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:
WCRO-2023-03432

June 5, 2024

Todd Tillinger
Chief, Regulatory Division
U.S. Army Corps of Engineers, Seattle District
4735 E. Marginal Way South, Bldg. 1202
Seattle, Washington 98134-2388

Re: Endangered Species Act Section 7(a)(2) Concurrence Letter and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Jesse Engh Bulkhead Construction, Tahuya River, Tahuya, Mason County, Washington (NWS-2021-592)

Dear Mr. Tillinger:

Thank you for your request for after-the-fact consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the U.S. Army Corps of Engineers (Corps) issuance of a permit (NWS-2021-592) for bulkhead construction in Mason County.

Thank you also for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1855(b)) for this action. We have concluded that the action would adversely affect EFH designated under the Pacific Salmon Fishery Management Plans (FMP), and have provided two conservation recommendations. Section 305(b)(4)(B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving these recommendations.

As this is an after-the-fact consultation, and the action has already been completed, any adverse effects occurring from construction activities, including but not limited to take, are not covered in this Biological Opinion. The information in this Biological Opinion evaluates the continued effects from the modifications made to the habitat. In the attached biological opinion, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon, Puget Sound steelhead, or Hood Canal Summer-run chum, or result in the destruction or adverse modification of designated critical habitats for these species.

Please contact NMFS staff biologist Colleen McGee, at colleen.mcgee@noaa.gov or (206) 526-4103, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

cc: Joshua Taylor, U.S. Army Corps of Engineers

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

Jesse Engh Bulkhead Construction
Tahuya River, Tahuya, Mason County, Washington
(NWS-2021-592)

NMFS Consultation Number: WCRO-2023-03432

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook salmon *(Oncorhynchus tshawytscha)*	Threatened	Yes	No	Yes	No
Puget Sound Steelhead *(Oncorhynchus mykiss)*	Threatened	Yes	No	Yes	No
Hood Canal Summer chum *(Oncorhynchus keta)*	Threatened	Yes	No	Yes	No

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

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: June 5, 2024

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1. INTRODUCTION

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

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 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 part 600.

This letter underwent pre-dissemination review using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available at the Environmental Consultation Organizer (https://www.fisheries.noaa.gov/resource/tool-app/environmental-consultation-organizer-eco). A complete record of this consultation is on file at the Oregon Washington Coastal Office.

1.2. Consultation History

Updates to the regulations governing interagency consultation (50 CFR part 402) were effective on May 6, 2024 (89 Fed. Reg. 24268). We are applying the updated regulations to this consultation. The 2024 regulatory changes, like those from 2019, were intended to improve and clarify the consultation process, and, with one exception from 2024 (offsetting reasonable and prudent measures), were not intended to result in changes to the Services' existing practice in implementing section 7(a)(2) of the Act. 89 Fed. Reg. at 24268; 84 Fed. Reg. at 45015. We have considered the prior rules and affirm that the substantive analysis and conclusions articulated in this biological opinion and incidental take statement would not have been any different under the 2019 regulations or pre-2019 regulations.

The U.S. Army Corps of Engineers (Corps) requested an after-the-fact Section 7 informal consultation on December 15, 2023, following previous correspondence between NMFS and the Corps for emergency coordination due to bank erosion at property held by Jesse Engh.[1,]
The Corps provided with its request a Biological Evaluation and a Habitat Management Plan, which both had been prepared in July 2021. They also requested an EFH consultation. The project was assigned in January 2024. NMFS identified several adverse effects and contacted Corps regarding revising the request to formal consultation on January 31, 2024. Formal

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[1] Initial Contact with the Services, Corps-Declared Emergency Action Request for Recommendations to Minimize Effects from Emergency Response, dated July 28, 2021.

consultation was initiated on February 1, 2024. Additional information regarding the construction and scope of work was provided by phone call and email on February 8, 2024.

The construction detailed in this document occurred before the consultation was requested, thus this consultation evaluated the current condition of the habitat and the future implications of the habitat modification. The consultation does not retroactively exempt any take that occurred during construction activities.

1.3. Proposed Federal Action

Under the ESA, “action” means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not.

Under MSA, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded or undertaken by a federal agency (50 CFR 600.910).

The Corps issued an emergency authorization to Jesse Engh to construct a 125-foot (ft) long, 9-ft tall rock revetment (bulkhead) at the current ordinary high-water mark (OHWM) of the Tahuya River to stop landward migration of the river, and place large woody debris (LWD) and engineered log jams (ELJ) to redirect river current away from the property (Figure 1). The current residential house, built before the Mason County Shoreline Master Program (SMP) and Resource Ordinance (RO) required large buffers between structures and fish-bearing streams, is now 8 feet from the continually eroding cut bank of the Tahuya River.

The bulkhead was constructed from rock and supported by quarry spall fill. Three ELJs, consisting of LWD were constructed along the bulkhead, anchored in the channel by river-rock boulders. To further improve habitat, a derelict concrete septic tank, culvert, collapsed building, 24 yards of glass vinyl siding, concrete weirs, an old lawn mower, carpet, and concrete steps were removed from the riparian corridor, invasive species were removed, and native species were planted in the +750 sq. feet of backfill behind the new bulkhead as well as in the riparian buffer along the north bank of the river (Nagel, 2021) (Figure 1).

As this is an after the fact consultation, ‘the action’ refers to the future effects from the constructed bulkhead, ELJ, and the restoration plantings which will remain in the action area.

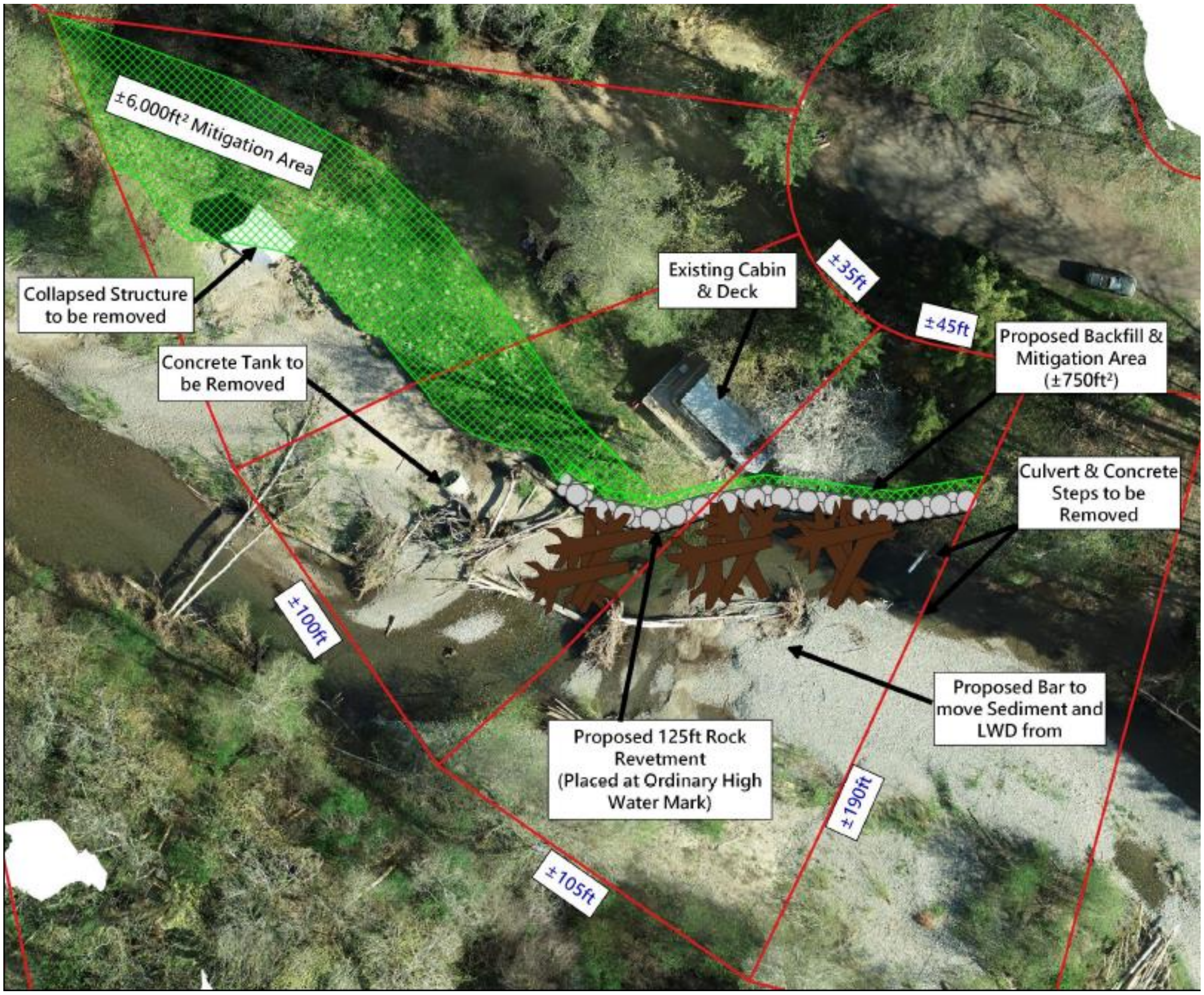

Figure 1. Site Vicinity for completed bulkhead construction, large woody debris and engineered log jam installation, and restoration. (Nagel, 2021)

1.4. Action Area

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

The action area is located at 47.417499, -122.988791, the address is 181 Northeast River Road, Tahuya, 98588, near river mile 7. The construction area includes two parcels in NW1/4, NW1/4, S7, T22N, R2W. The total sq. ft mitigation area where vegetation was restored is +6,000 feet^2. The action area includes the channel as it runs through both parcels, the riparian area surrounding the channel that was modified by the construction and restoration, and approximately 200 feet downstream. The extent of the action area downstream was determined by the downstream effects of bank revetments on natural hydrology.

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 to adversely modify or destroy their designated CH. Per the requirements of the ESA, Federal action agencies consult with NMFS, and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed ESA listed species and their CHs. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

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

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

The designations of CH for PS Chinook salmon and PS Steelhead trout use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the CH regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PBFs, PCEs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific CH.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

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

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each ESA listed species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the ESA listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of CH throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the essential PBFs that help form the conservation value.

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated CHs, in the Pacific Northwest. These changes will not be spatially homogeneous across the Pacific Northwest. Major ecological realignments are already occurring in response to climate change (IPCC WGII, 2022). Long-term trends in warming have continued at global, national, and regional scales. Global surface temperatures in the last decade (the 2010s) were estimated to be 1.09 °C higher than the 1850-1900 baseline period, with larger increases over land ~1.6 °C compared to oceans ~0.88 (IPCC WGI, 2021). The vast majority of this warming has been attributed to anthropogenic releases of greenhouse gases (IPCC WGI 2021). Globally, 2014-2018 were the 5 warmest years on record both on land and in the ocean (2018 was the 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth opportunities in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020). Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

Climate change will impact the forests of the western U.S., which dominate the landscape of many watersheds in the region. Forests are already showing evidence of increased drought severity, forest fire, and insect outbreaks (Halofsky et al. 2020). Additionally, climate change will affect tree reproduction, growth, and phenology, which will lead to spatial shifts in vegetation. Halofsky et al. (2018) projected that the largest changes will occur in low- and high-elevation forests, with the expansion of low-elevation dry forests and diminishing high-elevation cold forests and subalpine habitats.

Forest fires affect salmon streams by altering sediment load, channel structure, and stream temperature through the removal of the canopy. Holden et al. (2018) examined environmental factors contributing to observed increases in the extent of forest fires throughout the western U.S. They found strong correlations between the number of dry-season rainy days and the annual extent of forest fires, as well as a significant decline in the number of dry-season rainy days over the study period (1984-2015). Consequently, predicted decreases in dry-season precipitation, combined with increases in air temperature, will likely contribute to the existing trend toward more extensive and severe forest fires and the continued expansion of fires into higher elevation and wetter forests (Alizedeh 2021).

Agne et al. (2018) reviewed the literature on insect outbreaks and other pathogens affecting coastal Douglas-fir forests in the Pacific Northwest and examined how future climate change may influence disturbance ecology. They suggest that Douglas-fir beetle and black stain root disease could become more prevalent with climate change, while other pathogens will be more affected by management practices. Agne et al. (2018) also suggested that due to complex interacting effects of disturbance and disease, climate impacts will differ by region and forest type.

Freshwater Environments

The following is excerpted from Siegel and Crozier (2019), who present a review of recent scientific literature evaluating effects of climate change, describing the projected impacts of climate change on instream flows:

Cooper et al. (2018) examined whether the magnitude of low river flows in the western U.S., which generally occur in September or October, are driven more by summer conditions or the prior winter's precipitation. They found that while low flows were more sensitive to summer evaporative demand than to winter precipitation, interannual variability in winter precipitation was greater. Malek et al. (2018), predicted that summer evapotranspiration is likely to increase in conjunction with declines in snowpack and increased variability in winter precipitation. Their results suggest that low summer flows are likely to become lower, more variable, and less predictable.

The effect of climate change on groundwater availability is likely to be uneven. Sridhar et al. (2018) coupled a surface-flow model with a ground-flow model to improve predictions of surface water availability with climate change in the Snake River Basin. Projections using RCP 4.5 and 8.5 emission scenarios suggested an increase in water table heights in downstream areas of the basin and a decrease in upstream areas.

As cited in Siegel and Crozier (2019), Isaak et al. (2018), examined recent trends in stream temperature across the Western U.S. using a large regional dataset. Stream warming trends paralleled changes in air temperature and were pervasive during the low-water warm seasons of 1996-2015 (0.18-0.35°C/decade) and 1976-2015 (0.14-0.27°C/decade). Their results show how continued warming will likely affect the cumulative temperature exposure of migrating sockeye salmon (*O. nerka*) and the availability of suitable habitat for brown trout (*Salmo trutta*) and rainbow trout (*O. mykiss*). Isaak et al. (2018) concluded that most stream habitats will likely remain suitable for salmonids in the near future, with some becoming too warm. However, in cases where habitat access is currently restricted by dams and other barriers salmon and steelhead will be confined to downstream reaches typically most at risk of rising temperatures unless passage is restored (FitzGerald et al. 2020, Myers et al. 2018).

Streams with intact riparian corridors that lie in mountainous terrain are likely to be more resilient to changes in air temperature. These areas may provide refuge from climate change for a number of species, including Pacific salmon. Krosby et al. (2018), identified potential stream refugia throughout the Pacific Northwest-based on a suite of features thought to reflect the ability of streams to serve as such refuges. Analyzed features include large temperature gradients, high canopy cover, large relative stream width, low exposure to solar radiation, and low levels of human modification. They created an index of refuge potential for all streams in the region, with mountain area streams scoring the highest. Flat lowland areas, which commonly contain migration corridors, were generally scored lowest, and thus were prioritized for conservation and restoration. However, forest fires can increase stream temperatures dramatically in a short time span by removing riparian cover (Koontz et al. 2018), and streams influenced by low snowpack melt due to climate change may see the largest increases in stream temperature due to the removal of temperature buffering (Yan et al. 2021). These processes may threaten some habitats that are currently considered refugia.

Marine and Estuarine Environments

Along with warming stream temperatures and concerns about sufficient groundwater to recharge streams, a recent study projects nearly complete loss of existing tidal wetlands along the U.S. West Coast, due to sea-level rise (Thorne et al. 2018). California and Oregon showed the greatest threat to tidal wetlands (100 percent), while 68 percent of Washington tidal wetlands are expected to be submerged. Coastal development and steep topography prevent horizontal migration of most wetlands, causing the net contraction of this crucial habitat.

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, salmon life-history traits, and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey.

Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

Perhaps the most dramatic change in physical ocean conditions will occur through ocean acidification and deoxygenation. It is unclear how sensitive salmon and steelhead might be to the direct effects of ocean acidification because of their tolerance to a wide pH range in freshwater (see Ou et al. 2015 and Williams et al. 2019), however, the impacts of ocean acidification and hypoxia on sensitive species (e.g., plankton, crabs, rockfish, groundfish) will likely affect salmon indirectly through their interactions as predators and prey. Similarly, increasing frequency and duration of harmful algal blooms may affect salmon directly, depending on the toxin (e.g., saxitoxin vs domoic acid), but will also affect their predators (seabirds and mammals). The full effects of these ecosystem dynamics are not known but will be complex. Within the historical range of climate variability, less suitable conditions for salmonids (e.g., warmer temperatures, lower stream flows) have been associated with detectable declines in many of these listed units, highlighting how sensitive they are to climate drivers (Ford 2022, Lindley et al. 2009, Williams et al. 2016, Ward et al. 2015). In some cases, the combined and potentially additive effects of poorer climate conditions for fish and intense anthropogenic impacts caused the population declines that led to these population groups being listed under the ESA (Crozier et al. 2019).

Climate change effects on salmon and steelhead

In freshwater, year-round increases in stream temperature and changes in flow will affect physiological, behavioral, and demographic processes in salmon, and change the species with which they interact. For example, as stream temperatures increase, many native salmonids face increased competition with more warm-water tolerant invasive species. Changing freshwater temperatures are likely to affect incubation and emergence timing for eggs, and in locations where the greatest warming occurs may affect egg survival, although several factors impact inter-gravel temperature and oxygen (e.g., groundwater influence) as well as sensitivity of eggs to thermal stress (Crozier et al. 2020). Changes in temperature and flow regimes may alter the amount of habitat and food available for juvenile rearing, and this in turn could lead to a restriction in the distribution of juveniles, further decreasing productivity through density dependence. For migrating adults, predicted changes in freshwater flows and temperatures will likely increase exposure to stressful temperatures for many salmon and steelhead populations, and alter migration travel times and increase thermal stress accumulation for ESUs or DPSs with early-returning (i.e., spring- and summer-run) phenotypes associated with longer freshwater holding times (Crozier et al. 2020, FitzGerald et al. 2020). Rising river temperatures increase the energetic cost of migration and the risk of on-route or pre-spawning mortality of adults with long freshwater migrations, although populations of some ESA-listed salmon and steelhead may be able to make use of cool-water refuges and run-timing plasticity to reduce thermal exposure (Keefer et al. 2018, Barnett et al. 2020).

Marine survival of salmonids is affected by a complex array of factors including prey abundance, predator interactions, the physical condition of salmon within the marine environment, and carry over effects from the freshwater experience (Holsman et al. 2012, Burke et al. 2013). It is generally accepted that salmon marine survival is size-dependent, and thus larger and faster-growing fish are more likely to survive (Gosselin et al. 2021). Furthermore, early arrival timing in the marine environment is generally considered advantageous for populations migrating through the Columbia River. However, the optimal day of arrival varies across years, depending on the seasonal development of productivity in the California Current, which affects prey available to salmon and the risk of predation (Chasco et al. 2021). Siegel and Crozier (2019) point out the concern that for some salmon populations, climate change may drive mismatches between juvenile arrival timing and prey availability in the marine environment. However, phenological diversity can contribute to metapopulation-level resilience by reducing the risk of a complete mismatch. Carr-Harris et al. (2018), explored the phenological diversity of marine migration timing in relation to zooplankton prey for sockeye salmon (*O. nerka*) from the Skeena River of Canada. They found that sockeye migrated over a period of more than 50 days, and populations from a higher elevation and further inland streams arrived in the estuary later, with different populations encountering distinct prey fields. Carr-Harris et al. (2018) recommended that managers maintain and augment such life-history diversity.

Synchrony between terrestrial and marine environmental conditions (e.g., coastal upwelling, precipitation, and river discharge) has increased in spatial scale causing the highest levels of synchrony in the last 250 years (Black et al. 2018). A more synchronized climate combined with simplified habitats and reduced genetic diversity may be leading to more synchrony in the productivity of populations across the range of salmon (Braun et al. 2016). For example, salmon productivity (recruits/spawner) has also become more synchronized across Chinook populations from Oregon to the Yukon (Dorner et al. 2018, Kilduff et al. 2014). In addition, Chinook salmon have become smaller and younger at maturation across their range (Ohlberger 2018). Other Pacific salmon species (Stachura el. al. 2014) and Atlantic salmon (Olmos et al. 2020) also have demonstrated synchrony in productivity across a broad latitudinal range.

At the individual scale, climate impacts on salmon in one life stage generally affect body size or timing in the next life stage and negative impacts can accumulate across multiple life stages (Healey 2011; Wainwright and Weitkamp 2013, Gosselin et al. 2021). Changes in winter precipitation will likely affect incubation and/or rearing stages of most populations. Changes in the intensity of cool season precipitation, snow accumulation, and runoff could influence migration cues for fall, winter, and spring adult migrants, such as coho and steelhead. Egg survival rates may suffer from more intense flooding that scours or buries redds. Changes in hydrological regime, such as a shift from mostly snow to more rain, could drive changes in life history, potentially threatening diversity within an ESU (Beechie et al. 2006). Changes in summer temperature and flow will affect both juvenile and adult stages in some populations, especially those with yearling life histories and summer migration patterns (Crozier and Zabel 2006; Crozier et al. 2010, Crozier et al. 2019).

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018), compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook from the mid-Columbia than those from the Snake River Basin.

In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

The summaries that follow describe the status of the ESA-listed species, and their designated CHs, 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 listing regulations and CH designations published in the Federal Register and in the recovery plans and other sources at:https://www.fisheries.noaa.gov/species-directory/threatened-endangered and are incorporated here by reference.

2.2.1 Status of Critical Habitat

This section describes the status of designated CH affected by the proposed action by examining the condition and trends of the essential physical and biological features of that habitat throughout the designated areas. These features are essential to the conservation of the ESA-listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration, and foraging).

For salmon and steelhead, NMFS ranked watersheds within designated CH at the scale of the fifth-field hydrologic unit code (HUC_5) in terms of the conservation value they provide to each listed species they support.[2] The conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS's CH analytical review teams (CHARTs) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area (NOAA Fisheries 2005). Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (*e.g.*, one of a very few spawning areas), a unique contribution of the population it served (*e.g.*, a population at the extreme end of geographic distribution), or if it serves another important role (*e.g.*, obligate area for migration to upstream spawning areas).

The physical or biological features of freshwater spawning and incubation sites, include water flow, quality and temperature conditions, suitable substrate for spawning and incubation, as well as migratory access for adults and juveniles (Table 1). These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical or biological features of freshwater migration corridors associated with spawning and incubation sites include water flow, quality and temperature conditions supporting larval and adult mobility, abundant prey items supporting larval feeding after yolk sac depletion, and free passage (no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas and they allow larval fish to proceed downstream and reach the ocean.

[2] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" NOAA Fisheries (2005). Assessment of NOAA Fisheries' critical habitat analytical review teams for 12 evolutionarily significant units of West Coast salmon and steelhead. National Marine Fisheries Service, Protected Resources Division. Portland, Oregon..

Table 1. Primary constituent elements (PBFs) of critical habitats designated for ESA-listed salmon and steelhead species considered in the opinion and corresponding species life history events.

Primary Constituent Elements Site Type	Primary Constituent Elements Site Attribute	Species Life History Event
Freshwater spawning	Substrate Water quality Water quantity	Adult spawning Embryo incubation Alevin growth and development
Freshwater rearing	Floodplain connectivity Forage Natural cover Water quality Water quantity	Fry emergence from gravel Fry/parr/smolt growth and development
Freshwater migration	Free of artificial obstruction Natural cover Water quality Water quantity	Adult sexual maturation Adult upstream migration and holding Kelt (steelhead) seaward migration Fry/parr/smolt growth, development, and seaward migration
Estuarine areas	Forage Free of artificial obstruction Natural cover Salinity Water quality Water quantity	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 areas	Forage Free of artificial obstruction Natural cover Water quantity Water quality	Adult growth and sexual maturation Adult spawning migration Nearshore juvenile rearing

Puget Sound Recovery Domain. Critical habitat has been designated in Puget Sound for Puget Sound (PS) Chinook salmon, PS steelhead, Hood Canal summer-run (HCSR) chum salmon, and other fish[3]. 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 is systemically impaired by anthropgenic changes.

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 large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat.

[3] For this consultation only PS Chinook salmon, PS steelhead, and HCSR chum are relevant; the critical habitat of the other species in this domain will not be further addressed.

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (Shared Strategy for Puget Sound 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 (Shared Strategy for Puget Sound 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 mortality to fish. 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 (Hood Canal Coordinating Council 2005, Shared Strategy for Puget Sound 2007). The Hood Canal Coordinating Council, on the other hand, has engaged in extensive watershed restoration to benefit Hood Canal summer-run chum.

In summary, CH throughout the Puget Sound basin has been degraded by numerous management activities. Changes in habitat quantity, availability, and diversity, as well as flow, temperature, sediment load and channel instability are common limiting factors in areas of CH.

2.2.2 Status of Species

For Pacific salmon, steelhead, and certain other species, we commonly use the four "viable salmonid population" (VSP) criteria (McElhany, Ruckelshaus et al. 2000) to assess the viability of the populations that, together, 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 (McElhany, Ruckelshaus et al. 2000).

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

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

For species with multiple populations, once the biological status of a species’ populations has been determined, we assess the status of the entire species using criteria for groups of populations, as described in recovery plans and guidance documents from technical recovery teams. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany, Ruckelshaus et al. 2000).

The summaries that follow describe the status of the ESA-listed species, and their designated CHs, 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 CH designations published in the Federal Register (Table 2).

Table 2, below, provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 2. Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05 (70 FR 37159)	Shared Strategy for Puget Sound 2007 NMFS 2006	NMFS 2016; Ford 2022	This ESU comprises 22 populations distributed over five geographic areas. All Puget Sound Chinook salmon populations continue to remain well below the TRT planning ranges for recovery escapement levels. Most populations also remain consistently below the spawner–recruit levels identified by the TRT as necessary for recovery. Across the ESU, most populations have increased somewhat in abundance since the last status review in 2016, but have small negative trends over the past 15 years. Productivity remains low in most populations. Overall, the Puget Sound Chinook salmon ESU remains at "moderate" risk of extinction.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas 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
Hood Canal summer-run chum	Threatened 6/28/05	Hood Canal Coordinating Council 2005 NMFS 2007	NMFS 2016; Ford 2022	The Puget Sound Technical Recovery Team identified two independent populations for Hood Canal summer chum, one which includes the spawning aggregations from rivers and creeks draining into the Strait of Juan de Fuca, and one which includes spawning aggregations within Hood Canal proper. Natural-origin spawner abundance has increased since ESA listing, and spawning abundance targets in both populations have been met in some years. Productivity had increased at the time of the last review (NWFSC 2015), but has been down for the last three years for the Hood Canal population, and for the last four years for the Strait of Juan de Fuca population. Productivity of individual spawning aggregates shows that only two of eight aggregates have viable performance. Spatial structure and diversity viability parameters, as originally determined by the TRT, have improved, and nearly meet the viability criteria for both populations.	• Reduced floodplain connectivity and function • Poor riparian condition • Loss of channel complexity Sediment accumulation • Altered flows and water quality

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				Despite substantive gains toward meeting viability criteria in the Strait of Juan de Fuca and Hood Canal summer chum salmon populations, the ESU still does not meet all of the recovery criteria for population viability at this time. Overall, the Hood Canal summer-run chum salmon ESU therefore remains at "moderate" risk of extinction.	
Puget Sound steelhead	Threatened 5/11/07	NMFS 2019	NMFS 2016; Ford 2022	This DPS comprises 32 populations. Viability of has improved somewhat since the PSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance were observed in a number of populations over the last five years within the Central & South Puget Sound and the Hood Canal & Strait of Juan de Fuca MPGs, primarily among smaller populations. There were also declines for summer- and winter-run populations in the Snohomish River basin. In fact, all summer-run steelhead populations in the Northern Cascades MPG are likely at a very high demographic risk.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization

2.3 Environmental Baseline

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

2.3.1 Habitat Conditions in the Action Area

Factors including climate change, contaminants, habitat modification, nutrients and pathogens affect the condition and quantity of habitat features and processes necessary to support the listed species in the area

The top of the Tahuya watershed comprises mainly of a Washington Department of Natural Resources (DNR) forest. The river meanders down a valley into Hood Canal through small scale timberlands, rural developments, and hobby farms. (Bernthal and Rot 2001)

Fish habitat in the action area has been adversely affected by a variety of in-water and terrestrial human activities, including small scale agriculture, urbanization, and climate change (as described in Section 2.2). Analysis of historical habitat distributions in a Geographical Information System (GIS) indicates that vegetation has stayed relatively consistent since 1984. The most noticeable change over that time period (1984 – 2022) is clear cutting in the surrounded areas for forestry, however, this did not invade the riparian buffer zone based on visual analysis. (Figure 2)

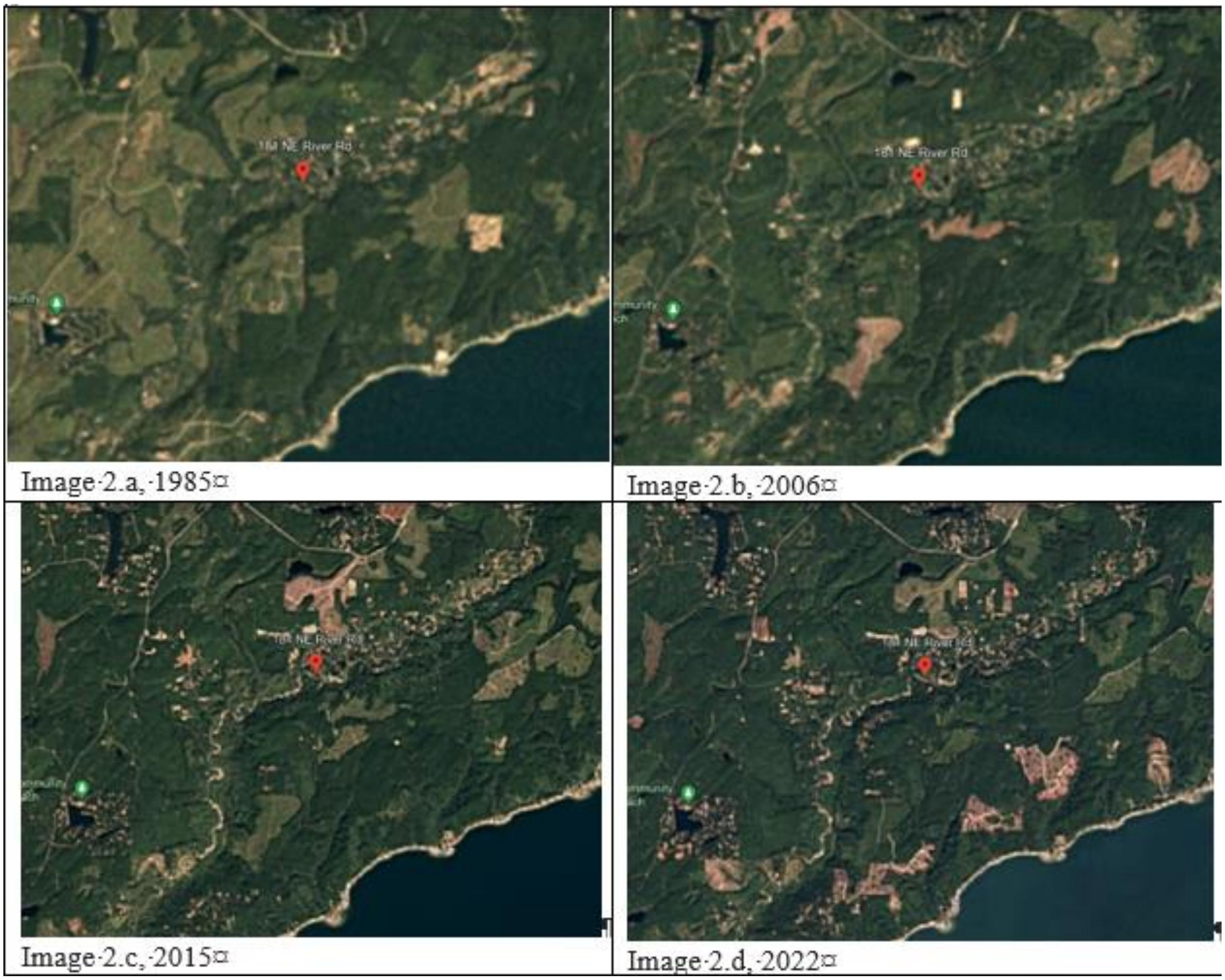

Figure 2. Google earth images of the action area from 1985 to 2022.

Of all the anthropogenic changes to the river, the greatest basin-wide changes are due to logging. Loss of tree cover results in increased precipitation (less water is diverted through the foliage and absorbed into the tree roots) which increases flows, thereby increasing bed and bank erosion. The solution to this increased erosion is bank revetments, such as the action described in this document. Revetments tend to have a more localized impact on channel morphology, limiting the lateral movements of the channel and increasing sediment supply to downstream reaches. The action area specifically, at river mile 7, had higher sediment loading than any other reach (aside from the upper basin) before the action occurred (Starkes and Jensen 2020).

Urban development over the decades, including, but not limited to, bulkheads, has limited the natural hydrologic processes and cut off the Tahuya River from its natural floodplain. The action area is well within the FEMA regulatory floodplain (Figure 3).

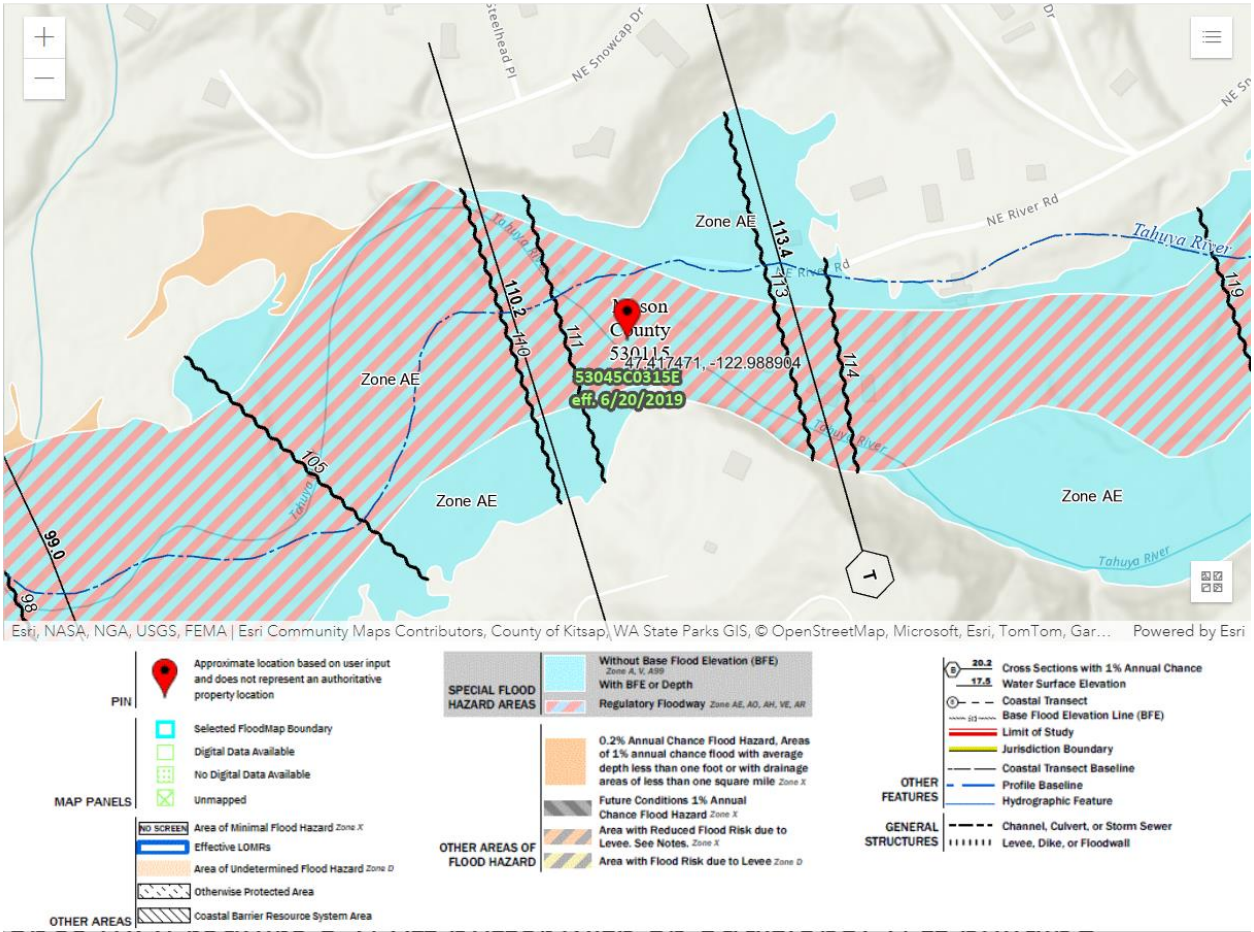

Figure 3. Floodplain Map of the action area from FEMA (FEMA)

The underlying geology is gravel in the Tahuya River basin. Surface water withdrawals are prohibited during low flows to protect the wetlands and flow within the basin. While this offers some protection, development of the basin has the potential to withdraw more water than the basin can support and damage the habitat with low flows. (Bernthal and Rot 2001) In 2011 and 2012, baseflows at USGS stations at river mile 7 ranged between 5 and 12 cfs. (Merten, Rae et al. 2017) The minimum instream flow required by Washington State Law is 5.5cfs (WAC 173-515-030) Additional water withdrawal, naturally caused by climate change (as discussed in section 2.2) or from continued urbanization and development, has the potential to lower water flow below the threshold established by WAC.

In addition to the urban features along the Tahuya River, there are multiple beaver damns which create diverse conditions in the channel with wetlands and fast, channelized portions of the river. On a macro level, this creates excellent salmon habitat with rearing, holding and migration corridors (Bernthal and Rot 2001).

The habitat potential of the Tahuya River is mixed. The channel is 79 percent spawning gravel and 10.5 percent fines. The frequency and percentage of pools, and large woody debris were all assessed as good. The channel was found lacking in presence of key pieces of LWD that are stable in the stream reach and are capable of retaining other pieces of wood, lacking in recruitment potential for all LWD, and lacking in canopy cover (Bernthal and Rot 2001).

The Tahuya River exceeds some of the state water quality thresholds. Dissolved Oxygen (DO) higher than 6.5 mg/L can be harmful to salmonid rearing and migration, and 10 mg/L can be harmful to salmonid spawning and core habitat for summer runs (such as HCSR Chum). (WAC 2024) Sampling in 2023 logged DO as 11.68 mg/L.(Services 2023) (Services, 2023) Optimal temperature ranges for Chinook, steelhead, and chum range from 4.4-19.4º C depending on the life stage of the individual. Temperature data from August and September of 1994 and 1995 found that the Tahuya River exceeded 16.3º C up to 16 days during the sample period. This exceeds the temperature thresholds for rearing, incubation, and spawning for all three ESA listed species and exceeds the temperature thresholds for upstream migration for all but Chinook (Bernthal and Rot 2001).

The Mason County Shoreline Master Program was adopted under the Shoreline Management Act of 1971 (RCW 90.58, WAC Ch. 173-29) in response to anthropogenic pressures on the shorelines. The Program balances protecting the public interests and rights associated with shorelines and private property rights. The regulations within the Program were intended to protect public health, land, vegetation, wildlife, and aquatic life. All new structures, and remodeled existing structures, built after 2003 are required to: a) be designed/maintained in a manner that maintains shoreline ecological functions, b) mitigate any unavoidable adverse impacts to ensure no net loss, c) maintain minimum shoreline buffers plus building setbacks, d) limit impervious coverage at a rate appropriate for the initial category of land, e) limit vegetation clearing to what is strictly necessary, f) utilize best management practices during construction work to limit stormwater runoff, erosion and all other pollution.(RCW 90.58 2021) We can infer from this that, while urbanization and development are continuing to increase along the Tahuya River, structures constructed and remodeled post 2003 are less impactful to the env. Baseline than those constructed earlier.

2.3.2 Species in Action Area

There are three ESA listed species in the action area, PS Chinook salmon, PS Steelhead, and HCSR chum.

PS Steelhead from the South Hood Canal Tributaries population are present year around in the Tahuya River basin – the hatchery proportion of the Tahuya winter run is approximately 50 percent. Adults begin migrating upstream in October and begin spawning in mid-January. Spawning in the Tahuya begins in February and last until the beginning of June (peak spawning is in April) and juveniles develop in the gravel until the end of August. Juveniles rear for 2 years on average, but range from 1-3 years, before out-migrating from mid-February to mid-May (Hard, Myers et al. 2007, Starkes and Jensen 2020). The 2015-2019 abundance estimate of this tributary run was 91 natural spawners (Ford 2022).

HCSR chum from the Hood Canal population are present in the Tahuya River basin approximately 8 months a year. The natural Tahuya River spawning population is considered extinct. Reintroduction in the Tahuya river begun in 1995 did not prove successful, and this supplementation was phased out. Adults migrate upstream in September and begin spawning shortly after. Typically, HCSR chum spawn within the first 3-5 miles of the river, but a 2016 survey found redds and spawned carcasses between miles 5-7.5 (near the action area) for the first time on record, showing that the population is expanding. Juveniles develop in the gravel until mid-April and out migrate from February to mid-April. They do not rear in freshwater in this basin, thus there are likely no HCSR chum present in the system from May to mid-August. (Hood Canal Coordinating Council 2005, Starkes and Jensen 2020)

PS Chinook salmon migrate up the Tahuya River in June and spawn from mid-September to mid-October. The Tahuya River is not considered to have historically supported self-sustaining Chinook salmon populations and presence in this river is largely expected to be hatchery strays (NMFS 2006). Juveniles develop in the gravel until early-February and rear until mid-July. Out-migration occurs during the later portion of the rearing season, from mid-April to mid-July. It is likely that Chinook will be in the action area all year at various life stages.(Starkes and Jensen 2020) Lisa G. Crozier, 2019)

2.4. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.02).

As described in Section 1.3, the Corps has built a bulkhead along the shoreline of the Tahuya River to prevent further natural erosion from damaging a structure on shore. As this is an after-the-fact consultation, the effects assessed in this document are from the continued presence of the bulkhead in the channel as so far as the extent of the action area as described in section 1.4. Any effects to ESA listed species or their CH caused by the construction actives or during the construction process are not assessed in this document.

Effects from the continued presence of the bulkhead in the action area include: 1) altered flow from the bank revetments and altered sediment quantity and quality adjacent to and downstream of the armored section, 2) restriction of habitat forming processes, and 3) reduced shade along the structure. Beneficial effects from the project include the 4) future re-establishment of riparian conditions due to plantings along the top of the bulkhead 5) habitat complexity created by the addition of large woody debris log jams engineered along the bulkhead, and the 6) reduced bank and nearshore degradation from the anthropologic debris removed. We evaluate in the following sections the influence of these effects on critical habitat, and species exposure and response to these effects.

2.4.1 Effects on Critical Habitat

The action area is located within designated CH for HCSR chum, PS Chinook salmon, and PS steelhead.

The effects listed above will modify several PBFs in the action area:

1) *Altered stream flow* can lead to significant scouring, removing suitable spawning substrate, and increase areas of stream energy reducing the suitability for juvenile rearing fish. If stream energy is reflected to un-armored areas across the stream or downstream, this can create an erosive force that contributes fine material, occluding interstitial spaces. Ideal bed structure for spawning is gravel not so large that fish can't move individual rocks to create a redd, and sediment not so fine that the eggs are smothered. Sediment larger than gravel, such as cobbles and boulders, provide rest from strong flows while the juveniles are rearing. The diversity of sediment/gravel is key to this habitat feature and bank revetments, such as bulkheads, alter this natural distribution. The sediment size and distribution within the channel can also be affected by the LWD and ELJ. At low flows, LWD and ELJ encourage scour which creates pools and flushes fine sediment downstream. (C. Andrew Dolloff, 2003) As salmon are uniquely adapted to the habitat conditions of their natal stream, any alterations to sediment have the potential to be harmful and less suitable locations for resting and refugia of juvenile fish. Together, modified hydrology and sediment conditions can result in the action area having fewer appropriate substrate conditions to support spawning, incubation, and larval development. Spawning and rearing conditions are slightly diminished in the action area.

2) *Restriction of habitat forming processes*. The presence of the bulkhead and large wood installation are intended to direct the thalweg/river energy away from the bank. Bulkheads, like other bank revetments, limit the natural movements of channels. Where the action area lies on the Tahuya River is an especially influx portion of the river historically. This is evident by the bank erosion creating the need for this action in the first place. Between 1951 and 1969 the river around river mile 7, near the action area, migrated up to 500 ft north. (Final Tahuya Assessment) Floodplains are critical to salmonids, contributing to large woody debris accumulation, habitat with high abundance of food and fewer predators, refuse from high velocity flows, course sediments which filters nutrients and toxins, and diversion of fine sediment from spawning grounds. All of these contributions create spawning and rearing habitat during high flows, as well as generally good habitat for all life stages. (NMFS 2011)

In a natural environment, such erosion and lateral migration would be considered a habitat forming process that creates habitat complexity (i.e. off channel or side channel habitat, braided streams) and floodplain connectivity which support rearing life stages for both PS Chinook salmon (particularly spring Chinook salmon) and PS steelhead, which have longer freshwater rearing life history behaviors. In the action area, the floodplain connectivity to form and maintain physical habitat condition and support juvenile growth and mobility is diminished due to the bank revetment.

3) *Reduced shade* and 4) *Improved natural cover from* riparian area alterations will be both negative and positive, changing over time. Removal of vegetation in the location where the bank was armored was offset with replacement plantings. If replacement plantings have high survival rate, the loss of shade, cover, and detrital prey (insects that fall into the river from the riparian canopy) would be a temporary loss, persisting for about 5- 10 years until the plantings have enough growth to re-establish canopy. Rearing conditions for this habitat feature are slightly diminished but likely to regain their baseline level of function over sufficient time.

5) *Habitat complexity* is modified in the action area. The natural bank, before the action, was eroded and undercut creating shade at the edge of the channel creating a niche of natural cover. The installed bulkhead filled in the eroded bank with gravel and rip rap, exposing the edge of the channel to sun. Shade lowers water temperatures and obscures juveniles from predators. When shade is removed from the channel, from clearing or other mechanisms, and its protection is no longer present, juveniles move from the shallow edges of the channel into deeper water to seek cooler conditions, resulting in them being more exposed to predators. (Kahler, Grassley and Beauchamp 2000). Also, a rock face in contact with water can absorb thermal energy and release heat back to the stream, modifying the suitability of stream temperatures for rearing fish. The stasis in the channel alignment and the reduction in natural cover is somewhat offset be the introduction of the engineered log jam/woody debris.

Engineered log jams and large woody debris are part of the bulkhead design, as discussed in Section 1.3. Large wood provides many essential habitat features, one of which is to create deep scour pools juvenile salmonids use to rest in between feeding. Secondly, large wood presence in channels creates variable habitat with pools of various depths and sediments of different sizes, thereby creating a variety of salmonid habitats. Large wood provides a structure to support algae and microorganism growth, and catches and retains spawned salmon carcasses, all contributing the nutrients in the ecosystem.(Dolloff and Warren 2003) The large wood can also provide cover and refuge from predatory birds or larger fish. There was little to no LWD in the channel as part of the environmental baseline. The addition of LWD and ELJ will benefit the CH by providing habitat features that were previously lacking. We consider this aspect of rearing habitat to be at incrementally improved for the foreseeable future, relative to the baseline condition.

6) *General habitat condition* was improved by the removal of human generated debris (trash) in and adjacent to the stream. Spawning and rearing conditions are slightly improved for the long term by this aspect of the action.

2.4.2 Effects on Listed Species

Effects of the action on ESA listed species are based on individual fish exposure to the habitat changes described above, or effects occurring to the fish themselves. In this case, the Tahuya population or subpopulation of each of the three ESA-listed salmonids occur in the action area, and both returning spawners and future cohorts of redds and juveniles will be exposed to the habitat effects of the action articulated above, for the foreseeable future. In other words, all three ESA listed species will be exposed to the action’s effects for many generations at three distinct life stages.

Eggs

All three species spawn in the action area and will experience substrate changes. Increasing fine sediment in spawning grounds lowers the survival rate for all salmonids, including the three ESA listed species addressed in this document. There are several theories addressing the mechanisms that lead to this lowered survival rate. One of which suggests that fine sediment blocks oxygenated water from the eggs, causing delayed embryo development, early emergence, and/or smaller size at emergence. For both Chinook and steelhead, survival decreased rapidly when percentage fines was greater than 20 percent. (Jenson, Steel et al. 2009), If small rock/cobble is scoured out this also makes redd construction more difficult and increases the potential for redd superimposition. Restoration planting will eventually reestablish shade and help ensure appropriate temperatures for egg and alevin survival.

Juveniles

PS steelhead and PS Chinook salmon rear in the action area. HCSR chum out-migrate immediately after hatching and do not inhabit the action area as juveniles. The two ESA listed species who rear juveniles in the action area will be exposed to changes in habitat complexity and hydrology. While the action will preclude habitat forming processes that would increase rearing values, the action will also benefit rearing fish through the addition of LWD and ELJs, as large wood is a CH feature that is currently lacking in the system. A study of coho salmonids in streams throughout Washington and Oregon showed that juveniles have a 1.8-fold increase during the summer immediately following LWD installation and this increased to 3.2-fold the following winter. Steelhead showed a different trend in this study, favoring riffles and fast-water during the summer over the pools created by large woody debris. They did, however, increase in density by 1.7-fold during the winter. Given that the effects of the LWD on the habitat grow each year as the pools deepen and the hydrology shifts to accommodate the structures, we can expect these effects to increase each year following installation (Roni and Quinn 2001). Cover and prey communities within the large wood complex is likely to support juvenile growth and survival.

The installation of these LWD and ELJ are designed to mitigate the effects of the bulkhead. Bulkheads, regardless of the material they are constructed from, do not provide shade/natural cover which juvenile salmon require to hide from predators. Without shade/natural cover, juveniles are either preyed upon along the edges of the channel at a higher rate than normal, or are preyed upon in the new sections of channel they seek refuge in. When fish density increases territorial behavior increases, forcing smaller fish to the external edges of the area of refugia, meaning that some individuals may not successfully compete for prey or refugia. (Kahler et. al, 2000)

Adults

Adult salmon in the action area will be those spawning, or migrating to spawn upstream. We do not believe that migration values will be impaired for adult spawning returners. However, some spawning conditions may be affected as was briefly described above in the section on eggs.

HCSR chum spawn up to the action area currently. The other two ESA listed species, PS Chinook and PS steelhead, both spawn in the action area and upstream of the action area as well. Spawning gravel can be used by female salmonids as long as they are strong enough to move the gravel to create their redd. Larger gravel will begin favoring larger returning fish which produce more eggs up to the threshold of eggs the substrate can hold. When larger salmon lay more eggs than the gravel in their redd can support, the surplus does not survive. Each river’s population of salmonids has been evolving in tandem with the river to lay the exact number of eggs that the gravel can support (Riebe, Sklar et al. 2014). However, in this case, all three salmonids are heavily influenced genetically by hatchery populations and the influence of the action on sediment conditions may occur at a small enough scale that spawning gravels remain consistent and suitable in the action area. The addition of large woody debris is often referenced as beneficial, as it slows river energy which allows trapping and retaining spawning gravel in channels, however, depending on the size of gravel retained there is potential that the modified conditions could shift in a manner that increases the habitat benefits and detriments among the ESA listed species depending on their size (Roni and Quinn 2001).

2.5. Cumulative Effects

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

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

Over the lifetime of the proposed action, some climate effects, described in the baseline, such as warming water temperatures, or increasing variability of volume (low flows, high flows) become more pronounced. These effects could increase food web disruptions, migration success, or other stresses on any or all of the listed species that rely on the action area.

Our analysis also considers how future activities in the Tahuya River basin are likely to influence habitat conditions in the action area.

The land flanking the Tahuya River is a mix of residential, agricultural, forest, and conservation land. All structures built after the Mason Country Shoreline Master Program will be set back from the channel, allowing for natural movement of the river and unencumbered hydrologic process. While continued population growth is expected, new structures are expected to be built back away from the river banks, preventing the need for emergency bank revetments. We also recognize that the Hood Canal Coordinating Council encourages habitat restoration throughout the area including the Tahuya. Accordingly, other than the effects of climate change consistent with those described in Section 2. 2, we foresee see no significant negative non-federal cumulative effects in the Tahuya River basin.

2.6. Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to ESA listed species and CH. 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 ESA listed species and CH (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed ESA listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed CH as a whole for the conservation of the ESA listed species.

The three ESA listed salmon that reside in the action area are PS Chinook, PS steelhead, and HCSR chum. All three species are listed as threatened (Table 2), based on a combination of low abundance, productivity, spatial structure, and diversity (though HCSR chum are shown notable improvements). Limiting factors for all three ESA listed species include insufficient presence of LWDd and log jams, substrate that can support spawning, and altered flow regimes from bank revetments, culverts, climate change, and other activities that create obstacles to flow and cut off access to floodplains and side channels. Adequate water quality is a limiting factor for PS Chinook and HCSR chum. Lack of genetic diversity is a limiting factor for PS steelhead due to hatchery spawning in native spawning grounds.

All of these specific factors of decline are part of the systemic degradation of habitat features across the habitat for these ESA listed species, including the action area. In the action area, the Tahuya population or subpopulation of each species is affected by the action. These populations are not identified as critical for recovery by any of the recovery plans for these species, but no population or subpopulation's extirpation is supported by any recovery plan. The status of these species is due in part to degraded habitat conditions throughout their action areas.

Additionally, when considering cumulative effects, future development, even if limited, together with climate change, has the potential to further diminish the water table and lower the water quality past the threshold required by the three ESA listed species.

To this context, we add the future effects of this project which for this consultation are those effects from the continued presence of the previously conducted work in the action area.

The effects of the action on critical habitat are both positive and negative. Negative effects on PBFs are restricted habitat forming process, such as construction of the bulkhead, will further separate the natural channel from the floodplain, limit the shade and undercut banks that would provide natural cover and thermal reduction, and alter the natural hydrology, changing the sediment deposition downstream, thereby effecting the spawning conditions and rearing conditions throughout the action area. The positive effects on PBFs include an increase in large wood, providing an alternate source of cover, prey and shade, and creating pockets of deeper cool water for rearing and refugia. Removal of human debris (trash) in, and adjacent to, the stream, along with the replacement plantings, provide an increment of additional benefit. On the whole, NMFS considers actions to ensure that the PBFs are largely retained in a condition that continues to serve conservation of the three listed species in this action area, even when cumulative effects are considered.

We next consider these effects on species themselves, given the current status of the threatened fish populations and the degraded environmental baseline within the action area. We anticipate that the shift of sediment condition, water quality, and riparian condition, could slightly impair spawning success, egg and alevin survival (affecting all three species), and juvenile to smolt survival (primarily affecting Chinook and steelhead), but the proposed action's annual decrease in ESA listed species abundance is likely to be very small. The reductions are expected to be only of a few fish, and, as such, their loss will likely be indistinguishable among that cohort as returning adults. Moreover, the elements of the proposed action that are intended to minimize or offset effects of the bank revetments may provide conditions that allow juvenile fish (primarily steelhead and to a lesser degree Chinook salmon) greater cover, predator avoidance, and prey opportunities, so that juvenile growth, fitness and survival increase among the fry that emerge successfully from redds. Considered together, the effects on juvenile salmonids is expected to be slight, with HCSR chum affected somewhat more than PS Chinook salmon or PS steelhead. No species' Tahuya component population will be so affected in terms of abundance that the distribution, diversity, or productivity of the ESA-listed species will be impaired, even when cumulative effects are considered.

2.7. Conclusion

After reviewing and analyzing the current status of the listed ESA listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is ***not likely*** to ***jeopardize*** the continued existence of PS Chinook, PS steelhead or HCSR chum. Nor is the action likely to ***destroy*** or ***adversely modify*** Designated Critical Habitat for any of the three species.

2.8. Incidental Take Statement

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

2.8.1 Amount or Extent of Take

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

Take in the form of harm to eggs, alevin and fry life stages of PS Chinook, PS steelhead, and HCSR chum from the 125-foot (ft) long, 9-ft tall bulkhead on the Tahuya River. This metric is causally related to the harm caused by modified stream conditions including hydrology, sediment condition, habitat complexity/floodplain connectivity, stream temperature, and riparian vegetation which are modified by the presence of the armored bank.

2.8.2 Effect of the Take

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

2.8.3 Reasonable and Prudent Measures

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

> The Corps of Engineers or its permittee will monitor take associated with modified bank conditions, to ensure take is minimized.

2.8.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any contactor complies) with the following terms and conditions. The USCG or has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the ESA listed 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.

The following terms and conditions implement the reasonable and prudent measure:

1. The applicant or property owner shall routinely monitor replanting to ensure 85 percent survival over the next 5 years. Replace failed plants with replacement native vegetation during this 5-year period and ensure watering of plants during periods of excessive heat or prolonged dry conditions.

2. The applicant or property owner shall routinely check the structural integrity of the large wood installation for stability, and if aspects appear unstable or prone to failure promptly prepare a revised plan to prevent failure, and obtain all requisite permits to implement those revisions.

3. The applicant shall provide the Corps and NMFS photo documentation of habitat conditions at the site, annually, no later than August 1 each year of the 5-year monitoring period, to verify plantings and the large wood are performing to expectation. Send such photo document report to:

   projectreports.wcr@noaa.gov and include the WCRO number assigned to this project (WCRO-2023-03432) in the regarding line. Also provide a CC to Colleen McGee at Colleen.McGee@noaa.gov.

2.9 Reinitiation of Consultation

This concludes formal after the fact consultation for the Corps' issuance of the permits for the Engh Bulkhead.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed ESA listed species or CH in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed ESA listed species or CH that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or CH designated that may be affected by the identified action."

In the context of this opinion, there is no incidental take anticipated and the reinitiation trigger set out in § 402.16(a)(1) is not applicable. If any of the direct take amounts specified in this opinion's effects analysis (Section 2.4) are exceeded, reinitiation of formal consultation will be required because the regulatory reinitiation triggers set out in § 402.16(a)(2) and/or (a)(3) will have been met.

2.9. Conservation Recommendations

The COE should include a term on its permit indicating that the land owner, on reasonable notice, will grant access to spawning surveys completed by WDFW staff or their subcontractors to discern long-term effects on spawning salmonids. Should any effects be documented, the Corps, in coordination with WDFW or the Hood Canal Coordinating Council, will suggest improvements to the site to address identified habitat impacts noted as causing lowered spawning rates.

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

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

3.1 Essential Fish Habitat Affected by the Project

The proposed project occurs within EFH for various federally managed fish species within the Pacific Coast Salmon FMP.

In addition, the project occurs within, or in the vicinity of riverine floodplain, which is designated as a habitat area of particular concern (HAPC) for various federally managed fish species within the Pacific Salmon FMP. HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under the MSA; however, federal projects with potential adverse impacts on HAPC will be more carefully scrutinized during the consultation process.

3.2 Adverse Effects on Essential Fish Habitat

NMFS determined the proposed action would adversely affect EFH as follows.
The completed action would alter the natural hydrology, effecting floodplain connectivity, substrate size and distribution, and available shade/cover. Overall, the area of disturbance is relatively small in relation to the length of the Tahuya River, which in turn is a relatively small part of the habitat occupied by the three listed ESA listed species, PS Chinook, PS steelhead, and HCSR chum. The effects of the action will be felt into the foreseeable future and will be experienced by all three ESA listed species at various life stages. The completed action included mitigation in the form of installed large woody debris and engineered log jams. The effects of these features on the essential habitat will be beneficial, increasing pools and shade. There is potential for these installations to effect sediment size and distribution but it is unclear if these effects will be beneficial or not without on-site investigation.

3.3 Essential Fish Habitat Conservation Recommendations

To minimize the effects on Pacific Coast salmon EFH, including complex channels and floodplain habitats HAPC the Corps should:

1. Maintain trees onsite to the greatest degree possible to provide more shade and cooler water temperatures for ESA listed salmon.
2. Avoid the installation of additional bulkheads or other forms of bank revetments to the greatest degree possible to retain existing floodplain connectivity, shade/natural cover, and size and distribution of sediment.

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

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps 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 the 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)].

3.5 Supplemental Consultation

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

4 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps and other interested users which could include Mr. Jesse Engh. Individual copies of this opinion were provided to the Corps. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere 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 part 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 reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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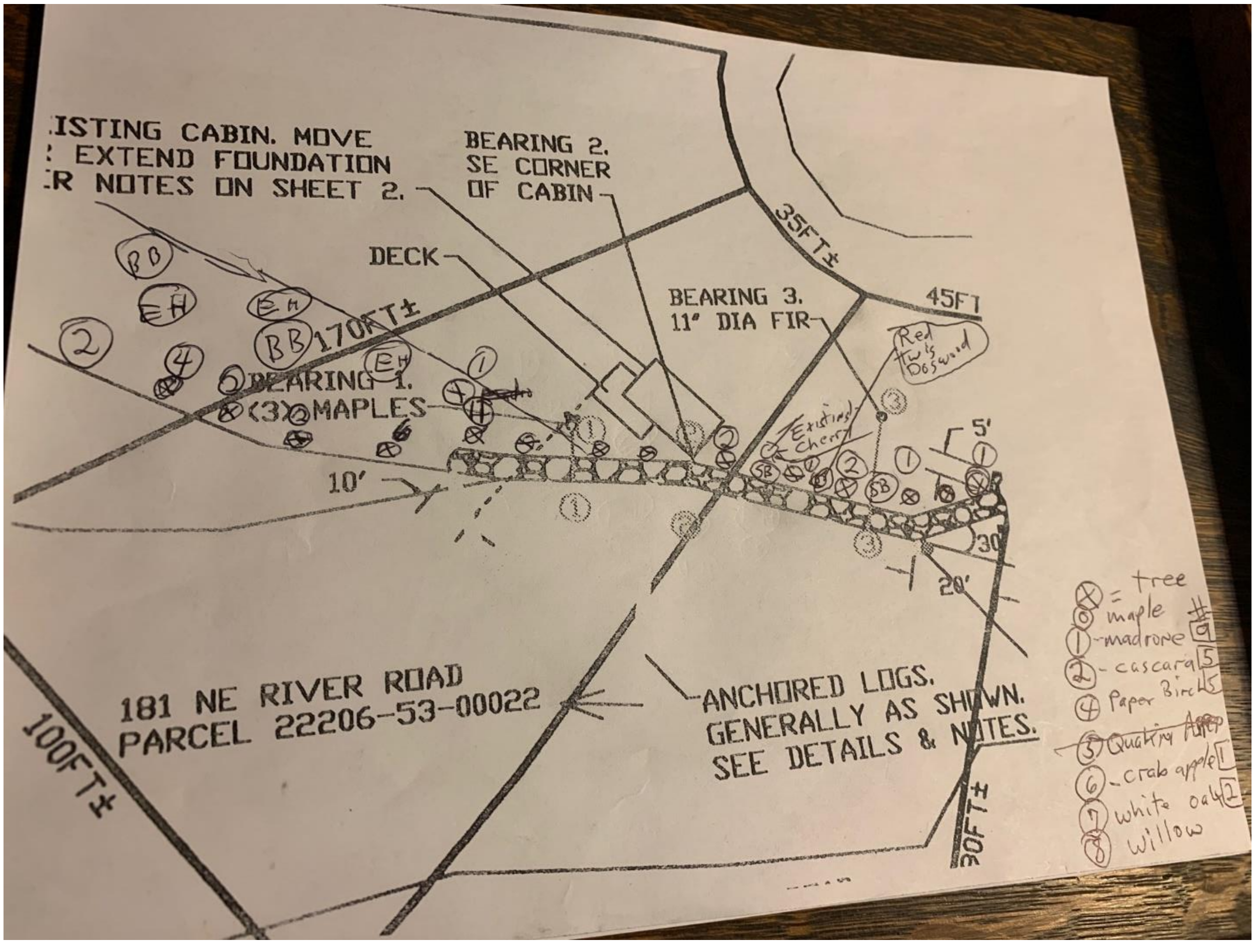
6 APPENDIX A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