UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
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**Refer to NMFS No:**
**WCRO-2024-00588**

June 6, 2024

Todd N. Tillinger, P.E.
Chief Regulatory Branch
U.S. Army Corps of Engineers, Seattle District
P.O. Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Section 7(a)(4) Conference Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Project Macoma Marine Carbon Dioxide Removal Pilot Study at the Port of Port Angeles (NWS-2023-915)

Dear Mr. Tillinger:

This letter responds to your March 19, 2024, request for initiation of consultation with the National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act (ESA) for the subject action. Your request qualified for our expedited review and analysis because it met our screening criteria and contained all required information on, and analysis of, your proposed action and its potential effects to listed species and designated critical habitat.

We reviewed the U.S. Army Corps of Engineers (USACE) consultation request and related initiation package. Where relevant, we have adopted the information and analyses you have provided and/or referenced but only after our independent, science-based evaluation confirmed they meet our regulatory and scientific standards. In our biological opinion below, we indicate what parts of your document(s) we have incorporated by reference and where that information is being incorporated.

We adopt by reference here:

- Sections 2.1 through 2.3 and 2.6 of the Biological Assessment (BA) for the proposed action and timeline of project activities,
- Sections 2.1 through 2.5 of the BA for the Best Management Practices (BMPs) that will be utilized to minimize project impacts,
- Section 3 for the action area,
- Sections 4.1 through 4.3 for the environmental baseline of the action area,
- Sections 5.1 through 5.5 and 5.7 through 5.9 for the status of ESA-listed and proposed species, and their designated critical habitat affected by the proposed action,
- Sections 6.1 through 6.5, 7.1 through 7.5, and 7.7 through 7.9 for the effects of the proposed action on ESA-listed species and their designated critical habitat, and
- Sections 8.1 and 8.2 for the effects of the proposed action on Essential Fish Habitat (EFH).

Per 50 CFR § 402.10, we have also completed a conference opinion (ESA Section 7(a)(4)) evaluating the effects of the proposed program of activities on sunflower sea stars (*Pycnopodia helianthoides*),[1] as it is currently a species proposed for listing under the ESA. An opinion issued at the conclusion of the conference may be adopted as the biological opinion when the species is listed or critical habitat is designated, but only if no significant new information is developed (including that developed during the rulemaking process on the proposed listing or critical habitat designation) and no significant changes to the federal action are made that would alter the content of the opinion. Hereafter, the combination of the biological opinion and conference opinion are referred to as a singular "Opinion."

We note where we have supplemented information in the BA with our own data analysis. The BA will be included in the administrative record for this consultation and we will send it to readers of the biological opinion as an email reply attachment when we receive requests for the Opinion.

On December 18, 2023, NMFS met with the applicant, Ebb Carbon, and the Port of Port Angeles (Port) to discuss the pilot study and its potential ESA consultation pathway. NMFS confirmed that the project would not be eligible for programmatic consultation under the Salish Sea Nearshore Programmatic and recommended that the pilot study should proceed through individual formal consultation.

On February 22, 2024, the applicant shared a draft Biological Assessment (BA) with the USACE and NMFS for review. After several emails and a meeting on March 4, 2024, the applicant agreed to revise its BA to incorporate additional information into its effects determination. Based on these conversations, the USACE agreed to request formal consultation for ESA-listed species and EFH.

On March 19, 2024, the USACE submitted a request for formal consultation to NMFS for the subject project. On March 19, 2024, NMFS initiated formal consultation.

On April 23, 2024, the applicant informed NMFS that, at the request of the U.S. Fish and Wildlife Service, it would modify the project description to reduce the intake's velocity to 0.2 feet per second to further reduce the risk of entrainment to fish.

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.

[1] https://www.federalregister.gov/documents/2023/03/16/2023-05340/proposed-rule-to-list-the-sunflower-sea-star-as-threatened-under-the-endangered-species-act

**BIOLOGICAL OPINION**

**Proposed Action:**
Per the BA, Section 2 on pages 8 through 17, the USACE proposes to authorize a permit under Section 404 of the Clean Water Act for the installation and operation of a small-scale marine carbon dioxide removal (mCDR) pilot project, located at Terminal 7 of the Port Angeles, WA. This pilot project (Project) would be owned and operated by Project Macoma, LLC, a wholly owned subsidiary of Ebb Carbon, LLC in partnership with the Pacific Northwest National Laboratory (PNNL) and the University of Washington. Project Macoma is interested in exploring options to remove existing carbon dioxide ($CO_2$) from the ocean to allow for greater carbon capture in an effort to counteract planetary warming resulting from climate change. The purpose of the Project is to test how the mCDR technology operates under real-world conditions and to gather additional data and conduct scientific research to inform future deployments. The Project would run for 1.5 to 2 years, beginning in summer 2024 pending receipt of all county, state, and federal permits and ending in the summer of 2026 when Project Macoma, LLC's lease of the site ends.

Ebb Carbon is currently demonstrating its technology inside the marine labs at PNNL-Sequim, whereby water from Sequim Bay is pumped into open-air mixing tanks in the laboratory at PNNL using existing infrastructure at the lab. The alkaline seawater produced by the Ebb system is added to these open-air tanks for research purposes. Once the research concludes, the tanks drain to PNNL's wastewater treatment system as all water-based research there does. The water that is released back to Sequim Bay from the wastewater treatment system meets all requirements of PNNL's existing discharge permits. The proposed action intends to build upon the research at PNNL-Sequim by drawing water from Port Angeles Harbor, treating it to create alkaline-enhanced seawater, and returning this enhanced seawater to the harbor with the intention of enhancing marine carbon capture and reducing coastal acidification in the vicinity. The pilot study will result in intentional changes to pH under a range of operational conditions to allow for robust scientific evaluation of the mCDR technology. The discharged seawater effluent would not contain any new constituents (e.g., metals or organic compounds) or waste products.

The Project would involve the installation of a 2,400 square-foot barge moored at the Port's Terminal 7, which will house intake and outfall structures, pumps, utilities, and monitoring equipment, as well as construction of an onshore component at the Port's Log Yard that would include shipping containers, mobile tanks, utility sheds, and an office trailer. The Project would intake seawater via the barge, convey that water to onshore treatment facilities that would process and remove acid from the seawater, and then return the alkaline-enhanced seawater via three process streams to Port Angeles Harbor.

Under routine operations, the three process streams would be discharged as a single combined flow through the outfall pipe for 12 hours daily. The applicant anticipates that the Project would intake and discharge approximately 97,000 gallons (367,000 liters) of seawater per day from Port Angeles Harbor, and the discharged water would be approximately 20.4°C in temperature with a pH of 9.8. The applicant has provided a number of scenarios in which different combinations of process flow streams would be discharged to reflect the pilot technology's routine operation, scientific operations, and maintenance operations (refer to BA Table 2 on page 9). Among these scenarios, discharge temperatures would range from 17°C to 30°C and the pH would range from 2.3 to 13.5 Standard Units (SU). Preliminary mixing analyses indicate that in all discharge scenarios, the water temperature would drop steeply within 40 ft. from the discharge ports, and temperature would return to background levels (10°C) within 207 ft. of the discharge ports. These mixing analyses also indicate that the pH of the effluent would return to within 0.5 SU of background levels within 40 ft. of the discharge ports, and pH would return to background levels within 207 ft. of the discharge ports. Once permits have been secured, Project Macoma staff will validate this model using a dye test that tracks and measures the alkaline discharge. During Project operations, staff will monitor water quality parameters via remote monitoring sensors located 15 and 150 ft. from the outfall pipe to address any water quality parameter exceedances should they occur.

The applicant summarized project BMPs and conservation measures to reduce the reasonably certain adverse effects of the action throughout BA Section 2 on pages 10 through 13 and 16 through 18. BMPs address and minimize several of the incidental take pathways to ESA-listed species, including the storage of chemicals and plans to address spills and leaks, the minimization of turbidity during in-water construction and operation due to location of the outfall, and a reduction in risk of entrainment through the installation of a screen on the intake that complies with the Revised Code of Washington (RCW) 77.57.010 and RCW 77.57.070, as well as the NOAA Anadromous Salmon Passage Facility Design Criteria. The BMPs also include extensive water quality monitoring consistent with the conditions outlined in the National Pollutant Discharge Elimination System State Waste Discharge (NPDES SWD) permit issued by the Washington Department of Ecology and biological monitoring throughout Project operations. Finally, the proposed action includes the implementation of an adaptive management plan to address issues such as water quality parameter exceedances, and deceased aquatic organisms, if any are observed.

As the proposed action is within the Salish Sea, NMFS evaluated part of the Project using a Habitat Equivalency Analysis (HEA)[2] and the Puget Sound Nearshore Habitat Values Model (NHVM) adapted from Ehinger et al. (2015). Ecological equivalency that forms the basis of HEA is a concept that uses a common currency to express and assign a value to functional habitat loss and gain. Ecological equivalency is traditionally a service-to-service approach where the ecological functions and services for a species or group of species lost from an impacting activity are fully offset by the services gained from a conservation activity. The applicant has evaluated the impacts of overwater coverage cast by the barge for the duration of the Project using the NHVM and will offset these enduring effects as part of the proposed action. Appendix A has a summary sheet of debits for the proposed Project. A purchase agreement between Project

[2] A common "habitat currency" to quantify habitat impacts or gains can be calculated using Habitat Equivalency Analysis (HEA) methodology when used with a tool to consistently determine the habitat value of the affected area before and after impact. NMFS selected HEA as a means to identify section 7 project related habitat losses, gains, and quantify appropriate mitigation because of its long use by NOAA in natural resource damage assessment to scale compensatory restoration (Dunford et al. 2004; Thur 2006) and extensive independent literature on the model (Milon and Dodge 2001; Cacela et al. 2005; Strange et al. 2002). In Washington State, NMFS has also expanded the use of HEA to calculate conservation credits available from fish conservation banks (NMFS 2008, NMFS 2015), from which "withdrawals" can be made to address mitigation for adverse impacts to ESA species and their designated CH.

Macoma, LLC and the Puget Sound Partnership is available with the file in the NMFS Lacey office.

**Status of Species and Critical Habitat:**
We examined the status of each species that would be adversely affected by the proposed action to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. We also examined the condition of critical habitat throughout the designated area and discuss the function of the physical or biological features essential to the conservation of the species that create the conservation value of that habitat.

The BA summarizes, and we incorporate, the status of PS Chinook salmon in Section 5.3 on pages 28 and 29. The BA summarizes the approximate timing of juvenile migration through the nearshore area of Port Angeles Harbor in the spring and adult migration through the harbor in the summer months. We add here that during nearshore surveys conducted from 2006 through 2014 within the harbor, Chinook salmon were recorded from April to September (Fresh 2015). Yearling PS Chinook salmon may occur anywhere in the Puget Sound at any time of year, though not in concentrated numbers. Within the Salish Sea, resident Chinook salmon are found in highest numbers between the months of November and July (Quinn and Losee 2021).

The BA also describes the designated critical habitat for PS Chinook salmon within the action area in Section 5.3.1 on page 29 and describes the Physical and Biological Features (PBFs) that occur within the action area, including water quality, salinity conditions, natural cover, and forage opportunities that support salmon.

The BA summarizes, and we incorporate, the status of PS steelhead in Section 5.4 on page 30. The BA states that winter-run juveniles may be present within the action area during spring through mid-summer, and that steelhead smolts and juveniles are likely to migrate rapidly into open waters and are not expected to spend a long duration of time within the action area. We add here that of the 32 independent populations of the PS steelhead DPS, the Dungeness River summer/winter run, Strait of Juan de Fuca Independent Tributaries winter run, and the Elwha River winter run may occur within the action area (Myers et al. 2015). Winter-run PS steelhead return from the ocean in the fall, while summer-run steelhead migrate into natal streams from the ocean during the late spring and summer, though they are far less common within Salish Sea watersheds (NMFS 2019). Given this information, we expect that adult steelhead could be migrating through the action area at almost any time of year, though we anticipate that the highest concentration of adult PS steelhead may occur within the Project vicinity during the fall. As stated in the BA in Section 5.4.1 on pages 30 and 31, there is no designated critical habitat for PS steelhead within the action area.

The BA summarizes, and we incorporate, the status of Hood Canal summer-run (HCSR) chum in Section 5.5 on page 31, stating that adults could be migrating through the action area prior to and during their mid-August through October migration, and juveniles could occupy nearshore areas (outside of the action area) in the spring. We add here that during nearshore surveys conducted from 2006 to 2014, juvenile chum salmon were recorded near the action area from April through September, with higher abundances during the spring months (April through June) (Fresh 2015).

As described in Section 5.5.1 of the BA on page 31, there is no designated critical habitat for HCSR chum within the action area.

The BA summarizes the status of sunflower sea star (proposed for listing) in Section 5.9 on pages 34 and 35, stating that this species utilizes a variety of substrates and depths from the Aleutian Islands in Alaska to Baja California, Mexico, and that sea star wasting syndrome (SSWS) has resulted in the death of approximately 90 percent or more of the population throughout its range. We add here that within Puget Sound and Washington coastal waters, the population of sunflower sea star has experienced a decline of between 92-99 percent (Hamilton et al. 2021; Hamilton 2021; Harvell et al. 2019; ONMS 2022). Sunflower sea stars have almost completely disappeared from the Project area since 2014, though they have been observed in small numbers along the western end of Ediz Hook and Dungeness Bluffs (outside of the action area) in recent years (Sanchez et al. 2022).

Additionally, we supplement the BA's presentation of status of species and critical habitat with information summarized in the following two tables (Table 1, Table 2). Table 1, 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). A summary of the status of critical habitats considered in this opinion is provided in Table 2, below.

**Table 1.** 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<br>• Degraded estuarine conditions and loss of estuarine habitat<br>• Degraded riparian areas and loss of in-river large woody debris<br>• Excessive fine-grained sediment in spawning gravel<br>• Degraded water quality and temperature<br>• Degraded nearshore conditions<br>• Impaired passage for migrating fish<br>• 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. 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. | • Reduced floodplain connectivity and function<br>• Poor riparian condition<br>• Loss of channel complexity Sediment accumulation<br>• Altered flows and water quality |

| Species | Listing Classification and Date | Recovery Plan Reference | Most Recent Status Review | Status Summary | Limiting Factors |
|---|---|---|---|---|---|
| **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<br>• Widespread declines in adult abundance despite significant reductions in harvest<br>• Threats to diversity posed by use of two hatchery steelhead stocks<br>• Declining diversity in the DPS, including the uncertain but weak status of summer-run fish<br>• A reduction in spatial structure<br>• Reduced habitat quality<br>• Urbanization<br>• Dikes, hardening of banks with riprap, and channelization |
| **Sunflower sea star** | Proposed 03/16/2023 | N/A | Ongoing | Once prevalent in the Puget Sound, the sunflower sea star experienced a range-wide epidemic of sea star wasting syndrome (SSWS) from 2017 to 2017 (Gravem et al. 2021; Hamilton et al. 2021; Lowry et al. 2022). While the cause of this disease remains unknown, prevalence of the outbreak has been linked to a variety of environmental factors, including temperature change, sustained elevated temperature, low dissolved oxygen, and decreased pH (Hewson et al. 2018; Aquino et al. 2021; Heady et al. 2022). As noted above, changes in physiochemical attributes of nearshore waters are expected to change in coming decades as a consequence of anthropogenic climate change, but the specific consequences of such changes on SSWS prevalence and severity are currently impossible to accurately predict. This species is currently proposed for listing under the ESA. | • Sea Star Wasting Syndrome<br>• Climate-induced changes such as high ocean temperatures, low dissolved oxygen, and decreased pH |

**Table 2**. Critical habitat, designation date, federal register citation, and status summary for critical habitat considered in this opinion

| Species | Designation Date and Federal Register Citation | Critical Habitat Status Summary |
|---|---|---|
| **Puget Sound Chinook salmon** | 9/02/05<br>70 FR 52630 | Critical habitat for Puget Sound Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in Puget Sounds. The Puget Sound Chinook salmon ESU has 61 freshwater and 19 marine areas within its range. Of the freshwater watersheds, 41 are rated high conservation value, 12 low conservation value, and eight received a medium rating. Of the marine areas, all 19 are ranked with high conservation value. |

We also supplement the information provided in the BA with the following summary of the effects of climate change on the status of ESA-listed species considered in this opinion and aquatic habitat at large.

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 critical habitats, 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 (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 4$^{th}$ 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 opportunity 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 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 outbreak (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 at low- and high-elevation forests, with 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 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 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 ground water 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 and 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 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 short time-spans by removing riparian cover (Koontz et al. 2018), and streams that lose their snowpack with 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%), while 68% 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 of a wide pH range in freshwater (although see Ou et al. 2015 and Williams et al. 2019), however, 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 streamflows) 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 intergravel 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 *en 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 carryover 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 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 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).

Finally, we examined the likely effects on any listed species and critical habitats that your agency made "not likely to adversely affect" determinations for. Our conclusions regarding the effects of the action on those species and critical habitats is presented below under the heading: NLAA determinations.

**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 BA describes the action area in Sections 3.1 and 3.2 on pages 19 and 20. The BA determined that the maximum terrestrial extent of effects is the in-air noise generated by construction equipment (0.21 mile extending radially from the equipment). Additionally, the maximum extent of aquatic effects from the proposed action is the changes to water quality resulting from the electrochemical treatment process. Operation of the pilot technology would result in nearfield (acute) and far-field (diluted) changes to water quality extending from the diffuser ports that discharge the treated alkaline-enhanced seawater back into Port Angeles Harbor.

Based on modeling in the mixing zone analysis provided in the BA, the nearfield water quality changes are expected to dilute to meet Washington State marine surface water quality standards (Washington Administrative Code [WAC] 173-201A-210) for temperature, pH, and DO within 40 feet (ft.) (0.23 acre) of the outfall. The mixing zone analysis also determined that far-field water quality impacts would extend up to 207 ft. radially from the diffuser ports. With the 25 diffuser ports spaced 2 ft. apart along the 50 ft. outfall pipe, the far-field extent of water quality impacts (action area) would encompass 3.64 acres (Figure 1).

While mixing zone does not always adequately describe the full extent of exposure to changes in water quality (e.g. when chemicals are in effluent they remain in and disperse broadly in the environment beyond a regulatory mixing zone), here it is appropriate because all parameters (temperature, pH, and DO) are expected to be fully resolved, in other words, both will be indistinguishable, at the outer edge of the mixing zone and with no potential exposure of ESA-listed species or critical habitats beyond that area.

Based on migration patterns, salmonid populations in the action area could come from any multiple population group of the three ESA-listed species, but based on proximity of natal streams, NMFS considers the following are more likely to be present: PS Chinook salmon juveniles from Elwha River and Dungeness River; HCSR chum juveniles, if present, from

Jimmycomelately Creek, Salmon Creek, Snow Creek, Chimacum Creek subpopulations; PS steelhead juveniles of the Dungeness Winter-Run Strait of Juan de Fuca Tributaries Winter-Run and the Sequim/Discovery Bay Tributaries Winter-Run.


**Figure 1.** Project Action Area from BA (Figure 3, pg. 21)

**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).

The BA describes the environmental baseline of the action area in Sections 4.1 through 4.3 on pages 22 through 25, and we incorporate that section. The BA describes the action area within Port Angeles Harbor as highly degraded habitat due to the degree of upland development, legacy contaminants in the sediment from heavy industrial use of the Port's property, and highly modified shoreline. The BA also notes that the action area lacks significant aquatic vegetation, forage fish spawning beaches, and the features of a natural shoreline (overhanging vegetative cover, woody debris, sediment transport). We add that although no forage fish spawning habitat exists within the action area, restoration efforts along Ediz Hook (approximately 0.5 mile west) have created functional nearshore habitat including eelgrass beds and forage fish spawning within the Project vicinity. Additionally, Pacific sand lance, surf smelt, and Pacific herring are all known to occur within Port Angeles Harbor (Frick et al. 2022; Shaffer et al. 2008; WDFW 2024; PCSRF 2024).

We supplement the BA's description of the environmental baseline with the following. Port Angeles Harbor is a natural deepwater harbor that lies between the Elwha and Dungeness drift cells. Historically, Ediz Hook (the terminus of the Elwha drift cell) and Dungeness Spit (the terminus of the Dungeness drift cell) provided productive estuarine habitat with abundant submerged aquatic vegetation and acting as an essential migratory corridor for salmon entering the Strait of Juan de Fuca. While the Dungeness Spit complex continues to provide high functioning (if somewhat diminished) estuarine habitat, a century of industrial development and armoring along the Port Angeles Harbor shoreline has interrupted sediment transport, creating an area of no appreciable shore-drift and severely degrading the value of the habitat for salmon (Bubnick 1986; The Watershed Company et al. 2012).

The Project also lies within the footprint of the Western Port Angeles Harbor Hazardous Waste Site, which is undergoing remediation efforts for its contaminated sediments. The site is also under a federal Consent Decree to fund restoration activities including beach and dune restoration along Ediz Hook, reestablishment of eelgrass, and improvements to fish passage (PAHNRT 2021; WDOE 2024). The first restoration action implemented as part of the Port Angeles Harbor Restoration Program involved the planting of eelgrass along the south-central shoreline of Ediz Hook, and was completed in May of 2024. The eelgrass restoration area would occur approximately 0.5 mile west from the maximum extent of aquatic effects from the proposed action (Project action area). No other restoration actions are currently planned in or near the action area during the 2-year Project duration.

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

The effects of this proposed action are:

- Noise – underwater sound from the construction (short-term) and operation (long-term) of the pilot technology;
- Water quality diminishment – from turbidity, pollution, and possible resuspension of contaminants during construction (short-term) and operation (long-term) of pilot technology, and from the altered temperature, pH, and dissolved oxygen (DO) of the treated seawater being discharged (long-term);
- Entrainment of listed species and their prey resources via the intake of seawater from Port Angeles Harbor (long-term);
- Shade cast from the berthing of a barge (predation, disruptions to migration – long-term).

These effects, both short- and long-term, alter habitat features and the listed (and proposed) species may be exposed to some or all of these effects. The influence of the projects effects on critical habitat is a function of duration. For this consultation, short term is measured in hours or days, long term is considered months, up to 2 years. Both timing and duration will influence the likelihood of species exposure.

**Effects on Listed Species:**
The BA provides a detailed discussion and comprehensive assessment of the effects of the proposed action on ESA-listed species in Sections 6 and 7 of the initiation package, and is incorporated here (50 CFR 402.14(h)(3)). NMFS has evaluated this section and after our independent, science-based evaluation determined it meets our regulatory and scientific standards. We add that PS Chinook salmon and HCSR chum are most likely to experience the effects discussed below in their subyearling or adult life stages, as the proposed action will occur within deeper waters, approximately 265 ft. offshore. We do not expect that many juvenile PS Chinook salmon and HCSR chum would be exposed to these effects pathways due to their nearshore dependence. Nevertheless, as the farfield extent of the action area does extend closer to the shoreline, and younger salmonids will utilize the deeper shore zone (DSZ) for limited forage opportunities, we conservatively assume that juvenile PS Chinook salmon and HCSR chum will experience exposure to water quality diminishment and forage opportunities to a lesser degree.

Noise - We supplement the BA analysis (page 37) of the effects of underwater sound from in-water construction and operation of the pilot technology with additional information provided by the applicant describing the source of underwater noise generated by ongoing operations. In a March 4, 2024, email, the applicant described that two electric drive pumps operating at approximately 300 horsepower each would be located on the barge deck and would be expected to generate underwater noise and sound pressure levels well below the ambient noise levels within the harbor. Given that the noise produced by the drive pumps would be well below the level at which fish experience behavioral changes (150 dB), we do not expect that this action would alter or diminish use of the action area by ESA-listed species. Therefore, the underwater noise resulting from construction and operation of the Project is not likely to increase exposure of ESA-listed species to sound in a manner that produces additional response.

Water Quality - We supplement the BA analysis (pages 38 and 39) of the effects of turbidity from in-water construction and the discharge of seawater during Project operations with the following. The BA describes how the discharge of alkaline-treated water could result in higher brucite and calcite concentrations that could result in higher turbidity within the water. We add that while outfall pipe placement approximately 21.5 to 28.5 ft. above the sea floor would reduce the resuspension of sediment from the sea floor, we expect that some sediment suspension would occur and contribute to turbidity. The BA states that the greatest degree of turbidity would occur within the near-field mixing zone (0.23 acre), with water quality conditions returning to background conditions well before the far-field mixing zone (3.64 acres).

Physical effects of fish resulting from turbidity are a function of the exposure duration and concentration of the suspended sediment causing the turbidity (Newcombe and Jensen 1996; Wilber and Clarke 2001). Studies have also shown that salmonids can detect and distinguish turbidity and other water quality gradients (Quinn 2005; Simenstad 1998), and fish will generally move away from areas within higher concentrations of total suspended solids (Kjelland et al. 2015). As a result, fish are more likely to respond with avoidance, or if turbidity is not fully avoided, to experience sublethal response (coughing or gill irritation). Given the distance offshore and depth of waters where the greatest turbidity would occur (the near-field mixing zone), we expect that adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead would experience exposure to turbidity. As these life stages of ESA-listed species are more mobile, we anticipate only avoidance behavior as a response during Project operations. As the outfall would be located approximately 265 ft. offshore and turbidity levels would return to background conditions within the far-field mixing zone 207 ft. from the discharge ports, we do not expect that juvenile PS Chinook salmon or HCSR chum rearing in the shallow, intertidal nearshore habitat would be exposed to elevated turbidity. We therefore expect a minor adverse effect on any adult PS Chinook salmon, adult HCSR chum, or juvenile or adult PS steelhead migrating through the action area during the 2-year operation of this project. Two cohorts of adult salmonids of each species are expected to experience short-term behavioral effects that would not impact their long-term fitness. As a result, these minor adverse effects would not impact any of these species on a population level.

We supplement the BA analysis (pages 37-45) of the effects of water quality diminishment on ESA-listed species with an analysis of the potential resuspension of contaminated sediments resulting from the discharge of seawater. The BA describes Port Angeles Harbor's high levels of hazardous substances within its sediment, including metals (mercury, cadmium, zinc), dioxins/furans, polychlorinated biphenyls, and carcinogenic polycyclic aromatic hydrocarbons. These contaminants can result in a variety of lethal and sub-lethal outcomes for salmonids, including impaired growth and reproduction, reduced forage success, increased predation, neurological effects, and reduced disease resistance (Meador 2002; Peterson et al. 1993; Lanham et al. 2011; Walker and Peterson 1992; Walker et al. 1994; Berntssen et al. 2003; Peterson et al. 2007; Baali and Yahyaoui 2016; Heintz et al. 2010). Resuspension of contaminated sediments is proportional to the amount of disturbance and the local levels of contamination. Disturbance of the substrate would increase contaminant concentrations by resuspending particulates, thereby allowing more contaminants to transport into the water column. We anticipate that contaminant concentration rates could be increased for the duration of Project operations (up to 2 years), with potentially harmful acute increases contained within the far-field mixing zone extending 207 ft. radially from the outfall's discharge ports.

Based on generally poor habitat conditions in the baseline, it is unlikely that nearshore dependent juvenile PS Chinook salmon and HCSR chum would rear within this area of Port Angeles Harbor in large numbers or for any significant duration of time. Additionally, as these species are highly dependent on shallow, intertidal habitat during their juvenile life stage, and the furthest extent of contaminant resuspension is expected to occur approximately 58 ft. offshore, their potential risk of exposure is extremely low. A majority of the adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead migrating through the action area are likely to avoid the immediate vicinity of the Project and would therefore experience very low (though significant) levels of exposure. As a result, we expect that a small number of fish from two cohorts of each of these age classes of PS Chinook salmon, HCSR chum, and PS steelhead would experience sub-lethal physiological effects leading to reduced fitness among some of the exposed fish.

We supplement the analysis (page 44) of the effects dissolved oxygen (DO) changes resulting from the discharge of enhanced alkaline-treated water into Port Angeles Harbor with the following. The BA outlines how seawater discharges would result in negligible reductions to DO compared to the ambient levels within Port Angeles Harbor (from 7.3 mg/L to 7.0 mg/L). We add that juvenile and adult salmon will exhibit avoidance behavior and delay migration when DO falls below 5.0 mg/L and will experience mortality when DO falls below 3.0 mg/L (Carter 2005). As discharges are expected to result in DO levels no lower than 7.0 mg/L and monitoring will occur to ensure that these parameters are not exceeded, we agree that the risk of low DO is not likely to result in measurable effects to ESA-listed salmon.

We supplement the BA analysis (pages 38-42) of the effects of pH changes resulting from the discharge of enhanced alkaline-treated water into Port Angeles Harbor with the following. The BA outlines various behavioral and physiological changes that salmonids exhibit when exposed to fluctuations in pH, noting that acidic pH can cause gill damage, decreased growth, reduced predator avoidance, and mortality. The BA further notes that short-term exposures to highly alkaline water (pH of 9.5) can result in damage to fishes' gills, eyes, and skin, though this is rarely lethal. Finally, the BA concludes that salmonid exposure to alkaline discharges is likely to be short term in nature coinciding with adult offshore emigration, and therefore impacts are likely to remain behavioral or sub-lethal in nature. We add that laboratory studies have shown that salmonids exposed to highly alkaline waters (pH of 10) for multiple days will exhibit ammonia toxicity and poor ionic regulation, resulting in a high mortality rate (Wilkie et al. 1993; McGeer and Eddy 1998). Field observations during a high-pH event revealed that densities of juvenile Atlantic salmon within the alkaline water were significantly lower than densities in the control area upstream (Foldvik et al. 2022). This suggests that salmon are likely to exhibit avoidance behavior when exposed to areas of high pH and are unlikely to remain within the action area for a long enough duration to experience ammonia toxicity or mortality. As stated in the BA, the pH of the effluent would return to within 0.5 SU of background levels within 40 ft. from the discharge ports, with pH levels returning to background conditions within 207 ft. of the outfall. Given these findings, we agree with the BA conclusion that adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead expected to encounter these conditions are far more likely to exhibit avoidance behavior or experience short-term, sub-lethal effects due to the relatively small area of effect and the highly mobile nature of the life stages exposed. As the outfall would be positioned approximately 265 ft. offshore, it is unlikely that juvenile PS Chinook salmon or HCSR chum that rely on shallow intertidal areas would be exposed to changes in pH.

We supplement the BA analysis (pages 42-45) of the effects of temperature changes resulting from the discharge of enhanced alkaline-treated water into Port Angeles Harbor with the following. The BA notes that extensive studies have linked increased freshwater temperatures to adverse outcomes for salmonids including delayed migration, stress responses, and acute lethality, though these conditions have been largely unstudied in marine waters. We add that for Chinook salmon, the temperature at which 50 percent of the population dies after indefinite exposure has been recorded as anywhere between 17.5°C and 25.1°C after multiple days of exposure, with 26.7°C producing mortality beginning at 100 seconds of exposure with complete mortality at 4 minutes of exposure (Richter and Kolmes 2006). Likewise, Hicks (2000) found that chum salmon will often die when exposed to continuous temperatures of 22° to 23°C, and Snyder and Blahm (1971) reported 50% mortality in less than 50 minutes for chum transferred from 15.6°C to 26.7°C, 50% mortality within one minute when transferred from 15.6°C to 29.4°C, and 100% mortality within 15 seconds when transferred from 15.6°C to 32.2°C. Finally, the upper lethal temperature for steelhead has been reported as between 21°C to 24°C, and mortality within 20.5 hours has been report for steelhead transferred from 12°C to 26.5°C (Richter and Kolmes 2006). As discharges during normal operations will be 20.4°C and effluent discharges could rise to 30°C during maintenance and scientific operations, it is possible that a small number of adult PS Chinook salmon, adult HCSR chum, or juvenile or adult PS steelhead could experience mortality as a result of direct exposure to discharges. However, given the highly mobile nature of these age classes of fish and the sharp temperature drops that would occur within 40 ft. from the discharge ports, it is far more likely that exposed fish would experience short-term, sub-lethal effects and behavioral changes, as discussed below.

Numerous studies from the Columbia and Snake Rivers have documented the behavioral strategies that salmon and steelhead exhibit when exposed to high water temperatures during migration. Goniea et al. (2011) found that fall-run Chinook salmon would slow their emigration when water temperatures were above 20°C, preferring to reside longer in side channels and tributaries that were between 2 to 7°C cooler than the mainstem channel. Clabough et al. (2018) observed similar behaviors from Chinook salmon and steelhead within the Snake and Columbia Rivers and found that steelhead would utilize these thermal refugia for weeks while Chinook salmon would typically delay their migration by hours or days. These studies indicate that salmon and steelhead will alter their behaviors to avoid higher water temperatures. Given the very limited footprint in which water temperatures would be altered within Port Angeles Harbor and the highly mobile nature of the life stages likely to be migrating through the action area, we expect that exposed fish are most likely to exhibit behavioral changes or experience limited sub-lethal effects related to high water temperatures rather than remaining within areas of extreme high temperature for a long enough duration to result in mortality. As the outfall would be positioned approximately 265 ft. offshore, it is unlikely that juvenile PS Chinook salmon or HCSR chum that rely on shallow intertidal areas would be exposed to changes in temperature.

We further note our analysis of the potential for exposure to co-occurring temperature and salinity stressors to result in additional impacts to salmonids. Laboratory studies conducted on rainbow trout revealed that while high pH and temperatures both act as stressors, the trial that combined these conditions resulted in significantly increased mortality when temperatures were above 22°C (Wagner et al. 2011). Furthermore, studies examining the effect of acute stressors such as salinity shock on Chinook salmon heat tolerance have shown that mild stressors can heighten heat tolerance while severe stress can reduce heat tolerance (Rodgers and Gomez Isaza 2022). Given the interaction of high temperatures and high pH in the effluent, we conservatively assume that any ESA-listed fish migrating through the area could be more susceptible to mortality or long-term adverse health outcomes than they would if the discharged water contained only one stressor rather than two. However, we agree with the BA finding that the majority of adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead that migrate through the action area during Project operations will experience short-term, sub-lethal effects due to the relatively small area of effect and the highly mobile nature of the life stages exposed. We disagree that these effects would be insignificant based on the short-term duration of exposure and the Project's compliance with the NPDES SWD permit and the Aquatic Life Criteria outlined in WAC 173-201-210. We expect that any PS Chinook salmon, HCSR chum, and PS steelhead migrating through the action area during the 2 years of Project operation would experience sub-lethal physiological effects leading to reduced fitness, with the potential for mortality coinciding with prolonged exposure to high temperature and pH discharges. As the outfall would be positioned approximately 265 ft. offshore, it is unlikely that juvenile PS Chinook salmon or HCSR chum that rely on shallow intertidal areas would be exposed to combined changes in pH and temperature.

We supplement the BA analysis (pages 37 and 40-44) of the effects of diminished water quality on sunflower sea star with the following. The BA states that while no specific studies have addressed the potential effect of water quality changes on sunflower sea star, there is evidence indicating that warming ocean temperatures increase sea star susceptibility to SSWS. We add that a study analyzing the effects of higher temperature water discharge from a nuclear power plant in California resulted in a significant reduction in sea stars within the area, which was thought to be the result of turbidity rather than changes in temperature (Schroeter et al. 1993). The diminished water quality resulting from Project operations has the potential to impact sunflower sea star fitness. Sunflower sea stars are habitat generalists. This species may occur over sandy, muddy, and rocky bottoms both with and without appreciable vegetation in nearshore intertidal and subtidal marine waters, up to a depth of 450 m (~1400 ft). However, because current abundance is a fraction of historic level, this species, if present is expected to be in very low numbers. Nevertheless, we expect that any larval, juvenile, or adult sunflower sea star within the action area during the project's two years of operation would experience reduced fitness as a result of diminished water quality. However, we do not expect this species to be affected on a population level due to the small scale of the impacts and the very low numbers of sunflower sea star detected within the surrounding area in recent years that could be exposed.

Entrainment - We supplement the BA analysis (pages 45 and 46) of the effects of entrainment or impingement caused by the intake of seawater with the following. Entrainment typically kills the entrained individuals and impingement results in death, or injury with a high subsequent mortality rate. We agree that with this project, the likelihood of entrainment or impingement for juvenile or adult PS Chinook salmon, HCSR chum, or PS steelhead is very low due to the location of the intake in deeper waters, because adults are strong swimmers unlikely to become entrained. Likewise, juvenile salmonids do not tend to utilize these deeper waters and the fitting of the intake pipe with a screen meeting NOAA's Anadromous Salmonid Passage Facility Design Criteria would further reduce the risk of juvenile salmonid entrainment.

However, the intake could entrain or impinge smaller fish that comprise the prey base for ESA-listed salmonids. Forage fish make up a primary component of the prey base for adult PS Chinook salmon, HCSR chum, and PS steelhead (NMFS 2019; HCCC 2005; WDFW 2021). Over 14 years of survey efforts in Port Angeles, 76.4 percent of all fish caught were forage fish, and surf smelt was the most common species. Among the forage fish caught in Port Angeles, Pacific herring and surf smelt were overwhelmingly captured in their post-larval (<50mm) life stage and Pacific sand lance were primarily juveniles (50-120mm) (Frick et al. 2022). Given the sizes of these forage fish, it is very likely that several forage fish swimming through the action area could be entrained by the intake pipe. While it is impossible to quantify the number of forage fish that could be entrained over the 2-year Project, we expect that this reduction in prey resources would result in the reduced fitness of ESA-listed species utilizing Port Angeles Harbor. Given the relatively small footprint of the Project, even though individual fish could be adversely affected by reduced prey base, we do not expect a large number of salmonids from any population to be affected by this highly localized reduction in prey. Of the small number of individual ESA-listed fish that would experience reduced prey, it is possible that a subset could experience reduced growth or fitness.

We supplement the BA analysis (pages 45, 46, and 53) of the effects of entrainment or impingement caused by the intake of seawater on sunflower sea star larvae with the following. While sea star adults and juveniles are very uncommon in the Strait of Juan de Fuca at this time, one adult can produce millions of larvae, thus larvae in the water column are likely to be more plentiful than benthic adults and juveniles. Abundance surveys within the Project vicinity prior to SSWS indicated that sunflower sea star densities were relatively low within 600 meters from the shoreline. This trend has increased in post-epidemic abundance surveys, though individuals have been identified near the Project area as recently as 2020 (the last year of the surveys) (Sanchez et al. 2022). We therefore anticipate that a very small number of sunflower sea star larvae are likely to enter the action area during Project operations and some will become entrained and die.

Shade - We supplement the BA analysis (page 45) of the effects of the shade cast by the barge to invertebrate prey resources and potential modification of habitat with the following. Berthing vessels and barges can cast wide shadows that could result in juvenile salmonids swimming around the structure or risk predation from larger fish utilizing the overwater cover (Nightingale and Simenstad 2001; Shipman et al. 2010; Dethier et al. 2016). As the barge would be berthing over deeper waters (greater than 25 ft.) where light penetration is already low, it is likely that any juvenile salmonids utilizing the area would be larger in size than those remaining in shallow waters and therefore more adept at avoiding predators (Duffy et al. 2005; Schnreiner et al. 1977). Therefore, we do not expect that the berthing of this barge would result in increased predation of PS Chinook salmon, HCSR chum, or PS steelhead. Furthermore, while we concur that these deeper waters provide fewer forage opportunities for juvenile salmonids due to the lack of submerged aquatic vegetation, the deeper shore zone does provide important migratory and rearing habitat for juvenile salmonids (Ehinger et al. 2015). The NHVM determined that berthing of the barge for the duration of the Project would result in habitat impacts equivalent to 6 conservation credits. The applicant is offsetting this impact through the purchase of 6 conservation credits through the Puget Sound Partnership, which will defray the loss of ecological functions and services for PS Chinook salmon and HCSR chum within the Salish Sea. While this offsetting action would not prevent adverse effects to individuals of these species utilizing the action area during the Project, it would result in no-net-loss of long-term habitat function for these species. We therefore determine that the barge would result in minor impacts (behavioral response to shade, greater energy expenditure) to ESA-listed salmonids due to diminished rearing and migratory opportunities for juvenile PS Chinook salmon and HCSR chum.

Overwater shading may decrease the abundance of prey species which sunflower sea stars rely on, such as bivalves, small crustaceans, and other invertebrates, potentially leading to food scarcity. However, given that sunflower sea stars are currently in low abundance, reductions in prey are not likely to create conditions of competition, even if prey is reduced. Sunflower sea stars are highly mobile and this makes localized prey reductions less meaningful as individuals from this species are able to seek out prey over relatively broad areas (Hodin et al. 2021).

**Effects on Critical Habitat:**

We supplement the BA analysis (pages 29, 46, and 50 through 51) of the effects of the proposed action on PS Chinook salmon critical habitat within the action area with the following. The BA characterizes the impacts to the water quality and forage elements of the nearshore and offshore marine PBFs as short-term in nature and limited in scope such that these impacts to critical habitat would be insignificant. We supplement the BA analysis of these effects on habitat features, and include additional analysis of noise and entrainment on these PBFs, below.

Noise – The operation of the pilot technology will result in underwater noise generated by electric drive pumps operating at approximately 300 horsepower each located on the barge deck. Increased underwater noise has the potential to diminish the migration and forage PBFs for PS Chinook salmon, as this species will exhibit avoidance behavior when exposed to elevated sound (van der Knaap et al. 2022). However, given that the drive pumps will generate underwater noise at levels well below the 150 dB acoustic threshold at which fish exhibit behavioral responses, we do not expect that this action would diminish the value of forage and migration habitat within the action area. The conservation value of the habitat in the action area for PS Chinook salmon would therefore not be reduced by underwater noise.

Water Quality – Water quality is an essential element of the PBFs of PS Chinook salmon critical habitat. The BA (page 50) states that increases in turbidity, pH, and temperature, as well as a minor reduction in DO, have the potential to impact PS Chinook salmon critical habitat, though it ultimately concludes that these impacts would not adversely affect critical habitat due to the limited extent and duration of these effects. NMFS agrees with the conclusion that reduced DO would impact critical habitat, as seawater discharges would result in negligible reductions to DO compared to the ambient levels within Port Angeles Harbor (from 7.3 mg/L to 7.0 mg/L).

However, NMFS disagrees with the conclusion that turbidity, pH, and temperature increases would be insignificant, and supplements this analysis with the following. In laboratory settings, when exposed to incremental or immediate temperature increases, salmon have exhibited stress and behavior responses indicative of pain (Nilsson et al. 2019; Beemelmans et al. 2021). Salmon have also demonstrated avoidance behavior in response to warmer temperatures and low levels of DO (Stehfest et al. 2017). We therefore expect that the value of the migratory, water quality, and forage PBFs for PS Chinook salmon within the action area would be somewhat diminished during Project operations, as salmon are likely to avoid the area or alter their behavior while migrating through the action area. The value of this critical habitat would be somewhat diminished during the 2 years of Project operations, though due to the limited extent of these water quality changes, and the low reliance on this location by salmonids, it is not likely that this action will greatly reduce the value of this habitat for migrating juvenile PS Chinook. The condition of this critical habitat is expected to return to its current state upon completion of the Project.

We therefore supplement the BA analysis of the effects of water quality diminishment on PS Chinook salmon critical habitat with an analysis of the potential resuspension of contaminated sediments resulting from the discharge of seawater. The BA describes Port Angeles Harbor’s high levels of hazardous substances within its sediment, including metals (mercury, cadmium, zinc), dioxins/furans, polychlorinated biphenyls, and carcinogenic polycyclic aromatic hydrocarbons, each of which have the potential to impair the forage, growth and maturation PBFs. We anticipate that contaminant concentration rates could be increased for the duration of Project operations (up to 2 years), resulting in a reduction in the function and condition of these PBFs during that time. Because salmonid presence is low in the action area, this duration of degraded condition is not expected to affect a significant number of PS Chinook salmon from the two cohorts of adults most likely to migrate through the action area; therefore, the habitat reduction has less influence on conservation. The condition of this critical habitat is expected to return to its baseline level state upon completion of the Project.

Entrainment – The risk of entrainment from the operation of the intake has the potential to impact the forage PBF for adult PS Chinook salmon. The intake could entrain or impinge benthic and microbenthic fauna, as well as smaller fish that comprise the prey base for adult PS Chinook salmon. Among the forage fish caught in Port Angeles, Pacific herring and surf smelt were overwhelmingly captured in their post-larval (<50mm) life stage and Pacific sand lance were primarily juveniles (50-120mm) (Frick et al. 2022). Given the sizes of these forage fish, it is very likely that several forage fish swimming through the action area could be entrained by the intake pipe, which would in turn diminish the value of the designated critical habitat for forage within the action area. The applicant has taken measures to reduce these impacts by fitting the intake with a screen that would protect larger fish and by reducing the volume of water drawn into the pipe to 0.2 feet per second. We expect that forage availability and the conservation value of the habitat would return to current conditions upon the completion of the project, though the value of this habitat would be diminished during its two years of operation.

Shade – Shade has three main effects on features of aquatic habitat: 1) it can promote conditions for piscivorous fishes, 2) it presents a barrier to migration for juvenile salmonids, and 3) it can reduce subaquatic plant and prey communities. As the barge would be moored approximately 265 ft. offshore, we do not expect juvenile PS Chinook salmon to utilize this area for rearing, forage, or migration and therefore do not anticipate that the barge would diminish the value of these PBFs for juvenile PS Chinook salmon. Furthermore, we expect that adult salmon will be larger in size and less vulnerable to predation when passing beneath the barge. We do, however, anticipate a slight degradation of the forage PBF for adult PS Chinook salmon as a result of the barge. The BA notes that the barge would be placed on the edge of the photic zone and would have minimal impacts on existing aquatic vegetation (page 50). We add that the shade cast by the barge is also likely to reduce the productivity and abundance of benthic communities beneath the structure (Shipman et al 2010). As these benthic invertebrates comprise the prey base of forage fish and other prey species for adult PS Chinook salmon, we expect that the forage PBF will be diminished within this area during the 2 years when the barge is moored. As the barge would be moored over the Deeper Shore Zone where aquatic vegetation is absent and light penetration is already low, it is likely that the benthic communities in this location are already somewhat limited. Furthermore, the shade would be highly localized due to the size of the barge (2,400 SF). Shade cast by the barge will not impact the new or existing eelgrass plantings along Ediz Hook, as they are located well outside of the action area. The applicant will offset the impacts to these PBFs for PS Chinook salmon through the purchase of 6 conservation credits from the Puget Sound Partnership. These conservation credits would contribute funding for restoration projects within the Strait of Juan de Fuca marine basin where the adverse effects are expected. Though these habitat functions within the action area would be degraded for the duration of the Project, these activities would offset the enduring effects of the Project to nearshore habitat function and ensure that physical and biological features remain available at a level to support species conservation. We therefore expect a very small reduction in the function of the forage PBF for the duration of the project, at which point the function of this PBF would return to its current condition.

The applicant has agreed to offset the Project impacts to PS Chinook salmon critical habitat through the purchase of 6 conservation credits from the Puget Sound Partnership, resulting in no-net-loss of ecological function. While the value of water quality and forage PBFs within the action area would be diminished during operations, the Project would not preclude the use of the action area as critical habitat for PS Chinook salmon. We expect that the effects of the proposed action would be most impactful during periods of peak migration from the nearshore to open waters and during adult migration back to spawning habitat. In other words, migration values may be slightly diminished for up to 2 years.

**Cumulative Effects:**

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

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described earlier in the discussion of environmental baseline and status of the species. Because Port Angeles Harbor and its nearshore environment are expected to remain highly industrialized and utilized for several decades to come, we do expect climate change conditions to become more pronounced over that time period. As a result, we anticipate that these changes may disrupt important habitat features and ecosystem functions that are critical to the survival and recovery of the species discussed in this opinion.

Other than commercial and recreational use of the waters, NMFS does not expect any non-federal activities within the action area, as work within the water would fall under federal authorities such as the Clean Water Act. However, as the human population continues to grow, demand for agricultural, commercial, and residential development and supporting public infrastructure is also reasonably certain to grow. We believe the majority of environmental effects related to future growth will be linked to these activities, in particular land clearing, associated land-use changes (i.e., from forest to impervious, lawn or pasture), increased impervious surface, and related contributions of contaminants to area waters. Land use changes and development of the built environment that are detrimental to salmonid habitats are reasonably certain to continue under existing regulations. Though the existing regulations minimize future potential adverse effects on salmon habitat, as currently constructed and implemented, they still allow systemic, incremental, additive degradation to occur.

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

As indicated in Table 1, ESA-listed salmon and steelhead species, listed as threatened, are at a low level of persistence and moderate to high risk of extinction. Moreover, several of the limiting factors for the viability of these species (e.g., degraded habitat conditions, poor water quality) are prevalent within the action area. While the Project could incrementally degrade water quality and habitat conditions further within the action area, the scope and duration of this proposed action is such that we do not expect that these effects would be expressed on a population level. We add to this the effects of the proposed action, described in Sections 6 and 7 of the BA, and with our supplemental analysis presented above.

Species: We expect that some adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead could be exposed to degraded water quality (turbidity, modified pH, modified temperature) and diminished prey availability over the 2 years of the project, with responses ranging from behavioral changes that reduce fitness and increase the risk of injury or death in a small number of exposed individuals, to actual injury or death in a very small number of individuals, each year for 2 years. This will result in a reduction in abundance in each species, but because exposure is most likely among PS Chinook, that species is likely to have the greater reduction.

The last element in the integration of effects includes a consideration of the cumulative effects anticipated in the action area. As stated above, the existing condition of habitat within Port Angeles Harbor is highly degraded and these conditions are expected to decline over the coming decades. The Project would result in minor, adverse effects to ESA-listed salmonids; however, conditions within the action area are expected to return to existing conditions upon completion of the Project in the summer of 2026. Given the relatively short duration of the Project, we do not expect that the effects of this action would alter fitness, growth, or survival of enough fish to discernably reduce the abundance of any cohort of any population within this timeframe.

Accordingly, when NMFS adds the very small reduction in numbers of PS Chinook salmon, HCSR chum, and PS steelhead caused by the proposed action, to baseline conditions, even when considered with cumulative effects, the reduced abundance would be insufficient to alter the productivity, spatial structure, or genetic diversity of any of the species.

Regarding sunflower sea stars, we are not currently aware of any specific habitat types or locations used by sunflower sea stars for mating or spawning, larvae are planktonic, and newly settled juveniles appear in a variety of habitats in the action area. The sunflower sea star is proposed for listing throughout its range, and no data exist to suggest anything other than a single, panmictic population, so, to reach a determination of jeopardy, a proposed action would have to impact range-wide population dynamics. This single site-specific action is insufficient to alter the productivity, spatial structure, or genetic diversity of sunflower sea stars.

Critical Habitat: The short- and long-term effects on features of designated critical habitat for PS Chinook salmon added to the baseline, would be reductions to water quality, forage, two PBFs that support the conservation role of salmonid growth and reproduction.

We expect diminishment of water quality by elevated turbidity, pH, temperature, and resuspension of contaminated sediments). The diminishment of water quality by resuspended contaminants and turbidity would be minor in nature due to temporal and spatial limit. The temperature and pH increases would slightly reduce water quality throughout a majority of the 3.64-acre action area for 2 years (though this diminishment would be more significant within 6 ft. of the discharge ports). The duration of these discharges would be brief though continuous for the 2-year operation of the pilot project. Because the discharges would occur in deeper waters where juvenile PS Chinook salmon do not heavily rely on the habitat for growth or development, the impaired water quality PBF does not diminish conservation values of the action area.

The entrainment of prey resources would likewise diminish the forage PBF for PS Chinook salmon for the duration of Project operations. Despite the duration of this effect, the forage PBF diminishment is not sufficient to reduce conservation values of the action area due to the area of effect and the nearby areas with more abundant prey resources, in higher functioning habitat within Port Angeles Harbor along Ediz Hook.

The last element in the integration of effects includes a consideration of the cumulative effects anticipated in the action area. As stated above, the existing condition of habitat within Port Angeles Harbor is highly degraded and these conditions are expected to decline over the coming decades. The Project would result in minor, adverse effects to the water quality, forage, and growth and reproduction PBFs for PS Chinook salmon. However, conditions within the action area are expected to return to current conditions upon completion of the Project in the summer of 2026. Furthermore, the applicant will offset the overwater coverage impacts resulting from the berthing of the barge through the purchase of 6 conservation credits from the Puget Sound Partnership. The purchase of these conservation credits would compensate for the loss of ecological function and services within the Salish Sea by funding restoration projects within the bioregion where the adverse effects are expected. These activities offset some of the enduring effects of the Project to nearshore habitat function and ensure that physical and biological features remain available at a level to support species conservation. Given the relatively short duration of the Project and the location of these impacts in an area where PS Chinook salmon are more likely to encounter the habitat impacts as adults rather than in their more vulnerable juvenile life stage, we do not expect that the effects of this action would discernably reduce the value of the critical habitat in the action area for PS Chinook salmon.

**Conclusion:**
After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, HCSR chum, or PS steelhead, or destroy or adversely modify the designated critical habitat of PS Chinook salmon. It is NMFS' opinion on the sunflower sea star conference, that this species will not be jeopardized.

## 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 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.

**Amount or Extent of Take:**
The amount or extent of take in this ITS serves two functions: (1) it identifies the quantity of incidental take exempted for the action agency and applicant. In the case of a species without 4(d) protective regulations, such as the sunflower sea star, the exemption is not needed because incidental take is not prohibited; and (2) it serves as a check on NMFS's jeopardy analysis. The amount or extent of take identifies the anticipated level of take NMFS considered in reaching its conclusion that the proposed action will not jeopardize the continued existence of a listed species. If this level of take is exceeded, reinitiation of consultation is triggered to ensure that NMFS's no-jeopardy conclusion remains valid.

Take in the form of harm is often impossible to quantify as a number of individuals, because the presence of the individuals (exposure to the harmful conditions) is highly variable over time, and is influenced by factors that cannot be easily predicted. Additionally, the duration of exposure is highly variable based on species behavior patterns, and the wide variability in numbers exposed and duration of exposure creates a range of responses, many of which cannot be observed without research and rigorous monitoring. In these circumstances, we described an "extent" of take which is a measure of the harming condition spatially, temporally, or both. The extent of take is causally related to the amount of harm that would result, and each extent of take provided below is an observable metric for monitoring, compliance, and re-initiation purposes.

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

1. Take in the form of harm of adult PS Chinook salmon, adult HCSR chum, and juvenile and adult PS steelhead, and larval, juvenile, and adult sunflower sea star from diminished water quality (alkaline-treated seawater, turbidity, and the resuspended contaminated sediments). The extent of this take is a zone that extends radially 207 ft. (3.64 acres). This metric causal because a larger area of degraded water quality would expose a greater number of fish. This metric is easily observed, as the Project would include extensive water quality monitoring, and is causally related to take because a larger mixing zone would increase the risk of injury for fish migrating through Port Angeles Harbor.

2. Take in the form of harm of adult PS Chinook salmon, adult HCSR chum, juvenile or adult PS steelhead, and juvenile and adult sunflower sea star from reduced prey availability. The extent of take is the volume and velocity of water being drawn in per day (97,000 gallons at 0.2 feet per second at). This metric is easily observed, as monitoring of intake function would be a regular component of Project operations, and is causally related to take because a greater velocity of intake or amount of water being drawn in would increase the risk of fish impingement and further diminish prey resources for ESA-listed salmonids.

3. Take in the form of injury or death of larval sunflower sea star from entrainment. The extent of take is the volume and velocity of water being drawn in per day (97,000 gallons at 0.2 feet per second at). This metric is easily observed, as monitoring of intake function would be a regular component of Project operations, and is causally related to take because a greater velocity of intake or amount of water being drawn in would increase the risk of larval sea stars floating within the water column being sucked into the intake and injured or killed.

4. Take in the form of harm of juvenile PS Chinook salmon and HCSR chum from diminished rearing and migratory opportunities resulting from the berthing of a barge at Terminal 7. The extent of take is the size of the overwater structure (2,400 SF) casting shade over the water. This metric is easily observed, and is causally related to the take because a larger shaded area would expose juvenile salmonids to greater behavioral changes associated with shade and increased energy expenditure during migration.

**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.

**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).

1. Minimize take from entrainment of prey species and of larval sunflower sea star within the intake.

2. Complete and implement a monitoring and adaptive management program to confirm the take exemption for the proposed action is not exceeded, and that the terms and conditions in this incidental take statement are met.

**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 applicant complies) with the following terms and conditions. The [name federal agency] or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

    a. Project Macoma, LLC shall visually inspect the intake screen for holes or damage weekly during Project operations. Should Project Macoma, LLC staff identify damage to the screen that risks entrainment of prey fishes, ESA-listed salmonids and sunflower seas stars, they shall immediately shut down the intake and notify

NMFS via phone or email within 24 hours after the damage is identified. Project Macoma, LLC staff shall not resume Project operations until such time that the screen can be satisfactorily repaired and NMFS grants written approval that operations can continue.

b. If a sunflower sea star is identified on Terminal 7 or the barge during construction, operation, or disassembly of the pilot technology, Project Macoma, LLC staff shall carefully relocate it outside of the action area and promptly (within 5 days) notify NMFS of this specimen, and where it was removed from, and where it was placed. Project Macoma, LLC staff shall make every effort to take photographs of the sunflower sea star prior to and during its relocation. If photos are not taken, the report should indicate estimated size (in inches) and general condition (i.e. appears healthy, injured, or sick) of any sunflower sea star handled.

This notification shall be submitted to:

ProjectReports.wcr@noaa.gov
Reference Project #: WCRO-2024-00588
CC: Bonnie.shorin@noaa.gov

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

   a. Project Macoma, LLC shall supplement the adaptive management plan outlined in Table 3 of the BA with the following conditions:

      i. Should Project Macoma, LLC staff observe a dead aquatic organism within the action area, they shall make every effort to take pictures of and identify the species.

      ii. Project Macoma, LLC shall notify NMFS of any water quality parameter exceedances, aquatic vegetation changes, and observations of aquatic organism behavioral changes or deaths within 24 hours of their observation. Should an exceedance in the water quality parameters outlined in the NPDES SWD permit occur, Project Macoma, LLC will notify NMFS within 24 hours of the exceedance, identify the nature and details of the exceedance, and include an explanation of what Project modifications will be made to prevent future exceedances.

      Project Macoma, LLC shall share the results of its water quality monitoring, as well as the findings of the pilot study, with NMFS upon completion of the Project within the full report as outlined below.

   b. Project Macoma, LLC shall provide a report to NMFS upon completion of the Project documenting the dates in which the adaptive management strategy was employed, as well as the strategies implemented to address the issue(s). This report shall be submitted to:

      ProjectReports.wcr@noaa.gov
      Reference Project #: WCRO-2024-00588
      CC: Bonnie.shorin@noaa.gov

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

1. The USACE should continue to support the recovery of ESA-listed species and critical habitat in the Salish Sea through restoration efforts such as the planting of eelgrass and restoration of shorelines, particularly along Ediz Hook where restoration efforts are ongoing.

2. The USACE should support the evaluation and implementation of efforts to address ocean acidification and marine carbon dioxide capture through natural processes such as the enhancement of eelgrass forests, as well as potential bioengineered solutions including mCDR technology.

3. The USACE should support Ebb Carbon and the Port of Port Angeles in conducting additional studies that analyze the effect of this mCDR technology on aquatic organisms, such as shellfish, forage fish, or salmonids. The results of these studies should be incorporated into future mCDR research and testing to ensure that all efforts are being made to reduce the potential impacts of this technology on species and their habitat.

**Reinitiation of Consultation:**
Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the federal agency where discretionary federal 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 species or critical habitat 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 species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

**NLAA DETERMINATIONS**

We reviewed the USACE consultation request document and related materials. Based on our knowledge, expertise, and your action agency's materials, we concur with the action agency's conclusions that the proposed action is not likely to adversely affect the following NMFS ESA-listed species and/or designated critical habitat: Puget Sound/Georgia Basin (PS/GB) bocaccio, PS/GB yelloweye rockfish, southern resident killer whale (SRKW) and its designated critical habitat, and the Central America DPS and Mexico DPS of humpback whale.

*PS/GB bocaccio:*
We supplement the BA analysis (pages 32 through 33 and 51) of the potential for PS/GB bocaccio to occur within the Project area with the following. The BA describes the preferred

habitat conditions for PS/GB bocaccio in each of its life stages and outlines how these characteristic habitat features are absent within Port Angeles Harbor. We add here that the Victoria Sill water mass that runs from east of Port Angeles north to Victoria regulates larval rockfish transport, making it unlikely that bocaccio regularly occupy Port Angeles Harbor (Drake et al. 2010). However, some pelagic juvenile and adult bocaccio will migrate long distances, which could re-establish aggregations of fish in formerly occupied habitat (NMFS 2017). PS/GB would be most vulnerable to Project impacts in their larval stage, as the risk of entrainment would be highest. The lack of suitable habitat conditions, absence of any PS/GB bocaccio observations within Port Angeles Harbor, and Victoria Sill's current regulation make it extremely unlikely that any PS/GB bocaccio would occur within the action area during Project operations. Therefore, we consider the effects of the proposed action to be discountable.

*PS/GB yelloweye rockfish:*
We supplement the BA analysis (page 33 and 52) of the potential for PS/GB yelloweye rockfish to occur within the Project area with the following. The BA describes the preferred habitat conditions for PS/GB yelloweye rockfish in each of its life stages and outlines how these characteristic habitat features are absent from Port Angeles Harbor. We add here that the viability of this DPS is likely highly influenced by the localized loss of populations, limited adult movement, and the low likelihood of juvenile recruitment from different Puget Sound marine basins (NMFS 2017). As there are no historic occurrences of yelloweye rockfish within Port Angeles Harbor and very limited suitable habitat conditions at this location, it is highly unlikely that PS/GB yelloweye rockfish would occur within the action area during Project operations. Therefore, we consider the effects of the proposed action to be discountable.

*SRKW and Critical Habitat:*
We supplement the BA analysis (pages 25 and 46 through 47) of the potential for SRKW to occur within the Project area with the following. The BA describes how SRKW are unlikely to be directly affected by Project operations due to the action area's proximity to the shoreline within Port Angeles Harbor. The BA further states that effects to the SRKW prey base via adverse effects to PS Chinook salmon would be discountable due to the limited scope and duration of the project. We add here that between 1999 and 2022, there have been a total of 36 sightings of SRKW within the 4.6 km x 4.6 km quadrant where the Project would occur (NOAA Fisheries 2024). The Orca Network also has records of SRKW sightings off of Ediz Hook, the most recent of which occurred in February of 2023, though it was not determined whether the whale was an SRKW or transient orca (Orca Network 2024). However, presence of SRKW within Port Angeles Harbor is relatively rare (1.6 sightings per year on average). While the area affected by water quality modification is 3.64 acres, the likelihood of an SRKW entering the action area in specific is expected to be low even if a small number of this species does enter the general area during the 2 years of operation, the relatively shallow depths (between 28-35 ft.). Direct exposure to the project may not be discountable, but we do not expect this species to linger in the action area. Furthermore, as stated above in the Effects of the Action Section, the effects of this Project on PS Chinook, which are prey of SRKW, would cause a very small annual reduction of juveniles for at most two years, and this is not expected to produce a population level result, so that that prey quantity of adult salmon is expected to be unmodified. Accordingly, we consider the effects on SRKW insignificant.

We supplement the BA analysis (pages 26 and 47 through 48) of the effects of the proposed action on SRKW critical habitat within the action area with the following. The BA characterizes the impacts to the water quality and prey availability PBFs as short-term in nature and limited in scope such that these impacts to critical habitat would be insignificant. We add that killer whales frequent a variety of marine habitats with varying temperatures, and that temperature variation tends to affect SRKW through prey availability rather than via direct effects. Likewise, the primary pathway of effect resulting from diminished water quality (with the exception of contaminants) appears to be in diminished prey availability (NMFS 2008). Given the relatively small area where water quality would be diminished, the negligible effect that minor variations in temperature, pH, turbidity, and DO would have on SRKW, we concur that the project would have an insignificant effect on the water quality PBF. Similarly, effects on SRKW prey resources as a result of this Project, would not be measurable among adult fish or at a population level. Therefore, we concur that the Project effects on the designated critical habitat for SRKW within the action area are insignificant.

*Humpback Whale:*
We supplement the BA analysis (pages 26 through 27 and 48) of the potential for humpback whale to occur within the Project area with the following. The BA describes how humpback whales are unlikely to be directly affected by Project operations due to the action area’s proximity to the shoreline within Port Angeles Harbor. The BA further states that effects to the humpback whale prey base via adverse effects to PS Chinook salmon would be discountable due to the limited scope and duration of the project. We add here that since 2000, humpback whales have been sighted with increasing frequency in the inside waters of Washington (Falcone et. al. 2005). In 2014 and 2015 sightings sharply increased to around 500 each year. The Orca Network has several records of humpback sightings off of Ediz Hook, the most recent of which occurred in May of 2023 (Orca Network 2024). Humpback whales pass by the outlet of the Port of Port Angeles while transiting the Juan de Fuca; however, humpback presence within the action area is exceedingly rare. As such, humpback whales are not expected to be near the area during Project operations. Therefore, because the likelihood of exposure is extremely low, we concur with the conclusion reached in the BA that effects on humpback whale are considered discountable.

## ESSENTIAL FISH HABITAT RESPONSE

Thank you also for your request for essential fish habitat (EFH) consultation. NMFS reviewed the proposed action for potential effects on EFH pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation. We have concluded that the action would adversely affect EFH designated under the fishery management plans (FMPs) developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce for coastal pelagic species (CPS) (PFMC 2023a), Pacific Coast groundfish (PFMC 2023b), Pacific Coast salmon (PFMC 2022), and U.S. West Coast highly migratory species (HMS) (PFMC 2023c). EFH Conservation Recommendations are provided below.

**Magnuson-Stevens Fishery Conservation and Management Act:**
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 associated physical, chemical, and biological 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 may result from actions occurring within EFH or outside of it and may include direct, indirect, site-specific or habitat-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 (50 CFR 600.905(b)).

**EFH Affected by the Proposed Action:**
The proposed project occurs within EFH for various federally managed fish species within the CPS FMP (PFMC 2023a), Pacific Coast groundfish FMP (PFMC 2023b), and Pacific Coast salmon FMP (PFMC 2022). Groundfish, coastal pelagic, and salmonid fish species that could have designated EFH in the action area are listed in Table 3.

**Table 3.** EFH species in action area

| Groundfish | | | |
|---|---|---|---|
| **Common Name** | **Scientific Name** | **Common Name** | **Scientific Name** |
| arrowtooth flounder | Atheresthes stomias | rosy rockfish | Sebastes rosaceus |
| big skate | Raja binoculata | rougheye rockfish | Sebastes aleutianus |
| black rockfish | Sebastes melanops | sablefish | Anoplopoma fimbria |
| bocaccio | Sebastes paucispinis | sand sole | Psettichthys melanostictus |
| brown rockfish | Sebastes auriculatus | sharpchin rockfish | Sebastes zacentrus |
| butter sole | Isopsetta isolepis | English sole | Parophrys vetulus |
| cabezon | Scorpaenichthys marmoratus | flathead sole | Hippoglossoides elassodon |
| California skate | Raja inornata | greenstriped rockfish | Sebastes elongatus |
| canary rockfish | Sebastes pinniger | hake | Merluccius productus |
| China rockfish | Sebastes nebulosus | kelp greenling | Hexagrammos decagrammus |
| copper rockfish | Sebastes caurinus | lingcod | Ophiodon elongatus |
| curlfin sole | Pleuronichthys decurrens | longnose skate | Raja rhina |
| darkblotch rockfish | Sebastes crameri | Pacific cod | Gadus macrocephalus |
| Dover sole | Microstomus pacificus | Pacific ocean perch | Sebastes alutus |
| Pacific sanddab | Ctlharichthys sordidus | shortspine thornyhe | Sebastolobus alascanus |
| petrale sole | E opsetta jordani | spiny dogfish | Squalus acanthias |
| quillback rockfish | Sebastes maliger | splitnose rockfish | Sebastes diploproa |
| ratfish | Hydrolagus colliei | starry flounder | Platichthys stellatus |
| redbanded rockfish | Sebastes babcocki | stripetail rockfish | Sebastes saxicola |
| redstripe rockfish | Sebastes proriger | tiger rockfish | Sebastes nigrocinctus |
| rex sole | Glyptocephalus zachirus | vermilion rockfish | Sebastes miniatus |
| rock sole | Lepidopsetta bilineata | yelloweye rockfish | Sebastes ruberrimus |
| rosethorn rockfish | Sebastes helvomaculatus | yellowtail rockfish | Sebastes llavidus |
| **Coastal Pelagic** | | | |
| **Common Name** | **Scientific Name** | | |
| market squid | Latigo opalescens | | |
| northern anchovy | Engraulis mordax | | |
| jack mackerel | Trachurus symmetricus | | |
| Pacific mackerel | Scomber japonicus | | |
| Pacific sardine | Sardinops sagax | | |
| **Salmonid Species** | | | |
| **Common Name** | **Scientific Name** | | |
| Chinook salmon | Oncorhynchus tshawytscha | | |
| coho salmon | Oncorhynchus kisutch | | |
| pink salmon | Oncorhynchus gorbuscha | | |

In addition, the project occurs within, or in the vicinity of estuaries, which is designated as a habitat area of particular concern (HAPC) for various federally managed fish species within the Pacific Coast groundfish FMP (PFMC 2023) and Pacific Coast salmon FMP (PFMC 2022). The project also occurs within waters shoreward from the three nautical mile boundary of the territorial sea shoreward to MHHW, which is a designated HAPC for Pacific Coast groundfish (PFMC 2022). HAPCs 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 HAPCs 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.

**Adverse Effects on EFH:**
NMFS determined the proposed action would adversely affect EFH as follows:

1. Discharge of treated seawater could result in reoccurring short-term increases in turbidity and resuspension of contaminated sediments, as well as increased water temperature and pH.

2. Intake of seawater could result in the entrainment and impingement of prey communities of EFH species.

3. Operation of the pilot technology could result in alterations to aquatic habitat, including an estuary (a Habitat of Particular Concern [HAPC] for Pacific Coast salmon and Pacific Coast groundfish).

**EFH Conservation Recommendations:**
NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the adverse effects of the proposed action on EFH.

1. Conduct, or have recent equivalate analysis, of submerged aquatic vegetation within the action area to inform biological monitoring efforts outlined in the Project description.

2. Avoid use of galvanized steel, ACZA-treated wood, or other materials with the potential to introduce contaminants into the harbor for construction of Project infrastructure.

3. Monitor turbidity and other water quality parameters to ensure that seawater discharge events are compliant with NPDES SWD permit. Implement corrective measures if temporary water quality standards are exceeded.

**Statutory Response Requirement:**
As required by section 305(b)(4)(B) of the MSA, the USACE 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)).

**Supplemental Consultation:**
The USACE 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)).

**DATA QUALITY ACT**

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). [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at Lacey, Washington.

Please direct questions regarding this letter to Bonnie Shorin, in Lacey, Washington at bonnie.shorin@noaa.gov.

Sincerely,

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

cc: Pamela Sanguinetti, USACE
Jesse Waknitz, Port of Port Angeles
Kyla Westphal, Ebb Carbon

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**APPENDIX A**

| |
|---|
| Blue cells contain section headings |
| Rose cells contain questions that need to be answered to fill out calculator |
| Grey cells contain units requested for entry |
| Yellow cells indicate user entry fields |
| Green cells contain additional explanations and resource links |
| Maroon cells contain summary values |

| | |
|---|---|
| cy Reference Number: | NWS-2023-915 |
| FWS or NMFS # | WCRO-2024-00588 |
| Project Name: | Project Macoma Carbon Dioxide Removal Pilot Study |
| Prepared on and by: | S.Tilley on 3/22/2024 |

**Nearshore Habitat Conservation Calculator**

| | |
|---|---|
| Version 1.0 | 11/15/2023 |

This tool determines long-term habitat impacts and benefits for projects in the Salish Sea nearshore. Details about the use of this Conservation Calculator can be found in the User Guide, FAQs, and training materials, which are all available on the

Puget Sound Nearshore Habitat Conservation Calculator Webpage

| | | Conservation Credits/Debits | DSAYs (Discounted Service Acre Years) |
|---|---|---|---|
| Overwater Structures | Debit | -6 | -0.06 |
| | Credit | 0 | 0.00 |
| | **Balance** | -6 | -0.06 |
| underwater stuff | Debit | 0 | 0.00 |
| | Credit | 0 | 0.00 |
| | **Balance** | 0 | 0.00 |
| Riparian Enhancement/Degrada | **Balance** | 0 | 0.00 |
| SAV Planting | **Conservation Credit** | 0 | 0.00 |
| .oss / Remaining Conservation Offsets Needed | | -6 | -0.06 |