driving of sheet piles, pier and over-water demolition work, pile extraction, and pier column drilling could also occur any day during July through September in Year-1 and Year-2. Year-3 construction-related noise would be limited to in-water and upland vibratory extraction of piles between July 16 and the end of August. All of this work would overlap with the presence of returning adult Chinook salmon that migrate through the action area Mid-June through September every year to reach upstream spawning areas. Very low numbers of residual rearing Chinook salmon and steelhead may also be present in the action area year-round. Over-water bridge construction work would be done September through December of Year-1 and Year-2, which overlaps with the end of in-migration of adults and rearing of juveniles.

Sixteen days of upland daytime impact pile driving would occur January through May of Year-2. Some combination of upland vibratory driving of sheet piles, pier demolition, and over-water demolition work could also occur any day during that period. This work would overlap with rearing and out-migrating juvenile Chinook salmon that are likely to be present, and may overlap with adult and juvenile steelhead that have historically migrated past the site during this timeframe.

The effects that exposure to construction-related noise would have on individual fish would depend largely on the size of the fish, its distance from the source, and its duration of exposure. The context of the exposure may also affect the exposed fish's response. Fish within the area of acoustic effect are likely to experience some level of behavioral disturbance, which may include acoustic masking, startle responses, altered swimming patterns, and avoidance of the area. At the extreme edge of the area, exposed individuals would likely experience minor behavioral responses such as barely detectable startle responses, altered swimming, and the onset of avoidance. The intensity of these responses would likely increase with proximity to the source, as the received sound levels increase. In addition to behavioral effects, any individuals that remain within the area of acoustic effect long enough to accumulate sound energy in excess of

the 183/187 dB SEL_{cum} threshold may also experience auditory- and non-auditory tissue injury, which could reduce their likelihood of survival.

Adult PS Chinook salmon would be in the action area during the Year-1 and Year-2 July through August in-water work windows and into September. If present, adult PS steelhead would be in the action area during the Year-2 January through May work period when bank-side impact pile driving and over-water work would be done, and again the following year when minor upland and over-water work would be done. Temporary behavioral effects would be most likely response in the adults of both species that are exposed to construction-related noise. In some individuals, this may include temporary avoidance behaviors that could delay migration past the site, particularly during impact pile driving. The drive to reach spawning habitat would likely outweigh avoidance behaviors for many fish. The individuals that pass the site during impact pile driving would be exposed to high intensity sound levels that may increase stress and energetic costs in the exposed individuals. Also, any individuals that remain in the area of acoustic effect long enough to accumulate sound energy in excess of 187 dB SEL_{cum} may also experience auditory- and non-auditory tissue injury. Other individuals would likely pass the project site during lulls in loud work, which would occur frequently, and likely comprise most of a given work day. The impacts that delay, increased stress and energetic costs, and/or accumulated sound energy may have on the spawning success of affected individuals is uncertain. However, the sum of the impacts would likely be too small to cause any detectable population-level effects.

Most of the juvenile PS Chinook salmon and PS steelhead that would be exposed to construction-related noise would be out-migrating individuals that would pass through the area between January and May of Year-2 while bank-side impact pile driving and over-water work would be done. Very low numbers of rearing stream-type juveniles may also be exposed to construction noise from July 1 to the end of the year during Year-1 and Year-2. While within the area of acoustic effect, temporary behavioral effects are the most likely responses in the juveniles that are exposed to construction-related noise. They would likely experience the same suite of behavioral disturbances identified above for adults, with the possible addition of increased risk of predation. Also, any individuals that remain within the area of acoustic effect long enough to accumulate sound energy in excess of the 183/187 dB SEL_{cum} threshold may also experience auditory- and non-auditory tissue injury, which could reduce their likelihood of survival.

Temporary avoidance may delay migration past the site for some juveniles, particularly during bank-side impact pile driving. However, the drive to move downstream may outweigh the avoidance behavior in some individuals, and others may be swept through the area of acoustic effect by the current. Individuals that pass the site during impact pile driving would be exposed to high intensity sound levels that may increase their stress and energetic costs. Also, any individuals that remain in the area of acoustic effect long enough to accumulate sound energy in excess of 183/187 dB SEL_{cum} may experience auditory- and non-auditory tissue injury. The majority of the out-migrating juveniles would likely pass the project site during lulls in loud work, which would occur frequently, and likely comprise most of a given work day. The impacts that delay, increased stress and energetic costs, and/or accumulated sound energy may have on the likelihood of survival for affected individuals is uncertain, as is the number of individuals of either species that may be impacted by this stressor. However, given the small amount of habitat that would be affected by this project (about 900 feet of river), the episodic nature of the louder

noise sources, and the expectation that the majority of the juveniles would pass through the area of affect relatively quickly, the numbers of affected fish would comprise such small subsets of their respective cohorts, that their loss would cause no detectable population-level effects.

Construction-related Water Quality Impacts:

Exposure to construction-related degraded quality would cause minor effects in PS Chinook salmon and PS steelhead. Water quality would be temporarily affected by increased turbidity that may also reduce dissolved oxygen (DO) levels. It may also be affected by the introduction of toxic materials.

Turbidity: Pile removal (temporary pipe and sheet, and derelict timber) would mobilize bottom sediments that would cause episodic, localized, and short-lived turbidity plumes with relatively low concentrations of total suspended sediments (TSS). The intensity of turbidity is typically measured in Nephelometric Turbidity Units (NTU) that describe the opacity caused by the suspended sediments, or by the concentration of TSS as measured in milligrams per liter (mg/L). A strong positive correlation exists between NTU values and TSS concentrations. Depending on the particle sizes, NTU values roughly equal the same number of mg/L for TSS (i.e. 10 NTU = ~ 10 mg/L TSS, and 1,000 NTU = ~ 1,000 mg/L TSS) (Campbell Scientific Inc. 2008; Ellison *et al.* 2010). Therefore, the two units of measure are easily compared.

The effects of turbidity on fish are somewhat species and size dependent. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Newcombe and Jensen (1996) reported minor physiological stress in juvenile salmon only after about three hours of continuous exposure to concentration levels of about 700 to 1,100 mg/l. Water quality is considered adversely affected by suspended sediments when turbidity is increased by 20 NTU for a period of 4 hours or more (Berg and Northcote 1985; Robertson *et al.* 2006).

Vibratory removal of hollow 30-inch steel piles in Lake Washington mobilized sediments that adhered to the piles as they were pulled up through the water column (Bloch 2010). Much of the mobilized sediment likely included material that fell out of the hollow piles. Turbidity reached a peak of about 25 NTU (~25 mg/L) above background levels at 50 feet from the pile, and about 5 NTU (~5 mg/L) above background at 100 feet. Turbidity returned to background levels within 30 to 40 minutes. Pile installation created much lower turbidity. The planned extraction of 12-inch pipes, 24-inch sheets, and derelict timber piles is extremely unlikely to mobilize as much sediment as described above, because the piles all have much smaller surface areas for sediments to adhere to, and the sheet and timber piles have no tube to hold packed-in sediments. Therefore, the mobilization of bottom sediments, and the intensity of resulting turbidity from the planned pile removal is extremely unlikely to exceed the levels reported by Bloch, and may be much less, but given river currents, turbidity plumes may extend 300 feet or more from pile removal.

Based on the best available information, construction-related turbidity would be episodic, short-lived, and of TSS concentrations too low to cause more than temporary, non-injurious behavioral effects such as avoidance of the plume, minor gill flaring (coughing), and slightly reduced

feeding rates and success. None of these potential responses, individually, or in combination would affect the fitness of exposed individuals.

Dissolved Oxygen (DO): Mobilization of anaerobic sediments can decrease dissolved oxygen (DO) levels (Hicks *et al.*, 1991; Morton 1976). The impact on DO is a function of the oxygen demand of the sediments, the amount of material suspended in the water, the duration of suspension, and the water temperature (Lunz and LaSalle 1986; Lunz *et al.* 1988). Reduced DO can affect salmonid swimming performance (Bjornn and Reiser 1991), as well as cause avoidance of water with low DO levels (Hicks 1999), and impacts tend to be more severe lower in the water column (LaSalle 1988). However, the small amount of sediments that would be mobilized, combined with the water exchange in the action area suggests that any impacts on DO would be too small and short-lived to cause detectable effects in exposed fish.

Toxic Materials: Toxic materials may enter the water through construction-related spills and discharges, the mobilization of contaminated sediments, and/or the release of PAHs from creosote-treated timber piles during their removal. PS Chinook salmon and PS steelhead can uptake contaminants directly through their gills, and through dietary exposure (Karrow *et al.* 1999; Lee and Dobbs 1972; McCain *et al.* 1990; Meador *et al.* 2006; Neff 1982; Varanasi *et al.* 1993). Many of the pollutants that may enter the water column due to project activities can cause effects in exposed fish that range from avoidance of an affected area, to reduced growth, altered immune function, and immediate mortality in exposed individuals. The intensity of effects depends largely on the pollutant, its concentration, and/or the duration of exposure (Brette *et al.* 2014; Feist *et al.* 2011; Gobel *et al.* 2007; Incardona *et al.* 2004, 2005, and 2006; McIntyre *et al.* 2012; Meadore *et al.* 2006; Sandahl *et al.* 2007; Spromberg *et al.* 2015).

Many of the fuels, lubricants, and other fluids commonly used in motorized vehicles and construction equipment are petroleum-based hydrocarbons with PAHs that are known to be injurious to fish. However, the project includes comprehensive BMPs to reduce the risk and intensity of discharges and spills during construction. In the unlikely event of a construction-related spill or discharge, the event would likely be very small, quickly contained and cleaned. Further, most of the fuels and lubricants that are used for this type of work would evaporate relatively quickly, and/or be quickly diluted by river currents at the site. Also, non-toxic and/or biodegradable lubricants and fluids are strongly encouraged by the State, and are commonly used by many of the local contractors. Based on the best available information, the in-water presence of construction-related contaminants would be very infrequent, very short-lived, and at concentrations too low to cause detectable effects should a listed fish be exposed to them.

The sediments that would be mobilized during derelict pile removal very likely contain PAHs from the creosote-treated piles. PAHs may also be released directly from timber piles should they break during their removal (Evans *et al.* 2009; Parametrix 2011; Smith 2008; Werme *et al.* 2010). As described above, the amount of sediment that would be mobilized during pile removal would be small. Further, most lighter-weight PAHs would dissipate within a few hours after their release into the water through dilution in the current and evaporation at the surface (Smith 2008; Werme *et al.* 2010). The remaining contaminants would quickly settle out of the water along with the sediments. Based on the timing of in-water work, it is extremely unlikely that juvenile salmonids would be exposed to in-water contaminants. Also, the in-water concentration of

sediment-related contaminants would likely be too low and short-lived to cause detectable effects on the fitness and normal behaviors in any adults that may be exposed to it.

Based on the best available information, as described above, any PS Chinook salmon and PS steelhead that may be exposed to construction-related water quality impacts would experience no more than temporary minor behavioral effects which, individually, or in combination would not affect their fitness.

Construction-related Contaminated Forage:

Exposure to contaminated forage is likely to adversely affect juvenile PS Chinook salmon and PS steelhead, but is unlikely to cause detectable effects in adults of either species. In addition to direct uptake of contaminants through their gills, salmonids may absorb contaminants through dietary exposure (Meador *et al.* 2006; Varanasi *et al.* 1993). The removal of creosote-treated derelict timber piles would mobilize small amounts of contaminated subsurface sediments that would settle onto the top layer of substrate, where contaminants such as PAHs and PCBs may remain biologically available for years.

Romberg (2005) discusses two projects in the Seattle area that mobilized contaminated sediments during the removal and/or repair of creosote-treated piles. In the first, a clamshell bucket was used to remove numerous creosote-treated piles at the Seattle Ferry Terminal, including digging into the sediment to remove broken piles. Large amounts of creosote-laden sediment were mobilized by the work and contaminated a nearby clean sand cap that had been installed less than a year earlier. Based on satellite imagery of the project area, the distance between the work site and the sand cap were about 250 to 800 feet. Soon after work, high PAH levels were detected across the entire surface of the sand cap. Concentrations decreased with distance from the pile removal site, and with time. However, PAH concentrations remained above pre-contamination levels 10 years later. Lead and mercury values also increased on the cap, but the concentrations of both metals decreased to background levels after 3 years.

Amphipods and copepods uptake PAHs from contaminated sediments (Landrum and Scavia 1983; Landrum *et al.* 1984; Neff 1982), and pass them to juvenile Chinook salmon and other fish through the food web. The primary effects of dietary PAH exposure in salmonids include reduced growth, increased susceptibility to infection, and increased mortality. Varanasi *et al.* (1993) found high levels of PAHs in the stomach contents of juvenile Chinook salmon in a contaminated waterway (Duwamish). They also reported reduced growth, suppressed immune competence, as well as increased mortality in juvenile Chinook salmon.

Meador *et al.* (2006) demonstrated that dietary exposure to PAHs caused “toxicant-induced starvation” with reduced growth and reduced lipid stores in juvenile Chinook salmon. The authors surmised that these impacts could severely impact the odds of survival in affected juvenile Chinook salmon. Given their close relation to salmon, it is reasonable to expect that juvenile steelhead would be similarly affected by dietary uptake of contaminants.

The applicant’s project would remove close to 200 derelict timber piles. Although the sediment mobilization due to the planned work would likely be much less severe than was described in

Romberg (2005), the sediments that would be mobilized are almost certainly contaminated by PAHs of creosote origin. As discussed above, the turbidity plume from pile removal could extend as far as 300 feet downstream from the site. However, most of the sediment, and therefore the highest concentrations of contaminants would likely remain in the areas immediately adjacent to the piles.

The mobilized contaminants would be biologically available for years, at steadily decreasing levels. Benthic invertebrates in the affected areas would take up contaminants. Juvenile Chinook salmon and steelhead that forage in the affected area are likely to consume some of those contaminated invertebrates, and as a result may experience reduced growth, increased susceptibility to infection, and increased mortality.

The annual number of juvenile PS Chinook salmon and PS steelhead that would be exposed to PAH-contaminated forage that would be attributable to this action is unquantifiable with any degree of certainty, as is the amount of contaminated prey that any individual fish may consume, or the intensity of any effects that an exposed individual may experience. However, the relatively small affected area and the low volume of contaminated sediment that would be brought to the surface suggest that the probability of trophic connectivity to the contamination would be very low for any individual fish. Therefore, the numbers of fish that may be annually exposed to contaminated prey would be very low, and no detectable population-level effects are expected.

Construction-related Reduced Riparian Vegetation:

Construction related removal of riparian vegetation would cause minor effects in PS Chinook salmon and PS steelhead. Construction would cause the removal of a large black cottonwood tree and several large poplar trees northwest and within 40 feet of the bridge. Two or three small trees would also be removed near the river bank within 40 feet of the southwest end of the bridge. Beyond the 20 feet where the bridge expansion would be constructed, the affected areas would be replanted with native trees and shrubs, and the project also includes the planting of 114 native trees along the south side of the river. However, it will take several years to decades before the replacement vegetation would provide ecological functions equitable to pre-construction levels in areas where mature vegetation must be removed.

Reduced riparian vegetation can alter in-stream chemical and biological functions. Reduced shade can cause increased water temperatures, which Chemical processes involve inputs of thermal energy as well as linkages to terrestrial food webs, retention and export of nutrients and nutrient cycling in the aquatic food web, and gas exchange (Beechie *et al.* 2010). Biological processes include aquatic and riparian plant and animal growth, and community development and succession, which establish the biodiversity and influence the life histories of aquatic and riparian organisms (Harman *et al.* 2012).

The planned tree removal would cause no detectable increase in thermal energy input to the river. The majority and largest of the trees to be removed are located on the north side of the river where they cast no shadow on the river because the sun is always to the south of the site. Any lost shade from the southern trees would be more than offset by the temporary overwater trestles during construction. Similarly, because the southern trees are within the footprint of the

bridge width expansion, which would cause as much or more shade on the affected area than is currently provided by the existing trees, any lost shade from those trees would be more than offset by the bridge shadow. Therefore, reduced riparian vegetation would cause no detectable increase in solar input.

Many terrestrial insects are forage for salmonids, and terrestrial vegetative matter often provides cover. Terrestrial organic matter is also important to nutrient cycling in aquatic food webs that support aquatic algae and invertebrates that are important resources for juvenile salmonids.

The tree removal along 40 feet of both banks would slightly reduce the input of terrestrial-origin leaf litter, insects, and woody debris to the river. However, due to the relatively small size of the area that would be affected, the continued input of terrestrial material upstream and downstream of the project reach, and the diluting effects of flowing water, the impacts on aquatic food webs attributable to the project would likely be too small to cause detectable effects on the fitness or normal behaviors for any life stage of Chinook salmon and steelhead in the action area. Further, some of the lost terrestrial input would return as the replanted vegetation along the north bank returns to pre-construction levels of growth.

Structure-related altered riverine processes:

Structure-related altered riverine processes would cause minor effects on PS Chinook salmon and PS steelhead through alteration of hydrological and biological processes. Riverine habitats are the product of physical, chemical, and biological processes that interact together to form and maintain the streams (Fischenich 2003). Physical processes involve the interaction of hydrological forces with the substrate and objects in the streambed that drive geomorphic adjustments in the channel, floodplain, and riparian habitats. Chemical processes involve inputs of organic matter, retention and export of nutrients and thermal energy, nutrient cycling in the aquatic food web, linkages to terrestrial food webs, and gas exchange (Beechie *et al.* 2010). Biological processes include aquatic and riparian plant and animal growth, and community development and succession, which establish the biodiversity and influence the life histories of aquatic and riparian organisms (Harman *et al.* 2012).

Hydrological Impacts: Under natural conditions, the physical shape and structure of a channel is ever-evolving in response to the interaction between the native substrate, the volume and velocity of water flow, sediment loads, and the availability of large wood. Changes in any of these can alter erosion and deposition rates that drive geomorphic adjustments that can change the channel alignment and depth, as well as drive side channel formation or abandonment. It can also alter the exposed substrate (rock, gravel, sand, or mud bottoms), and cause changes in the presence of large wood. By design, bridge abutments and any stabilization structures that may be installed to protect them replace dynamic natural processes with a set of semi-permanent conditions that prevent natural channel migration past the structure and alter fundamental channel and aquatic habitat formation processes (Cramer 2012). These structures redirect water flows, which often increase erosion upstream and/or downstream of them.

Periodic maintenance and repair to prevent failure of the structures often leads to bank steepening and simplified aquatic habitats with reduced diversity in velocity, depth, and

substrate. It also often reduces large wood recruitment and retention, stream bank roughness, and edge habitat features such as undercut banks and alcove habitats (Fischenich 2003; Pracheil 2010). Altered flows caused by the abutments and bridge piers may also cause unexpected changes in the physical processes upstream and downstream from the structure that alter sediment recruitment and transport in the streambed, and may discourage the formation of complex off-channel habitats within the affected stream reaches.

Due to the complex relationships between the processes that are involved, it is virtually impossible to predict and quantify the exact effects that the new bridge would have on stream hydrology, geomorphology, and habitat forming processes beyond the knowledge that channel migration past the existing banks would be prevented at the abutment sites. It is possible that the abutments and piers may also slightly alter upstream and downstream erosion, sediment transport and deposition, and movement of LWD, which may alter or discourage the formation of spawning habitats and complex off-channel rearing habitats within the affected stream reach. In the absence of site-specific information, hydrological impacts are estimated to be limited to the river reach within the nearest river bends up and downstream from a bank hardening structure. For this project, the longest distance to the nearest bend is about 300 yards upstream from the bridge. However, given the relatively small size of the abutments, the low number of bridge piers that would be installed, and the highly confined nature of the river, the influence those structures would have on hydrological processes are expected to be too small to cause detectable impacts on the normal behaviors or fitness of any juvenile Chinook salmon or steelhead within the action area, and they would likely decrease with distance from the site.

Biological Impacts: The exact impacts the abutments and piers would have on in-stream chemical and biological processes are uncertain, but would likely include long-term small-scale simplification of the aquatic habitats where the abutments and piers are installed, and reduced input of terrestrial-origin organic material due to the absence of riparian vegetation along the affected sections of riverbank. Given the very small affected area, the effects of altered in-stream chemical and biological processes within the action area would be too small to cause detectable impacts on the normal behaviors or fitness of any juvenile Chinook salmon or steelhead that would be exposed to them.

Structure-related Altered Lighting:

Structure-related altered lighting is likely to adversely affect PS Chinook salmon and PS steelhead. The new west bridge would create unnatural lighting conditions across the river at the project site. The bridge would create unnaturally harsh shade under it during the day and artificial illumination along its sides at night.

Shade: The new solid-decked bridge would have an overwater footprint of about 10,000 square feet, an increase of about 4,100 square feet over the existing bridge, it would be totally opaque, and it would cast a hard shadow completely across the river. The bridge's shadow would reduce aquatic productivity. It is also likely to delay juvenile migration, and increase exposure and vulnerability to predators for juvenile salmon. The intensity of these effects are likely to vary based on the brightness and angle of the sun, being most intense on sunny days, and less pronounced to possibly inconsequential on cloudy days.

Shade limits primary production and can reduce the diversity of the aquatic communities under over-water structures (Nightingale and Simenstad 2001; Simenstad *et al.* 1999). Because the bridge would be solid-decked and casts a hard shadow over water and substrate that is otherwise supportive of submerged aquatic vegetation (SAV) and benthic invertebrates, it is highly likely that the bridge shadow would reduce the growth of SAV and limits the diversity of the organisms that are prey for juvenile salmonids. However, the size of the shade-impacted habitat would be very small compared to the amount of unshaded habitat along most of the adjacent river either side of the bridge. Further, mixing with the waters from the higher productivity areas adjacent to the bridge would quickly diminish the effects of any prey reduction at the site. Therefore, the effects of shade-related impacts on productivity would be too small to cause detectable effects on the fitness or normal behaviors of juvenile Chinook salmon and steelhead in the area.

Shade affects juvenile salmon migration, and the new bridge would cast a harsh shadow completely across the only route available to out-migrating juvenile Chinook salmon and steelhead. Numerous studies demonstrate that juvenile salmonids, in both freshwater and marine habitats, are more likely to avoid the shadow of an overwater structure than to pass through it (Celedonia *et al.* 2008a and b; Kemp *et al.* 2005; Munsch *et al.* 2014; Nightingale and Simenstad 2001; Ono *et al.* 2010; Southard *et al.* 2006). The intensity of the effect increases with proximity of the structure to the water and the increased contrast between light and dark areas. Celedonia *et al.* (2008b) report that two thirds of the juvenile Chinook salmon tracked during their study experienced a detectable delay in their migration under the SR 520 Bridge. One-third of the fish experienced an average delay of 15-minutes. One-third experienced delays of under 1 minute, and one-third showed no delay. Although the SR-520 Bridge is an imperfect analog for the applicant's pier, the authors' findings support the understanding that migration past the project site would be delayed for at least some of the juvenile PS Chinook salmon that encounter the bridge shadow. Out-migrating juvenile steelhead are typically 2 to 3 years old and larger than the majority of the out-migrating juvenile Chinook salmon that move through this section of the river. It is uncertain whether or not juvenile steelhead would experience similar migration delays.

Bridge shade is likely to increase juvenile salmonid exposure and vulnerability to predators. Shade and deep water both favor freshwater predatory species, such as smallmouth bass and northern pikeminnow that are known to prey heavily on juvenile salmonids (Celedonia *et al.* 2008a; Tabor *et al.* 2010). The bridge would cast about 10,000 square feet of shade completely across the river. The shadow would not increase the population of predatory fish in the action area, but it is likely to concentrate predatory fish within it. Therefore, it is likely that juvenile Chinook salmon and steelhead would be more likely to encounter predatory fish under the bridge than in areas away from it. For juveniles that swim into deeper water in their attempt to avoid the shadow, the risk of predation would increase further because the occurrence of larger predatory fish is likely higher in deeper water. Also, juvenile salmonid's are more vulnerable to attack in deeper water because the increased water volume allows predators to attack from below and from the sides instead of from just one side as would be the case in shallow water along the shore. In summary, juvenile Chinook salmon and steelhead are more likely to be exposed to predators under the bridge than away from it, and some of those individuals would be more vulnerable to attack than they would be in the absence of the shadow. Those that fail to escape would be killed. Individuals that do escape would experience reduced fitness due to increased energetic costs and stress-related effects that may reduce their overall likelihood of survival.

In summary, structure-related shade would cause a combination of altered migratory behaviors and increased risk of predation that would reduce fitness or cause mortality for juvenile PS Chinook salmon and juvenile PS steelhead that pass the site. We cannot predict the annual number of fish that would be impacted by this stressor, and the number is likely to vary greatly over time due to the complexities of predator/prey dynamics as well as variations in environmental conditions. However, the available information about predator/prey dynamics suggest that the probability of exposure to a predator at the site would be very low for any individual fish, and only a subset of the interactions would result in successful attacks. Therefore, the annual numbers of individuals that would be killed or experience reduced fitness due to the bridge shadow would be too low to cause detectable population-level effects.

Artificial Lighting: The post-construction bridge lighting system would cause artificial illumination of the river along the bridge's length. Artificial lighting attracts fish (positive phototaxis) and often shifts nocturnal behaviors toward more daylight-like behaviors. It may also affect light-mediated behaviors such as migration timing.

Tabor and Piaskowski (2002) report that juvenile Chinook salmon in lacustrine environments typically feed and migrate during the day, and are inactive at night, residing at the bottom in shallow waters. They tend to move off the bottom and become increasingly active at dawn when light levels reach 0.8 to 2.1 lumens per square meter. Tabor *et al.* (2017) found that subyearling salmon (Chinook, coho, and sockeye) exhibit strong nocturnal phototactic behavior when exposed to levels of 5.0 to 50.0 lumens per square meter, with phototaxis positively correlated with light intensity. Celedonia and Tabor (2015) found that juvenile Chinook salmon in the Lake Washington Ship Canal were attracted to artificially lit areas at 0.5 to 2.5 lumens per square meter. They also found that the quality of the light played a role, with orange-colored sodium lamps being more attractive to juvenile Chinook salmon than fluorescent and cooler wavelength lights. The authors also reported that attraction to artificial lights may delay the onset of morning migration by up to 25 minutes for some juvenile Chinook salmon migration through the Lake Washington Ship Canal.

The new bridge lighting system is designed to limit illumination of the river to the lowest practicable light level based on the pole placement and spacing required to meet the roadway light-level standards developed by the Illuminating Engineering Society of North America (IESNA). However, the project engineers predict that post-construction light spillage along both sides of both bridges would cause a maximum illumination of 0.1 foot-candles (fc) (1.076 lumens per square meter) on the river surface. Side illumination would be limited to 5-foot wide swath that would be slightly offset from the west side of the bridge, and a 60-foot wide swath along the east side of the east bridge. Under the bridge, along the 10-foot gap between the two bridges, the river's surface would receive a maximum of 0.8 fc (8.608 lumens per square meter) (WDOT 2019c).

The available information suggests that artificial illumination levels from the bridge would be above the illumination levels where the onset of daylight activities and phototaxis are expected to occur. Therefore, juvenile salmonids that are under or alongside of the bridge are likely experience some level of nocturnal phototaxis, and may experience other altered behaviors, such as delayed resumption of migration in the morning. Over the life of the bridge, it is likely that

small subset of the exposed individuals would experience reduced fitness and/or altered behaviors that could reduce their overall likelihood of survival.

The annual numbers of juvenile PS Chinook salmon and PS steelhead that would experience measurably reduced likelihood of survival due to bridge lighting is unquantifiable with any degree of certainty. However, the proportion of any year's cohort that would be exposed to the bridge's lighting would be extremely small because the majority would pass through the action area during the day, when artificial light would cause no effect. Further, only a small portion of the exposed individuals would experience reduced likelihood of survival. Therefore, the numbers of either species that would experience reduced likelihood of survival due to artificial lighting would be too low to cause any detectable population-level effects.

Structure-related Water Quality Impacts:

Exposure to structure-related degraded water quality would adversely affect PS Chinook salmon and PS steelhead. Untreated stormwater runoff from roads and bridges has been identified as an important source of water contamination in Puget Sound watersheds, and has been directly linked to pre-spawner die off in adult coho salmon and to mortality in aquatic invertebrates that are important forage resources for juvenile salmonids (McIntyre *et al.* 2015; Spromberg *et al.* 2015).

Traffic-related contaminants include PAHs, heavy metals, and a growing list of contaminants that are just beginning to be identified (Peter *et al.* 2018). Those contaminants accumulate on road surfaces and bridges until they are carried away with stormwater runoff. The primary effects of PAH exposure in salmonids are reduced growth, increased susceptibility to infection, and increased mortality (Meador *et al.* 2006; Varanasi *et al.* 1993). Exposure to dissolved copper at concentrations between 0.3 to 3.2 µg/L above background levels has been shown to cause avoidance of an area, to reduce salmonid olfaction, and to induce behaviors that increase juvenile salmon's vulnerability to predators in freshwater (Giattina *et al.* 1982; Hecht *et al.* 2007; McIntyre *et al.* 2012; Sommers *et al.* 2016; Tierney *et al.* 2010).

The new bridge would include a stormwater treatment system. At design flow rates of 0.113 and 0.060 cfs, for the north and south modules respectively, the system is designed to remove 80% of TSS, 50% of total phosphorous, 30% of dissolved copper, 60% of dissolved zinc, and petroleum-based chemicals to satisfy state standards from runoff within. However, runoff in excess of the design flow rates would bypass the filter media. The stormwater would be discharged through T-shaped diffusers installed 150 and 180 feet upland from the OHWM of the river for the northern and southern diffusers, respectively (Perteet 2018; WSDOT 2019a, d, and e).

Generally, 30 to 50% of the pollutants in highway stormwater runoff are contained in the first 10 to 20% of the runoff volume for a particular storm event. This is phenomena is known as first flush (CalTrans 2005). The percent of total pollutant loading that would be treated from a particular storm event would increase or decrease with the capacity of the system. For a system designed to treat the first 20% of the stormwater before bypass of the system begins, upwards of half of the total pollutant loading could bypass treatment during events where runoff exceeds design flows.

The project engineers report that the stormwater treatment system would be capable of treating a 2 hours of first flush from of a 25-year storm event as long as precipitation starts slowly and does not exceed the design flows during that time (WSDOT 2019e). This suggests that sudden heavy downpours, particularly from storms more intense than a 25-year event are likely to exceed design flow and begin to bypass treatment relatively quickly. Therefore, during moderate to heavy precipitation events, it is very likely that large proportions of the pollutant loading in the bridge's stormwater runoff would be discharged through the diffusers. The stormwater effluent is predicted to infiltrate into the soil before reaching the river. However, over the life of the new bridge, persistent pollutants would accumulate in the substrate, and some are likely to eventually migrate to the river where they would become biologically available to juvenile Chinook salmon and steelhead.

The annual numbers of juvenile PS Chinook salmon and PS steelhead that would experience measurable fitness impacts from exposure to structure-related water quality impacts is unquantifiable with any degree of certainty. However, the proportion of any year's cohort that would be exposed to this stressor would be extremely small because the majority of the pollutants that would be discharged through the diffusers would remain upland and out of the river. Therefore, the numbers of either species that would experience reduced likelihood of survival due to artificial lighting would be too low to cause any detectable population-level effects.

Structure-related Traffic Noise:

Exposure to structure-related traffic noise would cause minor effects in PS Chinook salmon and PS steelhead. In-water traffic noise has been reported near bridges in Washington State. However, the loudest in-water sound levels are typically below the 150 dB_{SEL} effective quiet threshold for fish, even for bridges that support high volumes of highway traffic, such the I-5 Bridge across the Snohomish River (COE 2011). Therefore, sound levels for structure-related traffic noise attributable to the project would likely be too low to cause detectable effects on the fitness or normal behaviors for any life stage of Chinook salmon and steelhead in the action area.

2.5.2 Effects on Critical Habitat

This assessment considers the intensity of expected effects in terms of the change they would cause in affected Primary Biological Features (PBFs) from their baseline conditions, and the severity of each effect, considered in terms of the time required to recover from the effect. Ephemeral effects are those that are likely to last for hours or days, short-term effects would likely last for weeks, and long-term effects are likely to last for months, years or decades.

Critical Habitat for Puget Sound Chinook Salmon:

The proposed action is likely to adversely affect critical habitat that has been designated for PS Chinook salmon. The essential PBFs of critical habitat for this species are listed below. The expected effects on those PBFs from completion of the planned project, including full application of the conservation measures and BMPs, would be limited to the impacts on freshwater rearing and migration PBFs as described below.

1. Freshwater spawning sites – None in the action area.
2. Freshwater rearing sites:
 - a. Floodplain connectivity – The proposed action would cause long term minor adverse effects on floodplain connectivity. The bridge abutments would permanently prevent natural channel migration past them. The altered hydrology at the site may also impact bank habitat forming processes within the nearest bends in the river.
 - b. Forage – The proposed action would cause long term minor adverse effects on forage. Construction would mobilize small amounts of PAH-contaminated sediments that could be taken up by benthic invertebrates that are forage resources for juvenile Chinook salmon. Sediment distribution would likely be limited to the area within 300 feet downstream of the bridge, but detectable levels of contaminants may last for years. The bridge would cause long-term shading that would slightly reduce the production and diversity of invertebrate prey organisms in the action area.
 - c. Natural cover – The proposed action would cause long term minor adverse effects on natural cover. The bridge abutments would permanently prevent the formation of edge habitat features such as undercut banks at their locations, and may affect similar features within the nearest bends in the river. The bridge would also prevent the growth of overhanging vegetation riparian vegetation within its footprint and slightly reduce the availability of woody debris and leaf litter that can provide in-water cover. The bridge shadow would reduce SAV growth. These effects would persist for decades.
 - d. Water quantity – No changes expected.
 - e. Water quality – The proposed action would cause long term minor adverse effects on water quality. Construction may briefly increase suspended solids and temporarily introduce low levels of contaminants. Low levels of pollutants from road runoff may enter the water over the life of the bridge. Detectable effects are expected to be limited to the area within about 300 feet of the project site.
3. Freshwater migration corridors:
 - a. Free of obstruction and excessive predation – The proposed action would cause long term minor adverse effects on obstruction and predation. The bridge's shadow is likely to cause migratory delays for some of the juvenile Chinook salmon that encounter it. The project would not increase predator abundance in the action area, but the bridge's shadow and piers would provide habitat conditions that are likely to concentrate predators in the area under the bridge. This would slightly increase the exposure and vulnerability to predators for some of the juvenile Chinook salmon that must migrate past it. This effect would persist for decades.
 - b. Water quantity – No changes expected.
 - c. Water quality – Same as above.
 - d. Natural Cover – Same as above.
4. Estuarine areas – None in the action area.
5. Nearshore marine areas – None in the action area.
6. Offshore marine areas – None in the action area.

2.6 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline section (Section 2.4).

The current condition of ESA-listed species and designated critical habitats within the action area are described in the Status of the Species and Critical Habitats and Environmental Baseline sections above. The contribution of non-federal activities to those conditions include past and on-going riverbank development in the action area, as well as upstream flood control, forest management, agriculture, urbanization, road construction, water development, and restoration activities. Those actions were driven by a combination of economic conditions that characterized traditional natural resource-based industries, general resource demands associated with settlement of local and regional population centers, and the efforts of social groups dedicated to river restoration and use of natural amenities, such as cultural inspiration and recreational experiences.

NMFS is unaware of any specific future non-federal activities that are reasonably certain to affect the action area. However, NMFS is reasonably certain that future non-federal actions such as the previously mentioned activities are all likely to continue and increase in the future as the human population continues to grow across the region. Continued habitat loss and degradation of water quality from development and chronic low-level inputs of non-point source pollutants will likely continue into the future. Recreational and commercial use of river waters within the action area is also likely to increase as the human population grows.

The intensity of these influences depends on many social and economic factors, and therefore is difficult to predict. Further, the adoption of more environmentally acceptable practices and standards may gradually reduce some negative environmental impacts over time. Interest in restoration activities has increased as environmental awareness rises among the public. State, tribal, and local governments have developed plans and initiatives to benefit ESA-listed PS Chinook salmon and PS steelhead within the watersheds of the action area. However, the implementation of plans, initiatives, and specific restoration projects are often subject to political, legislative, and fiscal challenges that increase the uncertainty of their success.

2.7 Integration and Synthesis

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

As described in more detail above at Section 2.4, climate change is likely to increasingly affect the abundance and distribution of the ESA-listed species considered in the Opinion. It is also likely to increasingly affect the PBF of designated critical habitat. The exact effects of climate change are both uncertain, and unlikely to be spatially homogeneous. However, climate change is reasonably likely to cause reduced instream flows in some systems, and may impact water quality through elevated in-stream water temperatures and reduced DO, as well as by causing more frequent and more intense flooding events.

Climate change may also impact coastal waters through elevated surface water temperature, increased and variable acidity, increasing storm frequency and magnitude, and rising sea levels. The adaptive ability of listed-species is uncertain, but likely reduced due to reductions in population size, habitat quantity and diversity, and loss of behavioral and genetic variation. The proposed action will cause direct and indirect effects on the ESA-listed species considered in the Opinion well into the foreseeable future. However, the action's effects on water quality, substrate, and the biological environment are expected to be of such a small scale that no detectable effects on ESA-listed species through synergistic interactions with the impacts of climate change are expected.

2.7.1 ESA-listed Species

Both of the species considered in this Opinion are listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and an array of limiting factors as a baseline habitat condition. Both species will be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, as described below, effects on viability parameters of each species are also likely to be negative. In this context we consider the effects of the proposed action's effect on individuals of the listed species at the population scale.

PS Chinook Salmon:

The PS Chinook salmon in the action areas are fall run fish from the North Lake Washington / Sammamish River population MPG. The population is small, has a slightly negative general trend, and a large proportion of the populations' spawners are hatchery-origin fish. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS Chinook salmon. Commercial and recreational fisheries also continue to impact this species.

The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development and by aquatic activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

The project site is located across the banks of the Sammamish River. The site provides rearing habitat for juveniles, as well as migratory habitat for juveniles and adults. Documented spawning habitat begins about 540 yards upstream from the site. The planned in-water work window overlaps with returning adults and with the year-round presence of rearing stream-type juveniles.

Short-term construction-related impacts, and long-term structure-related impacts, are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and mortality in low numbers of exposed individuals for decades to come.

The annual number of juveniles that are likely to be injured or killed by action-related stressors is unknown. However, the numbers are expected to be very low, and to represent such a small fraction of any annual cohort that it would have no detectable effect on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for this PS Chinook salmon population.

As compared to undisturbed habitats, the proposed action would slightly reduce the functional levels of habitat features within the river bends nearest to the project site. However, these impacts would not prevent the recovery of this species within the action area. Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any population level impacts on PS Chinook salmon. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

PS Steelhead:

The PS steelhead in the action area are winter-run fish from the North Lake Washington / Lake Sammamish DIP. The population is very small, with a strong negative trend. Both WDFW and NWFSC agree that there have been almost no steelhead in the basin since 2000. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The environmental baseline within the action area has been degraded by the effects of intense streambank and shoreline development and by aquatic activities. The baseline has also been degraded by nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

The project site is located across the banks of the Sammamish River. The site provides rearing habitat for juveniles, as well as migratory habitat for juveniles and adults. The planned in-water work window overlaps with the year-round presence of rearing juveniles.

Short-term construction-related impacts, and long-term structure-related impacts, are likely to cause a range of effects that both individually and collectively would cause altered behaviors, reduced fitness, and mortality in low numbers of exposed individuals for decades to come.

The annual number of juveniles that are likely to be injured or killed by action-related stressors is unknown. However, the numbers are expected to be extremely low, and to represent such a small fraction of any annual cohort that it would have no detectable effect on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for this PS steelhead population.

As compared to undisturbed habitats, the proposed action would slightly reduce the functional levels of habitat features within the river bends nearest to the project site. However, these impacts would not prevent the recovery of this species within the action area. Based on the best available information, the scale of the direct and indirect effects of the proposed action, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause any population level impacts on PS steelhead. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 ESA-designated Critical Habitat

Critical Habitat for PS Chinook Salmon:

As described above at Section 2.5, the proposed action is likely to adversely affect designated critical habitat for PS Chinook salmon. Past and ongoing land and water use practices have degraded salmonid critical habitat throughout the Puget Sound basin. Hydropower and water management activities have reduced or eliminated access to significant portions of historic spawning habitat. Timber harvests, flood control, agriculture, industry, urbanization, and shoreline development have adversely altered floodplain and stream morphology in many watersheds, diminished the availability and quality of estuarine and nearshore marine habitats, and reduced water quality across the region.

Global climate change is expected to increase in-stream water temperatures and alter stream flows, possibly exacerbating impacts on baseline conditions in freshwater habitats across the region. Rising sea levels are expected to increase coastal erosion and alter the composition of nearshore habitats, which could further reduce the availability and quality of estuarine habitats. Increased ocean acidification may also reduce the quality of estuarine habitats.

In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid habitats is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, by the implementation of non-federal plans that are intended to benefit salmonids, and by efforts to address the effects of climate change.

The PBFs of salmonid critical habitat that would be affected by the proposed action are freshwater rearing sites and migration corridors free of obstruction and excessive predation. As described above, the proposed action would cause short- and long-term minor adverse effects on water quality, forage, natural cover, and freedom from obstruction and excessive predation under and within about 300 feet downstream of the bridge. It would also cause short- and long-term minor adverse effects on floodplain connectivity within the river bends nearest to the bridge.

Based on the best available information, the scale of the proposed action's effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to measurably reduce the quality or functionality of the freshwater PBFs from their current levels. Therefore, the critical habitat would maintain its current level of functionality, and retain its current ability for PBF to become functionally established, to serve the intended conservation role for PS Chinook salmon and PS steelhead.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS' opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon or PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for either of these species.

2.9 Incidental Take Statement

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

2.9.1 Amount or Extent of Take

NMFS has determined that incidental take is reasonably certain to occur as follows:

Harm of juvenile Puget Sound Chinook salmon from

- exposure to fish salvage,
- exposure to construction-related noise,
- exposure to construction-related contaminated forage,
- exposure to structure-related altered lighting, and
- exposure to structure-related contaminated water.

Harm of juvenile Puget Sound steelhead from

- exposure to fish salvage,
- exposure to construction-related noise,
- exposure to construction-related contaminated forage,
- exposure to structure-related altered lighting, and
- exposure to structure-related contaminated water.

NMFS expects that a maximum of 66 juvenile Chinook salmon and/or steelhead may be captured during fish salvage activities, with up to 4 of those fish being seriously injured or killed.

NMFS cannot predict with meaningful accuracy the number of PS Chinook salmon and PS steelhead that are reasonably certain to be injured or killed by exposure to any of the remaining stressors. The distribution and abundance of fish that occur within an action area are affected by habitat quality, competition, predation, and the interaction of processes that influence genetic, population, and environmental characteristics. These biotic and environmental processes interact in ways that may be random or directional, and may operate across far broader temporal and spatial scales than are affected by the proposed action. Thus, the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NMFS 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.

Additionally, NMFS knows of no device or practicable technique that would yield reliable counts of individuals that may experience these impacts. In such circumstances, NMFS uses the causal link established between the activity and the likely extent and duration of changes in habitat conditions to describe the extent of take as a numerical level of habitat disturbance.

The most appropriate surrogates for take are action-related parameters that directly relate to the magnitude of the expected take. For this action, the timing of work, the type and size of the piles to be installed and/or extracted, and the method of their installation and extraction are the best available surrogates for the extent of take of PS Chinook salmon and PS steelhead from exposure to construction-related noise. Timing of work is applicable because the planned work windows were selected to reduce the potential for juvenile fish presence at the project site. Therefore, working outside of the planned work window would increase the number of fish likely to be exposed to construction-related impacts that are likely to cause injury or reduce fitness. The size and type of the piles and the method of their installation and/or extraction are applicable because

the intensity of effect is positively correlated with the loudness of the sound, which is determined by the type and size of the pile and the method of its installation and/or extraction. Further, the number of fish that would be exposed to the noise is positively correlated with the range of effect. In short, as the sound levels increase, the intensity of effect and the size of the affected area increases, and as the size of the ensonified area increases, the number of PS Chinook salmon and PS steelhead that would be exposed to the sound would increase despite the low density and random distribution of individuals of these species in the action area. Based on the best available information about the planned pile installation and extraction, as described in section 2.5, the applicable ranges of effect for this project are driven by the type and size of the piles and the method of their installation and extraction, not by the daily duration of the work. Therefore, daily duration of pile installation and extraction is not considered a measure of take for this action.

The extent of the turbidity plumes around pile extraction is the best available surrogate for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to construction-related contaminated forage. This is because construction-related contaminated forage would be positively correlated with the size of the area where contaminated subsurface sediments would be biologically available on riverbed's surface, which would be positively correlated with the extent of the visible turbidity plume. Therefore, as the size of the visible turbidity plumes increase, the number of prey organisms that may become contaminated and then eaten by juvenile PS Chinook salmon and PS steelhead would increase, despite the low density and random distribution of juveniles of both of these species in the action area.

The width of the new bridge, and the size and intensity of the nighttime artificial illumination alongside of it are the best available surrogates for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to structure-related altered lighting. The length of the bridge is not a factor because it is set by the river's width, and is not a variable. The length of the river reach that would be artificially shaded during the day is positively correlated with the width of the bridge. As the width of the bridge increases, the width and intensity of its shadow, and the amount of available habitat for piscivorous predators within it would increase. As the amount of predator habitat increases along the migratory route, the likelihood that any juvenile salmonid would encounter a predator in the area would increase. As the size and/or intensity of the artificially illuminated area alongside the bridge increases, the greater the number of fish that would be exposed to the light, and/or the more intense the behavioral modifications are likely to be for exposed individuals.

The size of the new bridge, and the capacity of its stormwater treatment system are the best available surrogates for the extent of take of juvenile PS Chinook salmon and PS steelhead from exposure to structure-related contaminated water. This is because, as the size of the impervious surface area of the bridge increases, the volume of vehicle-contaminated stormwater runoff from the bridge would increase. Conversely, as the capacity of the stormwater treatment system is reduced, the earlier and more frequently untreated stormwater would bypass the system. As the volume of untreated stormwater from the bridge increases, the concentration of contaminants reaching the river would increase, and the likelihood of juvenile PS Chinook salmon and PS steelhead being exposed to the contaminants would increase.

In summary, for Puget Sound Chinook salmon and Puget Sound steelhead, the extent of take for this action is defined as:

- A combined total of 66 juvenile PS Chinook salmon and PS steelhead captured, with a maximum of 4 seriously injured or killed during fish salvage;
- In-water work July 1 through August 31 for construction years 1 and 2, and July 16 through August 31 for construction year 3;
- Vibratory and impact installation of steel pipe piles no larger than 12 inches in diameter;
- Vibratory installation of steel sheet piles;
- Vibratory extraction of steel pipe piles, steel sheet piles, and timber piles;
- A visible turbidity plume not to exceed 300 feet from the project site during pile extraction; and
- A new 600-foot long by 50-foot wide bridge.
- A new lighting system that would cause no more than 0.1 fc of nighttime artificial illumination on the river surface along either side of both bridges, and no more than 0.8 fc on the river surface along the 10-foot gap between the two bridges.
- A new stormwater treatment system with two treatment modules that would remove 80% of TSS, 50% of total phosphorous, 30% of dissolved copper, 60% of dissolved zinc, and petroleum-based chemicals to satisfy state standards from runoff within the minimum design flows of 0.113 and 0.060 cubic feet per second (cfs), for the north and south modules respectively. Effluent would be discharged through diffusers no closer than 150 feet inland from the OHWM of the river.

Some of these take surrogates could be construed as partially coextensive with the proposed action. However they nevertheless function as effective reinitiation triggers. The construction-related take surrogates will likely be monitored on a near-daily basis; thus any exceedance of the surrogates will be apparent in real-time and well before the project is completed. Further, if the size the bridge or its lighting system exceeds the proposal, it could still meaningfully trigger reinitiation because the FHWA has authority to conduct compliance inspections and to take actions to address non-compliance, including post-construction (33 CFR 326.4).

2.9.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead, nor is it likely to destroy or adversely modify designated critical habitat for either of these species (Section 2.8).

2.9.3 Reasonable and Prudent Measures (RPM)

“Reasonable and prudent measures” are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

The FHWA shall:

1. Minimize incidental take of PS Chinook salmon and PS steelhead from fish salvage.

2. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to construction-related noise and activity.
3. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to contaminated forage.
4. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to structure-related altered light.
5. Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to structure-related contaminated water.
6. Ensure the implement monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded.

2.9.4 Terms and Conditions

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

1. To implement RPM Number 1, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to fish salvage, the FHWA shall require The City to:
 - a. Require their contractors to limit fish salvage July 1 through August 31.
 - b. Require their contractors to comply with the WSDOT Fish Removal Protocol and Standards identified in the project BA.
2. To implement RPM Number 1, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to construction-related noise and activity, the FHWA shall require The City to:
 - a. Require their contractors to limit in-water work to July 1 through August 31 for construction years 1 and 2, and to July 16 through August 31 for construction year 3;
 - b. Require their contractors to limit impact pile driving to proofing of 12-inch steel pile piles;
 - c. Require their contractors to utilize wood blocks for all impact driving, including upland driving;
 - d. Require their contractors to utilize an enclosed bubble curtain for all in-water impact pile driving; and
 - e. Require their contractors to comply with the Impact Avoidance and Minimization Measures, and EFH Conservation Measures that are identified in the project BA, and the Provisions that are identified in the WDFW HPA for the project.

3. To implement RPM Number 3, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to contaminated forage, the FHWA shall require The City to:
 - a. Require their contractors to comply with the Impact Avoidance and Minimization Measures, and EFH Conservation Measures that are identified in the project BA, and the Provisions that are identified in the WDFW HPA for the project; and
 - b. Require their contractors to adjust work practices, particularly pile extraction, to ensure that turbidity does not exceed 300 feet downstream from the project site, and to halt work should the visible turbidity plume approach and that range.
4. To implement RPM Number 4, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to structure-related altered light, the FHWA shall require The City to:
 - a. Ensure that the width of the new west bridge does not exceed 50 feet; and
 - b. Ensure that nighttime artificial illumination on the river surface does not exceed 0.1 fc along the sides of the bridge pair, or 0.8 fc between them.
5. To implement RPM Number 5, Minimize incidental take of PS Chinook salmon and PS steelhead from exposure to structure-related contaminated water, the FHWA shall require The City to:
 - a. Implement the programmatic approach to monitoring detailed in the Programmatic Monitoring Approach for Highway Stormwater Runoff in Support of Endangered Species Act (ESA) Section 7 Consultations (WSDOT 2009);
 - b. Use the HI-RUN model if the effects to listed species and their habitats may be above the biological thresholds; and
 - c. Report to NMFS the total pre- and post-project PGIS in acres and the net increase in PGIS.
6. To implement RPM Number 6, implement monitoring and reporting to confirm that the take exemption for the proposed action is not exceeded, the City shall collect and report details about the take of listed fish. That plan shall:
 - a. Require the contractor to maintain and submit fish salvage logs to verify that all take indicators are monitored and reported. Minimally, the logs should include:
 - i. The identity (name, title, organization), qualification, and contact information of the persons conducting fish salvage, and the person completing the report;
 - ii. The location, date, time, and air and water temperatures;
 - iii. The method(s) of capture and handling procedures that were used; and
 - iv. The species and quantities of captured fish, and their disposition at release (i.e. alive with no apparent injuries, alive with apparent minor/serious injuries, dead with/without apparent injuries).
 - b. Require the contractor to maintain and submit construction logs. Minimally, the logs should include:
 - i. The dates (with workday start and stop times) and descriptions of all in-water work, pile installation and extraction (including upland);
 - ii. The type, size, and number of piles installed or extracted;
 - iii. The method or installation or extraction;
 - iv. The application wood blocks and enclosed bubble curtains;

- v. The extent (feet) and duration of visible turbidity plumes downstream from pile extraction; and
- vi. The dimensions (length, width, height above the water) of bridge when constructed.
- c. Include periodic monitoring of the river surface to ensure that artificial illumination does not exceed 0.1 fc along the sides of the bridge set or 0.8 fc between them.
- d. Include periodic monitoring of the stormwater treatment system to ensure that it meets or exceeds the capacity for flow and pollutant reduction identified in the effects analysis section of this opinion.
- e. Establish procedures for the submission of construction logs and other materials to the appropriate FHWA office.
- f. Submit electronic post-construction reports annually to NMFS within six months of the close of the work window. Send the reports to: projectreports.wcr@noaa.gov. Be sure to include the NMFS Tracking number for this project in the subject line: Attn: WCR-2018-10298.

2.10 Conservation Recommendations

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

1. The FHWA should encourage the applicant to increase the capacity of the stormwater treatment system to allow the capture and treatment of a larger percent of the total pollutant loading before bypass of the system would begin.

2.11 Reinitiation of Consultation

This concludes formal consultation for the U.S. Federal Highway Administration' funding of the City of Kenmore's West Sammamish Bridge Replacement Project in King County, Washington. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect essential fish habitat (EFH). The MSA (section 3) defines EFH as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. The analysis that follows is based, in part, on the description of EFH contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The waters and substrates of the action area is designated as freshwater EFH for Pacific Coast Salmon, which within the Sammamish River include Chinook and coho salmon. This EFH is identified and described in Appendix A to the Pacific Coast salmon fishery management plan (PFMC 2014), and is summarized below.

3.2 Adverse Effects on Essential Fish Habitat

The ESA portion of this document (Sections 1 and 2) describes the proposed action and its adverse effects on ESA-listed species and critical habitats, and is relevant to the effects on EFH for Pacific Coast Salmon. Based on the analysis of effects presented in Section 2.5, the proposed action will cause small scale long-term adverse effects on EFH for Pacific salmon through direct or indirect physical and chemical alteration of the water and substrate. It would also alter habitat conditions at the site in a manner that slightly alters migratory behaviors, and reduces natural cover and forage resources for juvenile salmonids.

3.3 Essential Fish Habitat Conservation Recommendations

To reduce construction- and structure-related impacts on the quantity and quality of PC salmon EFH, the proposed action includes a comprehensive set of conservation measures and BMP and installation of a filter-media stormwater treatment system. The proposed action also includes the removal of derelict piles, the planting of over 100 riparian trees, and the installation of LWD. With the possible exception of increasing the capacity of the stormwater treatment system, NMFS knows of no other reasonable measures to further reduce the level of these effects. Therefore, additional conservation recommendations pursuant to MSA (§305(b)(4)(A)) are not necessary.

3.4 Statutory Response Requirement

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

Given that NMFS has made no conservation recommendations pursuant to MSA (§305(b)(4)(A)), the statutory response requirement is waived.

3.5 Supplemental Consultation

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this Opinion is the FHWA and WSDOT. Other users could include WDFW, the government and citizens of King County and the City of Kenmore, and Native American tribes. Individual copies of this Opinion were provided to the COE. The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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