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

Refer to NMFS No:
WCRO-2022-02512 (Clark)
WCRO-2022-02518 (Morgan)

April 3, 2023

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

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Issuance of Permits for 2 Projects under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for Actions Related to Shellfish Aquaculture, Taylor Shellfish Morgan Living Trust and Clark Leases

Dear Mr. Tillinger:

On September 28th and 29th 2022, we received 2 letters from the U.S. Army Corps of Engineers, Seattle District, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Corps' permitting of in-water and nearshore structures. Based on the locations of the proposed projects and their similar impacts on ESA-listed species and their critical habitat designated under the ESA, specifically in the nearshore of Puget Sound, and in an effort to expedite and streamline the ESA consultation processes, we have batched these actions into a single biological opinion. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson–Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

In this batched opinion, NMFS concluded that the proposed action is likely to adversely affect Puget Sound (PS) Chinook salmon (*O. tshawytscha*), PS steelhead (*O. mykiss*), their designated critical habitat, and juvenile bocaccio rockfish's (*S. paucispinis*) critical habitat, but is not likely to jeopardize the continued existence of these species or to adversely modify their critical habitat. NMFS also concludes that the proposed action is not likely to adversely affect yelloweye rockfish (*S. ruberrimus)*, Southern Resident killer whale (*Orcinus orca*), or adversely affect their designated critical habitat.

As required by section 7 of the ESA, NMFS is providing an incidental take statement with the PBO. The incidental take statement describes reasonable and prudent measures NMFS considers necessary or appropriate to minimize the impact of incidental take associated with the COE's proposed action.

The take statement sets forth nondiscretionary terms and conditions, including reporting requirements, that the Federal action agency must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions will be exempt from the ESA's prohibition against the take of ESA-listed species.

This document also includes the results of our analysis of the proposed action's likely effects on essential fish habitat (EFH) pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and includes two conservation recommendations to avoid, minimize, or otherwise offset potential adverse effects on EFH.

Section 305(b) (4) (B) of the MSA requires Federal agencies to provide a detailed written response to NMFS within 30 days after receiving our final recommendations. If the response is inconsistent with the EFH conservation recommendations, the Federal action agency must explain why the recommendations will not be followed, including the scientific justification for any disagreements over the effects of the action and the recommendations. In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we request that in your statutorily required reply to us regarding the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

Please contact Maria Pazandak, Central Puget Sound Branch, maria.pazandak@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

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

cc: Rory Lee, USACE
Erin Ewald, Applicant

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

Issuance of Permits for 2 Projects under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for Actions Related to Shellfish Aquaculture
Taylor Shellfish Morgan Living Trust and Clark Leases

NMFS Consultation Number: WCRO-2022-02512 (Clark)
WCRO-2022-02518 (Morgan)

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Puget Sound Chinook (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
PS/GB Bocaccio rockfish (*Sebastes paucispinis*)	Endangered	No	No	Yes – Juvenile No – Adult	No
PS/GB Yelloweye rockfish (*S. ruberrimus*)	Threatened	No	No	No	No
Southern Resident Killer whale (*Orcinus orca*)	Endangered	No	No	No	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes
Coastal Pelagic Species	No	No
Pacific Coast Groundfish	No	No

Consultation Conducted By: National Marine Fisheries Service
West Coast Region

Issued By:

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

Date: April 3, 2023

TABLE OF CONTENTS

1. INTRODUCTION

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

1.1. Background

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

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at Central Puget Sound Branch office in Lacey, Washington.

1.2. Consultation History

In February, 2022, NMFS performed pre-consultation review of the two proposed projects (shellfish aquaculture farms) with the applicant and the USACE present. It was addressed that under NWP 48, and carried forward in the Programmatic Biological Assessment (PBA) for aquaculture (WCR-2014-1502), the USACE makes distinctions regarding ‘continuing’ and ‘new’ shellfish activities. ‘Continuing’ shellfish activities are those activities that had been granted a permit, license, or lease from a state or local agency specifically authorizing commercial shellfish aquaculture activities and that were occurring within a defined footprint prior to 18 March 2007. ‘New’ activities are those activities that were undertaken after 18 March 2007 and essentially include all activities that do not qualify as continuing. Also stated in the U.S. Army Corps of Engineers’ PBA (Corps, 2015), is that for ‘new’ activities only, shellfish activities (e.g., racks, stakes, tubes, nets, flip-bags, long-lines, on-bottom cultivation) shall not occur within 16 horizontal feet of native eelgrass (*Zostera marina*) or kelp (rooted/attached brown algae in the order *Laminariales*).

The proposed projects are existing shellfish farms that do not propose any new cultivation or expanded footprint. Nonetheless, they are considered “new” for purposes of the PBA as they were not disclosed to the Corps by the previous operators during the relevant period of time for identifying continuing shellfish activities. Both proposed projects have portions that do not fit under NMFS Programmatic Biological Opinion due to their status as “new” farms, and the condition that they cannot farm in proximity to eelgrass (within 16 feet); thus an individual consultation was necessary for each.

It was brought to NMFS' attention at the February meeting that the PBA states that for projects a portion of which do not fit under the Programmatic, only the excluded portion would require individual consultation. NMFS stated both orally, and by email that it would need to discuss internally if this would be possible.

In mid-March, NMFS sent an email to the Corps stating that actions should not be segmented when evaluating effects under ESA, and that the projects would need to be consulted upon in full.

The Corps requested formal consultation on March 28, 2022 for Morgan Living Trust Lease. It was assigned on March 31, 2022 and NMFS requested additional information on April 1, 2022. NMFS met virtually with the applicant on April 14, 2022 to discuss project details and potential changes to project details. The Corps requested formal consultation on April 19, 2022 for Clark Lease. It was assigned on April 21, 2022 and NMFS requested additional information on April 25, 2022.

The applicant met virtually with NMFS to determine further steps on May 2, 2022. On May 10, 2022, NMFS initiated consultation. On July 19, 2022, USACE withdrew their consultation request as the applicant decided to modify the proposed project in order to meet the programmatic criteria.

On October 5, 2022, NMFS received consultation requests for the same projects that were incompletely consulted on previously. The following week, on October 12, 2022, NMFS met with the applicant to discuss the project. On November 2, 2022, NMFS requested additional information regarding the portion of the project in eelgrass and received a response on November 11, 2022. NMFS sent a follow-up email requesting further details regarding when in-water work, specifically harvesting, would occur. On December 19, 2022, NMFS spoke with the applicant regarding the email from November. NMFS determined it had all of the necessary information and initiated consultation on January 2, 2023. In the proposed project areas, there are some locations in which the farms are contiguous and thus NMFS determined that a batched opinion of WCRO-2022-02518 and WCRO-2022-02512 would expedite the process due to the proposed activities and potential effects being similar or the same.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under MSA, federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded or undertaken by a federal agency (50 CFR 600.910).

For the purposes of this biological opinion, the proposed action is the USACE's issuance of two permits, for the projects listed in Table 1. The USACE would authorize the projects under Section 404 of the CWA and Section 10 of the RHA and Corps NWP 27 for the commercial culture and harvest of shellfish. Taylor Shellfish proposes to grow and produce Pacific oysters (*Crassostrea gigas*), Kumamoto oysters (*C. sikamea*), and Manila clams (*Venerupis philippinarum*) for commercial harvest on intertidal tideflats in Samish Bay, Washington. The Morgan Living Trust Lease and Clark Lease plots are adjacent and would utilize similar culture and harvest methods. Multiple culture methods are used throughout the project areas, including on-bottom clam culture, on-bottom oyster culture, and near-bottom oyster culture using longlines and flip-bags (Table 1). For each project, a 10x30 scow would be on site up to 120 days for approximately 5 hours each day. Additionally, boats would be onsite, between 30-120 days, when crews are planting or harvesting.

Proposed Farms

<u>Morgan Living Trust Lease</u>
The Morgan Living Trust farm (Morgan Lease) is located across 5 parcels leased by Taylor Shellfish (P61571, P61572, P61598, P61634, and P61566). The project area consists of a 94-acre parcel, whereas the total culture area consists of 51.1 acres. The applicant would utilize on bottom clam culture (41 acres) and longline/flip-bag oyster culture (10.1 acres). Most of the proposed longline/flip-bag culture methods would be in eelgrass (9.2 acres). Clam and oyster cultivation would occur between +3' to -5' tidal elevation.

Across the 10.1 acres dedicated to flip-bag culture, the site can accommodate up to 180 lines that are no longer than 150' long and up to 7,020 bags. The required fiberglass poles and stakes are already on-site from previous use at 6-foot spacing between rows. For the structures within the eelgrass beds, the applicant would only cultivate oysters in every other row giving 12-foot spacing.

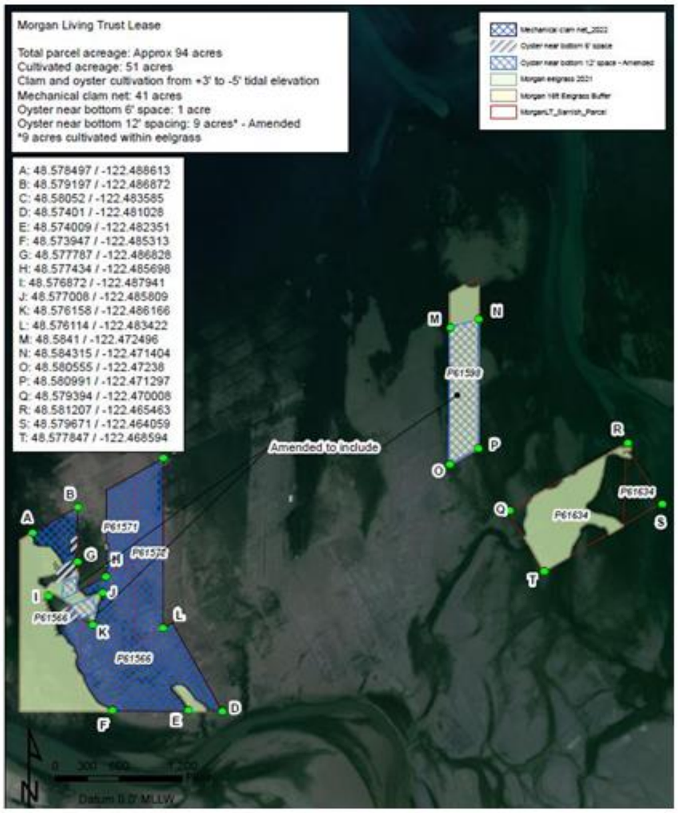

Figure 1. Morgan Living Trust Lease Parcels with Culture Type and Location of Eelgrass

<u>Clark Lease</u>

The Clark Shellfish Farm Project (Clark Lease) area consists of a 150-acre parcel, of which 46.3 acres would be used for culture. The applicant would utilize the following methods of cultivation: on bottom clam culture (21.6 acres), on-bottom oyster culture (16.3 acres), and longline/flip-bag culture (4.4 acres, 4 of which are in/within 16 horizontal feet of eelgrass). Clam and oyster cultivation would occur from +5' to -3' tidal elevation.

Longline and flip-bag culture in eelgrass would occur in four locations within the Clark farm. Across the 4.4 acres for longline and flip-bag culture, the site can accommodate up to 275 lines that are no longer than 150' long and up to 10,725 bags. The required flip-bag structures are already on site from previous use, and as mentioned above for the Morgan lease, the applicant would only place oysters in every other row giving 12 foot spacing when in eelgrass.

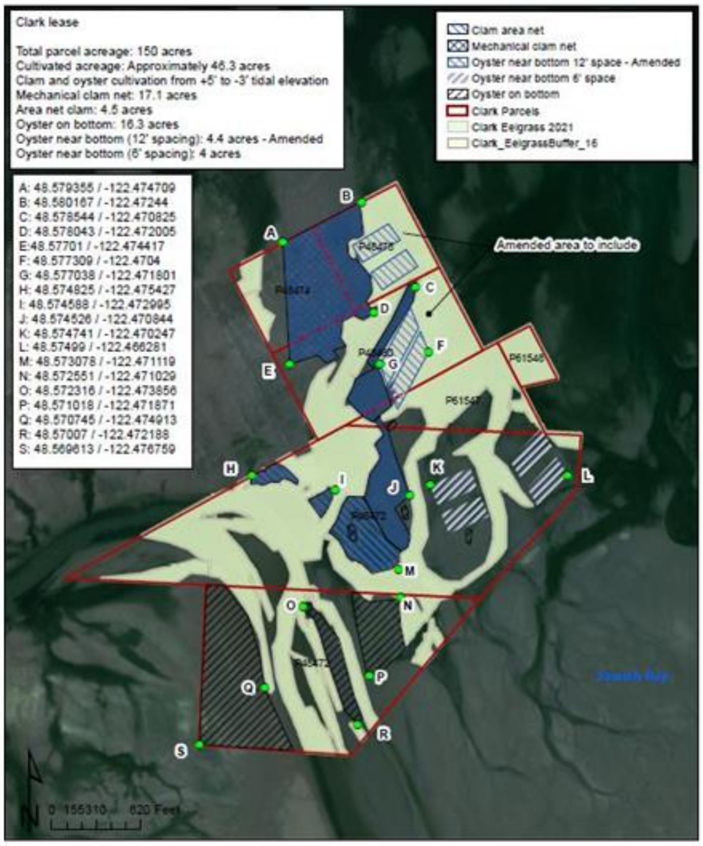

Figure 2. Clark Lease Parcels with Culture Type and Location of Eelgrass

Table 1. Lease and Proposed Culture Method

Project	**On-Bottom Clam Culture**	**On-Bottom Oyster Culture**	**Near-Bottom Oyster Culture (Longlines and Flip-bags)**
Morgan Living Trust Lease	X (41 acres)		X (10.1 acres, 9.2 in eelgrass)
Clark Lease	X (21.6 acres)	X (12.6 acres)	X (4.4 acres, 4 in eelgrass)

Types of Culture

<u>On-Bottom Clam Culture</u>
The Morgan Living Trust Lease would include 41 acres of on bottom clam culture (Figure 1; Table 1), whereas the Clark Lease would include 21.6 acres of on bottom clam culture (Figure 2; Table 1).

Prior to planting clam seed on the tidelands, beds are prepared by removing aquatic vegetation, mussels, and other undesired species. Any shellfish present on site may be harvested to reduce competition. These activities could be conducted by hand or by mechanical means (e.g., water jet, harrowing). Manila clam seed is broadcast by hand across intertidal areas and mechanically netted to protect against predation. The net's edges are typically buried in a trench or weighed with a lead line and would be secured manually with bent rebar. Harvest would also occur mechanically, and harvested clams are placed into sacks for retrieval by boat. Predator cover netting typically remains on site until harvest.

Surveys may be conducted during low tide to assess seed survival and distribution and to estimate potential yield after each growing season. Based on survey results, additional seeding activity may occur. Netting used to protect clams from predation can become fouled with barnacles, mussels, aquatic vegetation (e.g., algae, eelgrass) or other organisms. The nets usually remain on site throughout the growing period. Fouling organisms may be removed by hand or by mechanical means while the nets are in place and may be cleaned as often as monthly or not at all. Biofouling occurs most frequently during the late spring and summer months.

Harvest

Bed boundaries may be staked and any predator netting folded back during low tide before harvest begins. Hand harvesters dig clams during low tides using a clam rake, shovels, or other hand operated tools. In contrast, a mechanical harvester may be utilized instead of or in conjunction with hand harvest. The harvester is driven on the substrate when the tide is out and excavates the substrate to a depth of 4-6 inches in order to extract clams. Approximately 0.8 acres per day of clams can be mechanically harvested. Depending on the level of productivity of the ground, multiple crops may be planted at the same time.

Market-size clams (typically about 3 years of age) are selectively harvested and placed into sacks to be picked up later by boat. Undersized clams are returned to beds for future harvests. Since a given clam bed may contain multiple year classes of clams, it may be harvested on a regular schedule (such as annually) to harvest individual year classes of clams; clam beds may also be harvested as infrequently as once every four years. Clams harvested for sale are generally left in net bags in wet storage. Clams are typically maintained in wet storage either directly in marine waters or in upland tanks filled with seawater for at least 24 hours. Upland tanks are connected to the marine waters through intake and outfall structures (pipes) that are compliant with the NPDES.

<u>On-Bottom Oyster Culture</u>

The Clark Lease proposes to grow oysters on-bottom and in bags as both singles and clusters on the substrate within a 16.3 acre parcel (Figure 2; Table 1).

Prior to planting a new crop of oysters, minimal cleaning and preparation of the oyster beds would be conducted to remove debris and harvest the previous crop. The substrate at both project sites is comprised of consistent sand, making it suitable for planting oysters and not requiring graveling. Single oyster culture on the bottom would be done in hard plastic mesh bags or by spraying oysters attached to cultch shell from the deck of barges, or cast by hand onto marked beds at an even rate to achieve optimum densities.

Oysters may be transplanted from one site to another at some point during grow-out. For example, oysters may be moved from an initial growing area to "fattening" grounds where higher levels of nutrients are found, allowing the oysters to grow more rapidly for market.

In areas where the substrate is soft, the oysters may sink into the mud. Unlike clams that live in the substrate, oysters must stay on the surface to survive. When shells become buried, the oysters must be dug up with a harrow to periodically pull them out of the mud. The harrow is a skidder with rake-like tines, towed along the bottom by a boat. The harrow penetrates the substrate by a few inches and moves the oysters back to the surface.

Harvest
During hand harvest, workers hand-pick oysters and place them into bushel-sized containers at low tide. These would be emptied into tubs for pickup and transport by boat. Smaller containers are sometimes placed or dumped on the decks of scows for retrieval at high tide or are carried off the beach at low tide. Single oysters cultured loose on the bottom are frequently hand-harvested into mesh bags or baskets to reduce handling and shell damage. When single oyster culture on the bottom is done in hard plastic mesh bags, the bags are simply loaded into a boat or a scow for transport to shore, then transported to processing plants or the market.

Figure 3. On-bottom oyster culture in bags (Photo by Maria Pazandak)

<u>Near-Bottom Oyster Culture</u>
The Morgan Living Trust Lease would include 10 acres of near-bottom culture, whereas the Clark Lease would include 4.4 acres of near-bottom culture.

Fiberglass poles and stakes are stuck in the ground in rows by hand during low tide and are oriented parallel with the beach. The poles are approximately 6 feet long and would stand 3-4' tall from the surface of the substrate. The HDPE anchors are buried 3' below the substrate.

To culture the oyster, a long polypropylene rope with a piece of seeded oyster cultch attached approximately every foot and suspended above the ground by the stakes. The oysters grow in clusters supported by the longlines, which keep them from sinking into soft substrate and protect them from certain pests and predators. Alternatively, for flip-bags, single-set seed is placed in reusable plastic net bags closed with plastic ties or galvanized metal rings and are attached to the rope. The flip-bag technique is used to achieve a symmetrically formed shell and a higher value product. As the tide rises, the bag also rises, tumbling the oysters. The size of the bags are no larger than 3.5' x 1.5' x 6", and a small, crab-pot type bullet float is attached to the bottom of the bag.

Morgan Living Trust Lease and Clark Lease have portions of their project area within eelgrass. For longline and flip-bag culture that takes place in eelgrass, rows would be spaced 12 feet apart; the rows that are not in eelgrass would be spaced 6 feet apart.

Harvest

It typically takes 18 to 24 months for oysters to grow to harvestable size. They are then harvested every 1 year, with approximately ½ of the ground in oyster cultivation harvested and replanted. The lines are checked periodically during low tides to ensure that they remain secured to the fiberglass pipe and that the pipe remains in place.

Oysters grown on the lines and in the flip-bags would be harvested by hand. For longline culture, hand harvest entails cutting oyster clusters off lines by hand at low tide and placing the clusters in harvest tubs equipped with buoys for retrieval by a vessel. For flip-bags, the bags are taken off the line and emptied onto a barge for transfer. After that, the oysters are barged to shore.

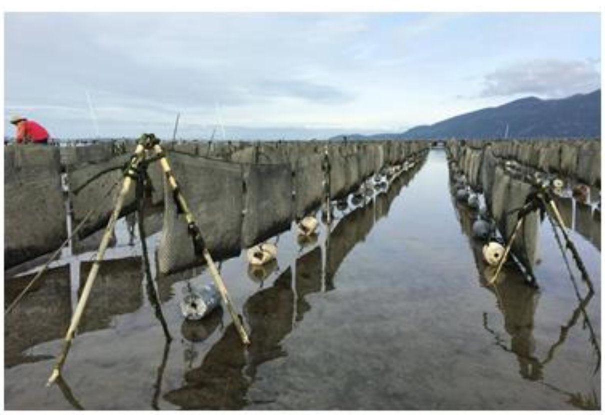

Figure 4. Flip-bag culture with floats (Photo by Northwest Fisheries Science Center)

Figure 5. Flip-bag culture in eelgrass bed (Photo by Maria Pazandak)

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not.

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

Conservation Measures

The project would comply with all applicable conservation and minimization measures as described in the NMFS programmatic consultation (WCR-2014-1502) and can be found in Section 1.3.1 of the aforementioned document. There is one proposed deviation from the conservation and minimization measure, which is that the following measure will not be applied:

> For 'new' activities only, shellfish activities (e.g., racks, stakes, tubes, nets, bags, long-lines, on- bottom cultivation) shall not occur within 16 horizontal feet of native eelgrass (*Zostera marina*) or kelp (rooted/attached brown algae in the order *Laminariales*).

As the Morgan and Clark leases propose to have near-bottom (long-line and flip-bags) culture within 16 feet eelgrass, the measure would be unable inapplicable.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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

The USACE determined the proposed action is not likely to adversely affect Puget Sound steelhead, Puget Sound/Georgia Basin bocaccio, Puget Sound/Georgia Basin yelloweye rockfish, and SRKW. The USACE also determined the proposed action would have no effect on Puget Sound/Georgia Basin bocaccio rockfish critical habitat and SRKW critical habitat. NMFS does not concur with USACE's not likely to adversely affect determination for Puget Sound steelhead and does not concur with USACE's no effect determinations for Puget Sound/Georgia Basin bocaccio rockfish critical habitat and SRKW critical habitat. Our concurrence for Puget Sound/Georgia Basin yelloweye rockfish and SRKW is documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12).

2.1. Analytical Approach

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

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

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

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

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

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

2.2. Rangewide Status of the Species and Critical Habitat

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

One factor affecting the status of ESA-listed species considered in this opinion, and aquatic habitat at large, is climate change. Climate change is likely to play an increasingly important role in determining the abundance and distribution of ESA-listed species, and the conservation value of designated 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 4th warmest) (NOAA NCEI 2022). Events such as the 2013-2016 marine heatwave (Jacox et al. 2018) have been attributed directly to anthropogenic warming in the annual special issue of Bulletin of the American Meteorological Society on extreme events (Herring et al. 2018). Global warming and anthropogenic loss of biodiversity represent profound threats to ecosystem functionality (IPCC WGII 2022). These two factors are often examined in isolation, but likely have interacting effects on ecosystem function.

Updated projections of climate change are similar to or greater than previous projections (IPCC WGI, 2021). NMFS is increasingly confident in our projections of changes to freshwater and marine systems because every year brings stronger validation of previous predictions in both physical and biological realms. Retaining and restoring habitat complexity, access to climate refuges (both flow and temperature) and improving growth 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 timespans 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).

2.2.1 Status of the Species

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

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

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05 (70 FR 37159)	Shared Strategy for Puget Sound 2007	NMFS 2017; Ford 2022	This ESU comprises 22 populations distributed over five geographic areas. All PS 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 PS Chinook salmon ESU remains at "moderate" risk of extinction.	• Degraded floodplain and in-river channel structure • Degraded estuarine conditions and loss of estuarine habitat • Degraded riparian areas and loss of in-river large woody debris • Excessive fine-grained sediment in spawning gravel • Degraded water quality and temperature • Degraded nearshore conditions • Impaired passage for migrating fish • Severely altered flow regime
Puget Sound steelhead	Threatened 5/11/07	NMFS 2019	NMFS 2016; Ford 2022	This DPS comprises 32 populations. Viability of has improved somewhat since the PSTRT concluded that the DPS was at very low viability, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Increases in spawner abundance were observed in a number of populations over the last five years within the Central & South Puget Sound and the Hood Canal & Strait of Juan de Fuca MPGs, primarily among smaller populations. There were also declines for summer- and winter-run populations in the Snohomish River basin. In fact, all summer-run steelhead populations in the Northern Cascades MPG are likely at a very high demographic risk.	• Continued destruction and modification of habitat • Widespread declines in adult abundance despite significant reductions in harvest • Threats to diversity posed by use of two hatchery steelhead stocks • Declining diversity in the DPS, including the uncertain but weak status of summer-run fish • A reduction in spatial structure • Reduced habitat quality • Urbanization • Dikes, hardening of banks with riprap, and channelization
Puget Sound/ Georgia Basin DPS of Bocaccio	Endangered 04/28/10	NMFS 2017d	NMFS 2016d; Ford 2022	Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin, their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Most bocaccio within the DPS may have been historically spatially limited to several basins	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
				within the DPS. They were apparently historically most abundant in the Central and South Sound with no documented occurrences in the San Juan Basin until 2008. The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant risk to the viability of the DPS.	

2.2.2 Status of the Critical Habitat

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

For most salmon and steelhead, NMFS's critical habitat analytical review teams (CHARTs) ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each ESA-listed species that they support (NMFS 2005). The conservation rankings were high, medium, or low. To determine the conservation value of each watershed to species viability, the CHARTs evaluated the quantity and quality of habitat features, the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Even if a location had poor habitat quality, it could be ranked with a high conservation value if it were essential due to factors such as limited availability, a unique contribution of the population it served, or is serving another important role.

A summary of the status of critical habitats, considered in this opinion, is provided in Table 3, below.

Table 3. 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 70 FR 52630	Critical habitat for PS Chinook salmon includes 1,683 miles of streams, 41 square mile of lakes, and 2,182 miles of nearshore marine habitat in PS. The PS 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.
Puget Sound steelhead	2/24/16 81 FR 9252	Critical habitat for Puget Sound steelhead includes 2,031 miles of freshwater and estuarine habitat in Puget Sound, WA. Nearshore and offshore marine waters were not designated for this species. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS.
Puget Sound/Georgia Basin DPS of bocaccio	11/13/2014 79 FR68042	Critical habitat for bocaccio includes 590.4 square miles of nearshore habitat and 414.1 square miles of deepwater habitat. Critical habitat is not designated in areas outside of United States jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for all three species, critical habitat was not designated in that area. Based on the natural history of bocaccio and their habitat needs, NMFS identified two physical or biological features, essential for their conservation: 1) Deepwater sites (>30 meters) that support growth, survival, reproduction, and feeding opportunities; 2) Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge. Habitat threats include degradation of rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality as specific threats to rockfish habitat in the Georgia Basin.

2.3. Action Area

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

The action area for the Project includes the geographic area potentially affected by the Project construction activities. Potential impacts from construction activities include in-air noise and potential turbidity and changes to prey distribution and abundance. For the purposes of NMFS’ analysis, we review the physical, chemical, and biological effects to aquatic features.

Proposed construction, maintenance, and harvest would occur during low tide, in the dry, as well as following tidal inundation. The action area includes the 97.4 acres (51.1 acres associated with the Morgan Living Trust lease and 46.3 acres associated with the Clark lease) in which the shellfish cultivation would occur. Activities that generate sediment may cause turbid water to drift outside of the footprint of the active plot, expanding the affected area by as much as a few hundred linear feet, depending on grain size, fetch, and current velocities. The Washington Shellfish Aquaculture Programmatic (WCR-2014-1502) indicates that a 450 foot buffer around each site should be included to account for potential turbidity and NMFS will adopt the same buffer for the purpose of this analysis.

2.4. 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 consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency’s discretion to modify are part of the environmental baseline (50 CFR 402.02).

Factors including climate change, contaminants, habitat modification, nutrients and pathogens, and the condition of estuarine submerged vegetation affect the condition and quantity of habitat features and processes necessary to support the listed species in the area. In addition, and notably, the shellfish aquaculture industry uses up to 31 percent of the intertidal zone for primarily Pacific Oysters, Manila Clams, mussels, and geoduck cultivation in Samish Bay; and it has a history of existence within the Bay possibly pre-dating the early 1900s (Ecology, 2008).

<u>Aquatic Conditions:</u>
Forage Fish: According to the WDFW Forage Fish Spawning Map online tool (https://www.arcgis.com/apps/mapviewer/index.html?webmap=19b8f74e2d41470cbd80b1af8dedd6b3; accessed on January 25, 2023), there is documented forage fish spawning at or adjacent to the project site. Herring spawning within the project area, and smelt adjacent.

Eelgrass and Kelp: According to the Ecology online tool, Washington State Coastal Atlas Map (https://apps.ecology.wa.gov/coastalatlas/tools/Map.aspx;accessed on January 25, 2023), the project is within a ShoreZone unit with eelgrass. Eelgrass beds are located in lower intertidal areas of the Samish Bay and outside of the Project area. Eelgrass beds are documented from 3.47 to -13.14 feet MLLW (WDNR, 2021). Between the two proposed farms, clam and oyster cultivation would take place from 5 to -5 feet MLLW.

"Native eelgrass occurs extensively throughout Samish Bay and constitutes one of the largest eelgrass beds on tidal flats in Washington (WDNR 2019). Furthermore, the eelgrass in Samish Bay has been monitored extensively and shows a stable or increasing trend since 2001 (WDNR, 2019)." (BE, 2021) Samish Bay contains one of the largest eelgrass meadows in Puget Sound, with around 5,350 acres. In Samish Bay, shellfish aquaculture has been conducted among eelgrass beds since at least the early 1900s. Surveys conducted from 2004 to 2020, as conducted by the Washington State DNR, show neither a positive or negative trend for seagrass growth where the proposed farms would be located. A neighboring survey plot showed an increasing long-term trend for seagrass and eelgrass growth.

Invasive European Green Crab: The European green crab (Carcinus maenas) is considered to be one of the most damaging invasive species in the world. They were first documented in Washington waters in 2016, and signs of their presence in Samish Bay were discovered in 2019. Efforts are being made by several groups in Washington waters and Samish Bay, including the applicant and the Northwest Straits Commission, to trap and remove the crabs. Despite these efforts, it has been stated that the species may be nearly impossible to eradicate once a population has been established (Government of Canada, 2023).

The following effects may occur within Samish Bay due to the existence of the green crab, although their occurrence has not been explicitly documented as occurring within Samish Bay or other Washington waters to date: disrupted food webs and destroyed critical habitat. Having few predators, the green crab has the potential to reduce the estuary's resiliency by disrupting food webs as a generalist predator. They also have the ability to destroy critical habitat, including estuarine marshes and eelgrass. When burrowing for shelter and foraging for prey, the species can damage eelgrass rhizomes and shoots, thus reducing its biomass (Garbary et al. 2014; Howard et al. 2019). In Newfoundland, underwater video sampling indicated a decline in eelgrass cover between 50-100% where green crabs had been present (Matheson 2016). Overall, the green crab may cause significant changes to critical habitat in Samish Bay, leading to declines in biodiversity and potentially long-term consequences for the ecosystem.

Water Quality: Within Samish Bay, water quality varies by location, with some areas listed as 303(d) impaired partially due to upland land use and freshwater runoff; the 303(d) listed streams mostly feed the area of the bay where the proposed farms would be located. The majority of the bay meets the standards for clean water and shellfish production, although there are portions that are closed to shellfish production by the Washington State Department of Health (WDOH 2022). In 2021, shellfish growing areas were classified as approved, conditionally approved, or prohibited. "The Conditionally Approved portion of the growing area was closed 13 times for approximately 29 days due to Samish River flow exceeding closure criteria. All of Samish Bay was closed twice in November for 17 days due to river flooding," (WDOH 2021). According to the Washington State Department of Health *Annual Shellfish Growing Area Review 2021: Samish Bay*, the action area is within the conditionally approved growing area.

North of Samish Island is a popular mooring area for oil and fuel ships en-route to unload product at the nearby oil refineries. Due to this, the action area remains at risk from serious spills. The magnitude of the risks posed by oil discharges in this area is difficult to precisely quantify or estimate, but may be decreasing because of new oil spill prevention procedures and technologies. In 2019, the WDFW purchased an airboat to respond to oil spills in areas that have extensive eelgrass beds (Keltner, 2019).

<u>Noise:</u>
"Baseline underwater noise levels in Samish Bay are primarily a result of recreational and aquaculture vessel traffic. Most vessels are less than 65 feet in length (e.g., oyster scows, recreational fishing boats). Baseline underwater noise levels in the bay are estimated to be 125 decibels (dB) reference to 1 microPascal (μPa), based on broadband background noise levels measured near the Coupeville, Kingston, and Mukilteo ferry terminals in Puget Sound, Washington (Laughlin 2015). The type and frequency of boat traffic at these locations are similar to those in Samish Bay and provide a useful approximation.

The estimated baseline underwater noise level noted above is suitable for subtidal, deep-water areas of the bay but likely overestimates underwater noise in intertidal areas. Underwater noise would not propagate into intertidal areas when they are exposed at low tides, which is when the majority of culture activities occur. Additionally, the action area is composed of shallow waters less than 6.7 feet deep, which do not efficiently propagate low frequency sounds. Sound propagation decreases significantly when water depths drop below a quarter of the sound pressure wavelength (Forrest et al. 1993). Based on an approximate average depth of 6.7 feet, sounds below 185 hertz (Hz) are not likely to propagate effectively within the intertidal parts of the action area. This sound level is at the lower end of the hearing range for mid-frequency cetaceans like SRKW (150 Hz to 160 kHz). The depth effect is most pronounced for lower frequency sounds (e.g., those produced by boat engines) because they have longer wavelengths, and this effect is particularly relevant in an environment like Samish Bay where a large proportion of the bay is intertidal." (BE, 2021)

<u>Use of the action area by listed species</u>:
Chinook salmon:
Chinook salmon presence is documented within Samish Bay, and juveniles and adults migrate in the action area (WDFW 2021a, 2021b). The bay is a migratory corridor for adult Chinook salmon and provides habitat for out-migrating juvenile Chinook salmon from rivers into Puget Sound before their eventual oceanic phase as adults. Juvenile Chinook salmon habitat in the vicinity of the action area includes estuarine areas. It is expected that adult and juvenile Chinook salmon may be present in the vicinity of the action area during construction, maintenance, and harvest activities. Adults are expected to occur in the deeper areas in the vicinity of the action area during the summer and fall during their upstream spawning migration. Juveniles may occur in the shallow nearshore during typical out-migration periods between February and July (the work window year-round, not avoiding peak presence of juvenile Chinook salmon). Because of its location, we believe the action area supports the presence of multiple populations of PS

Chinook, though the greatest abundance is likely to be from the unlisted Samish population of Chinook salmon.

Steelhead:
Steelhead presence is documented within Samish Bay, and juveniles and adults migrate within the action area (WDFW 2021a, 2021b). The closest steelhead-bearing waterway to the action area is the Samish River that flows directly into Samish Bay. There is documented spawning and rearing within the above mentioned river. Based on typical run timing for winter steelhead (December through mid-March) and spawning patterns, juvenile steelhead would be expected to out-migrate between mid-March and early June. Based on the year-round work window, both adult steelhead and juvenile steelhead would be present during construction, maintenance, and harvest activities.

2.5. 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 (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

For this batched Opinion, we incorporate by reference the analysis found in the programmatic biological opinion (WCR-2014-1502), and supplement that analysis with more recent science.

After the application of all minimization and conservation measures, as described in Section 1.3.1 of WCR-2014-1502, the proposed action would still result in adverse effects that cannot be avoided. Likely effects include short-term maintenance and harvest impacts, and long-term impacts from the existence of the anthropogenic structures.

2.5.1 Effects on Species

Period of Exposure and Species Presence
Puget Sound juvenile salmonids may reside within the Samish Bay estuary for a few days or up to several weeks to feed and adapt as they prepare to enter Puget Sound. Adults enter Samish Bay in December-March (steelhead) and June- September (Chinook salmon). Accordingly, listed PS Chinook salmon and PS steelhead may be exposed to all effects of the proposed action at almost any time of year, although timing of work during low tides, in dry conditions, reduces the likelihood of exposure. Harvest is intermittent but may occur in any month of the year but not necessarily every month. Site visits and maintenance are expected to occur several times every month throughout the year. Listed species present in the action area may also experience long-term beneficial effects from the proposed project, such as long term water quality improvements and increased habitat complexity.

Table 4. Species Presence and Effort Type by Month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Seeding												
Installation/Maintenance												
Grow-out												
Harvest												
Chinook – Adult												
Chinook – Juvenile												
W. Steelhead – Adult												
W. Steelhead – Juvenile												

Response to Diminished Water Quality:

Change in Nutrient Balance:

Molluscan aquaculture is relatively benign in terms of effects on water quality compared to fish and shrimp cultures, which discharge high volumes of effluent. Because no organic inputs are added (the mollusks filter their food directly from the water), the impacts on water quality from changes in nutrient content are, if anything, small, low intensity, and of brief duration. However, mollusks concentrated on a farm still consume oxygen, produce carbon dioxide, and produce ammonia as an excretory product; the extent to which these accumulate depends on the natural tidal flushing of water around the farm.

In the most extreme situations of altered water quality from shellfish culture, when amounts of organic material are deposited in excess of what local micro-flora and fauna can process, anaerobic processes will dominate once the deposited material exhausts the oxygen available for aerobic decomposition. The results of extensive anaerobic decomposition are evident as the water above the sediments can become hypoxic or anoxic and ammonia, hydrogen sulfide, and methane can be released into the water column.

One such study conducted in the River Exe estuary in England found a thinning of the aerobic zone and minor changes in the benthic community under rack and bag oyster cultivation (Nugues et al. 1996). However, this situation is probably unique to that study area (relative to the action area for this consultation), as a partially enclosed estuary, and a drainage channel from a nearby village delivers stormwater and associated nutrients directly to the culture site (CEFAS, 2013). While we are aware of discrete instances where anoxic conditions have occurred under mussel rafts, we are not aware of any instances of shellfish culture in the action area where anaerobic conditions have become dominant and affected ESA-listed organisms.

Studies found that juvenile Chinook salmon showed avoidance of areas with low oxygen concentrations near 1.5, 3, and 4.5 mg/L in warmer temperatures (Whitmore et al. 1960). Other studies reported that daily minimum oxygen concentrations must remain above 3.9 mg/L to avoid juvenile mortality. Juvenile steelhead, like juvenile Chinook, are sensitive to low oxygen concentrations (Bond et al. 2022; Carter 2005). Should hypoxic or anoxic conditions occur, they would likely occur in an isolated part of the farm. The effects on salmonids are insignificant, given the spacing of the near-bottom culture and the use of on-bottom culture, its location in a well-flushed system, and salmonids' ability to avoid areas with low dissolved oxygen.

Turbidity:

Throughout the length of time the proposed farms operate, turbid conditions would be created through the seeding, installation, maintenance, and harvest. As shown in Table 1, all of the aforementioned activities would overlap with salmonid migration to and from the Samish River, although it is important to note that some of these activities would not be conducted regularly. The time between seeding and harvesting is estimated to be three years.

Installation, maintenance, and harvest requires employees to conduct site visits, either by foot or by boat, and would be conducted during low tides, in dry conditions, and also during high tides. If accessing the site or conducting any of the aforementioned activities by boat, vessel prop wash may stir up the loose sediment, resulting in temporarily reduced water quality. When any work (installation, maintenance, and harvest) is conducted by foot, a temporary pulse of turbidity would be created during the following tidal cycle, reducing water quality.

The effects of turbidity on fish are species and size dependent, relate to the duration of exposure, level of suspended sediment, and sediment size. In general, severity typically increases with sediment concentration and duration of exposure, and decreases with the increasing size of the fish. Adult salmonids that may be present as they migrate back to their natal streams through the estuary have the ability to detect and avoid areas of higher suspended sediment and are highly mobile. Therefore, NMFS assumes the only response of this species at this life stage would be behavioral, in the form of avoidance, such that no injury results from exposure. Based on the size and age of this species, we do not expect the avoidance behavior to result in decreased foraging success, nor in greater susceptibility to being preyed upon.

For juvenile salmonids, a behavioral response is also likely, and those juveniles that are exposed would be briefly displaced from preferred foraging areas and/or have a slightly increased risk of being preyed upon by larger fish, as they avoid the suspended sediment. If juvenile fish do not avoid turbid conditions, other response can occur. Newcombe and Jensen (1996) reported minor physiological stress in juvenile salmon only after about three hours of continuous exposure to concentration levels of about 700 to 1,100 mg/L. With the proposed action, construction-related turbidity would be very short-lived and at concentrations too low to cause more than temporary, non-injurious behavioral effects (e.g., alarm reaction and avoidance of the plume), physiological effects (e.g., gill flaring and coughing), and temporary reduced feeding rates (Newcombe and Jensen 1996).

Response to General Disturbance:

Based on residency patterns, some juvenile salmonids are likely to encounter the shellfish culture and related gear during their time spent within the estuary, as both (near- and on-bottom) culture methods would be installed indefinitely; and the structures may disrupt their migration and/or increase their predation risk.

During tidal inundation, some juvenile salmonids swim from the tidal channels and into the shallow intertidal habitat and may encounter the culture related structures. On-bottom culture is unlikely to disturb migrating salmonids as their related components do not create movement or shade; and the salmonids are unlikely to have difficulty swimming over the low-profile nets. Long-line culture creates shading, although this effect is considered to be to a lesser degree due to their height, and the oyster cultch is not anticipated to move to such extents where juvenile salmonids may be affected.

Conversely, flip-bags move from their resting place and rise with the tide due to the floats attached to the bottom of the bags. Each bag creates movement and shade in the water, and juvenile salmonids may respond with a stress and startle reaction that can diminish both predator and prey detection for a short period of time with each encounter. Fish respond when they detect movement in water and shadows above it. This is typically a startle response that is adaptive to predator avoidance. When fish startle, both predator and prey detection may be impaired for a short period of time following that response. Numerous studies demonstrate that juvenile salmonids, in both marine and freshwater habitats, migrate along the edge of shadows rather than through them (Celedonia et al. 2008a; Celedonia et al. 2008b; Kemp et al. 2005; Moore et al. 2013; Munsch et al. 2014; Nightingale and Simenstad 2001; Ono et al. 2010; Southard et al. 2006).

We cannot estimate the number of individuals that would experience migration delays and increased predation risk from the proposed near-bottom structures. Adult salmonids are larger, more agile, and will have the ability to navigate around the structures without increasing the likelihood of predation. Conversely, when encountered, near-bottom culture may affect juvenile salmonids' ability to forage and migrate by creating a behavioral response that leads to reduced predator and forage avoidance.

In and overwater structures cause delays in migration for salmonids due to disorientation, fish school dispersal (resulting in a loss of refugia), and altered migration routes (Simenstad 1999). It's well documented that juvenile salmonids display avoidance behavior when encountering the edges of structures, or shadows, and that actively migrating juvenile Chinook salmon swim around structures through deeper water rather than swimming underneath a structure (Celedonia et al. 2008b). Structure width, light conditions, water depth, and the presence of macrophytes influenced the degree of avoidance.

The rows of flip bags are spaced 6 or 12 feet apart depending on their proximity to eelgrass, which may allow for undisturbed migration for a significant percentage of each cohort, although that number is not quantifiable. With 14.4 acres of near-bottom culture shared between the two farms, and the capacity to accommodate up to 17,745 flip-bags, it is likely that some juvenile salmonids would encounter and be disturbed by the shade or movement created by flip-bags. Should the above encounter occur, there would be increased bio-energetic expenditures and decreased growth, making them more vulnerable to predation. With the structures in the water indefinitely, likely coinciding with their migration every year as it occurs, a small fraction of every cohort would have a reduction in fitness. NMFS assumes that this would likely result in increased juvenile salmonid mortality, affecting a small number of fish in each year the equipment is present.

Response to Increased Predation:
Chinook salmon are preyed on by a wide variety of fish, birds, and mammals during their nearshore residence (Fresh 2006). Simenstad et al. (1982) suggested that some features of nearshore ecosystems may help reduce predation on juvenile salmon. These include high levels of turbidity, the presence of shallow water habitat (including eelgrass), and abundant and diverse

prey resources that sustain high growth rates and allow juvenile salmon to rapidly outgrow many of their predators. When exposed to predators, juvenile Chinook salmon preferentially chose eelgrass habitat over oyster clusters in field experiments in an enclosure, as well as in mesocosm experiments involving exposure to a mock predator (Dumbauld et al. 2005). The proposed action would result in decreased cover through the suppression of eelgrass throughout the nearshore range of Chinook salmon in Puget Sound. This effect would result in increased predation and would negatively affect the survival of PS Chinook salmon.

A study conducted by Ferriss et al. (2021) documented fish communities within eelgrass, on-bottom oyster and clam culture, flip-bag culture, and sediment mesohabitat. The study focused on three locations within Puget Sound, one of which is the Northern Basin where the proposed farms would be located. A variety of demersal, benthic, and pelagic species were documented across all culture types observed, one of which (sculpin, Cottidae) has been documented to prey on juvenile salmonids (Cardwell and Fresh 1979). Other studies have sighted Pacific staghorn sculpins more frequently in longline culture and edge habitats than in eelgrass (Muething et al. 2020; Clarke 2017). With the known habitat use of shellfish culture by predatory species, there is an increased likelihood of juvenile PS salmonids being preyed upon while migrating, foraging, or seeking refuge within the action area.

Response to Suppression of Eelgrass:
Another mechanism through which the proposed action is likely to affect PS Chinook salmon is through effects on eelgrass; effects on eelgrass are not likely to affect PS steelhead, as they are not known to rely on eelgrass for cover or forage. The proposed action is reasonably certain to disturb eelgrass and perhaps reduce plant densities within the footprint of management actions covered by the proposed action, as well as reduce the eelgrass' ability to naturally expand and contract. Eelgrass can be disturbed through the following interactions: shading, entanglement, and turbidity.

Eelgrass beds provide trophic resources, predator refugia, and structure for the spawning of species upon which juvenile salmonids prey. Eelgrass beds and eelgrass patches are a foundational element in the intertidal environment, throughout the action area, supporting the base of the food web. Throughout most of the Puget Sound region, eelgrass is of primary importance as a herring spawning substrate (Mumford 2007; Blackmon et al. 2006). Eelgrass patches also provide cover and forage for herring (and other foraging creatures) (Blackmon 2006) upon which juvenile salmon and steelhead feed (Groot and Margolis, 1991).

A study was conducted for longlines in Willapa Bay in 1999, and with lines spaced ~9 feet apart, a loss of eelgrass was noted within a 1-foot band directly underneath the structure, and the eelgrass between the lines remained unaffected. It was hypothesized that this loss was due to eelgrass becoming entangled with the lines during low tides and not due to shading (Thom et al. 2003).

In Humboldt Bay, California, Rumrill and Poulton (2003) found that at certain spacing of the longlines, eelgrass density was nearly the equivalent of that in the reference plots. Specifically, longline spacing of 2.5 feet, 5 feet, and 10 feet were observed. Spatial cover and density of eelgrass plants within the 10-foot spacing plot were within the range of variability observed in the reference (control) study plots (Rumrill and Poulton (2003). The longlines observed in the study were suspended ~1.5 feet above the substrate, limiting their interaction. As flip-bag structures are taller (creating more shading effects), and because the floats rest on the substrate, we believe impacts to eelgrass would be greater than that produced by the longlines.

A study conducted in 2016 in Willapa Bay, based on field measurements over a 4-week period and physical modeling, showed light levels were reduced slightly (14 to 23 percent) under flip-bags. It was noted, however, that eelgrass minimum requirements are lower than the light levels still available and that the shift of the shaded area throughout the day did not appear to alter cover beneath the bags (Confluence, 2016).

The regional nearshore section of the PS Chinook salmon recovery plan (2007) identifies potentially detrimental impacts from shellfish culture on nearshore habitats, including negative impacts on eelgrass meadows. However, as described above, more recent studies suggest that while some adverse effects are likely, the total effects are more nuanced than the regional nearshore section states. (Horwith 2013, Dumbauld et al. 2009, WSG 2013). The impacts described in the regional nearshore section include decreased eelgrass abundance, decreased shoot density and cover, and poor natural recovery after the cessation of oyster culture in a given area (Williams et al. 2001 in Recovery Plan 2005). The Recovery Plan cites "studies referenced by Williams 2001" that reported decreases in benthic surface area and direct physical disturbance as probable causes of eelgrass impacts at culture sites. Williams (2001) also looked at mechanical oyster harvest (oyster dredging) and noted a decrease in eelgrass not only within the harvest site but in adjacent, non-dredged sites as well, suggesting effects on eelgrass from elevated sedimentation can occur outside of managed shellfish plots. The Clark and Morgan leases would not conduct mechanical harvest in eelgrass beds, but the mechanical harvest would occur adjacently to eelgrass beds, potentially reducing growth through elevated sedimentation.

Although shellfish aquaculture does not prevent eelgrass growth or its spread to sites next to or near managed sites, the historic and ongoing activities of shellfish aquaculture limit the formation of high-density eelgrass beds within currently cultivated aquaculture sites, depending on the culture type (Tallis, 2009). While the proposed project would implement 12-foot spacing between the flip-bag and longlines to maximize light penetration, we note that the structures do limit some amount of eelgrass survival directly below the lines due to either shade or the blades becoming entangled. The flip-bags are oriented east-west, reducing light penetration to a greater extent than if the bags were oriented north-south. As such, complete recovery of eelgrass in one season following no disturbance is unlikely where aquaculture is occurring. Oysters harvested on an annual basis could lead to an incremental loss of eelgrass.

Response to Long-Term Beneficial Effects:

Improved Water Quality:

Shellfish aquaculture has the potential to bring multiple benefits to water quality in estuarine habitats. One of the main benefits is their role as natural filter feeders who feed by filtering large amounts of water and removing suspended particles, including pollutants and excess nutrients. The process can help reduce levels of pollutants, such as nitrogen and phosphorus, which can contribute to the development of harmful algal blooms and low oxygen conditions in aquatic ecosystems. Shellfish aquaculture can also help mitigate the impacts of other human activities, such as urbanization and agriculture, which can lead to increased levels of pollutants and excess nutrients.

Habitat complexity:
Additionally, shellfish aquaculture can provide habitat for other aquatic species, such as macroalgae and SAV, which play important roles in absorbing excess nutrients and improving water quality. By providing habitat for these species, the health of estuarine habitats is supported. The culture's structures and accessories can provide a substrate for other aquatic species to attach to and grow on. This can include the structure of the gear itself, such as ropes, nets, or mesh bags, as well as the shells of the shellfish themselves.

The attachment of other species, such as macroalgae and seagrasses, can create a diverse and complex habitat that supports a wide range of aquatic species, including finfish, crustaceans, and other invertebrates. This habitat can provide essential food and shelter for these species, helping to support the Bay.

Additionally, the waste produced by the shellfish can provide a source of food and nutrients for other aquatic species, helping to further support the health of the ecosystem. In conclusion, shellfish aquaculture has the potential to create habitat by providing substrate for other species to attach and grow on, supporting the health of the ecosystems through the creation of diverse and complex habitats.

Individuals from all species considered in this consultation document that rely on the action area would be slightly benefited in their feeding, growth, maturation, and survival by improved water quality. Any exposure would result in a slightly beneficial response at the individual scale (although difficult to detect or document) for listed fishes.

Increase in diversity and richness
The fixed benthic structures including on-bottom clam bags and anti-predator nets as well as biogenic structure created by the shells of the farmed organisms, may provide surface area for organisms that do not typically use sandy or muddy substrates. Longlines and flip-bags create vertical structure, adding to the habitat complexity where it is located. Ferris et al. (2021) found an increase in abundance of species of demersal and benthic species (including flatfish, sculpin, stickleback, and crab) in shellfish cultured areas versus non-cultured areas where only sediment is present. Other studies have also shown on-bottom oyster culture has greater abundances and diversities of fish in comparison to habitat areas without structure (Callier et al. 2017).

2.5.2 Effects on Critical Habitat

As described above, the effects of the proposed action are likely to include elevated levels of turbidity, substrate disturbance, shade, gear/equipment in aquatic habitat and noise. While some of these effects are temporary or episodic, some long-term effects on water quality may also occur, as well as beneficial effects. Features of critical habitat in estuarine and marine nearshore areas are:

PS Chinook salmon & PS Steelhead critical habitat PBFs

- Estuarine areas free of obstruction and excessive predation with:
    - Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater;

  - Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and
  - Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

<u>PS/GB juvenile bocaccio rockfish critical habitat PBFs</u>

- Nearshore juvenile rearing sites with sand, rock and/or cobbles to support forage and refuge with:
  - Quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and
  - Water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.
  - Structure and rugosity (geologic, macroalgae, seagrass) to support predator avoidance.

Thus, the Physical and Biological Features (PBFs) common to PS Chinook salmon, PS steelhead, and juvenile bocaccio rockfish critical habitat that may occur in the action area are: (a) water quality; (b) forage or prey; (c) safe migration areas are a feature of critical habitat; and (d) nearshore habitat with suitable conditions for growth and maturation, including sub-aquatic vegetation (with the exception of PS steelhead as they do not rely on SAV).

Migratory Obstruction & Predation (long term)
Safe migration of PS salmonids may be diminished by the presence of in water structures. The flip-bag and longline culture requires the introduction of a considerable amount of hard, physical structure into the substrate and water column. Migration values are not expected to be impaired for juvenile PS/GB bocaccio as they do not rely on the nearshore area for migration.

The existing near-bottom culture structures and proposed on-bottom culture structures represent an artificial habitat structure that constitutes an alteration of undisturbed habitat conditions. There is concern that these structures can present conditions that are disruptive to normal feeding, rearing, and migration behaviors, as well as posing elevated risks of predation by creating preferred habitat for ambush predators. Movement and shade created by the flip bag structures may cause avoidance by juvenile salmonids and increase their migration time, thus increasing the possibility of predation. The combined acreage between the two proposed farms is 97.4 acres. On-bottom aquaculture adjacent to the flip bags in eelgrass would create a patch-worked habitat and would reduce its resiliency and overall function of the system.

As mentioned in Section 2.5.2, several studies have observed Pacific staghorn sculpin associated with shellfish culture in comparison to eelgrass or sediment habitats. The proposed action would cause long-term, small-scale diminishments of obstruction and predation.

Water Quantity
The proposed action would have no effect on water quantity, and would cause no change in the quality and function of the PBFs for PS salmonids or juvenile PS/GB bocaccio.

Water Quality
Water quality will be occasionally diminished by the suspended sediments produced from on-site work including seeding, maintenance and installation, and harvest. It may also be diminished by hypoxic/anoxic conditions created when amounts of organic material are deposited in excess of what local micro-flora and fauna can process, exhausting the oxygen available for aerobic decomposition.

The *temporary, episodic water quality reductions from increased turbidity* –are expected to persist with the on-site work period for each project, and then to return to baseline within hours after work ceases or following tidal inundation. While disturbances that cause turbidity are not a discountable effect on water quality, we anticipate this effect would be insignificant, as studies have indicated that mechanical oyster harvest (which produces more turbidity than most shellfish culture actions) dissipates quickly as it moves beyond the harvest site and is largely absent within a few feet down-current of the harvest site. The episodes of mechanical harvest are expected to be intermittent and infrequent; and Samish Bay is a well-flushed system, so the water quality effect of suspended sediment/turbidity would be localized and ephemeral. As such, baseline water quality levels are re-gained quickly.

The *temporary water quality reduction from hypoxic conditions* –are expected to be rare but should it occur, it would likely only be associated with a small, specific part of the farm and only last the amount of time it takes in between tidal cycles. While detrimental, the spatial and temporal extent is brief and small, respectively. It is not expected to reduce the overall value of the designated critical habitat to support PS salmonids' or juvenile PS/GB bocaccio's growth or maturation.

Natural Cover
A mechanism through which the proposed action is likely to affect PS Chinook and juvenile bocaccio rockfish CH is through effects to eelgrass. Designated critical habitat will have enduring diminishment of SAV in rearing areas of juvenile PS/GB bocaccio and migration areas of juvenile PS Chinook.

As discussed above, eelgrass provides cover and foraging opportunities for juvenile PS Chinook. Both of these functions are elements of the estuarine PBF. Nearshore areas with substrates that support kelp and eelgrass are designated as juvenile bocaccio settlement sites due to their ability to provide refuge from predators (NMFS, 2017). We anticipate eelgrass density to decrease due to shade created by the flip-bags, shoot entanglement with the flip-bags and floats, and sedimentation from mechanical harvest.

Reduced Forage
Another mechanism through which the proposed action is likely to affect juvenile PS Chinook and juvenile PS/GB bocaccio CH is through the effects to eelgrass and reduced ability to access forage, and through bottom-disturbing activities. Juvenile Chinook and bocaccio feed on copepods and invertebrates. Kennedy et al. (2018) found a positive correlation between the abundance of eelgrass-associated prey and higher densities of eelgrass. The reduction of eelgrass growth and density as it is affected by shade, entanglement with equipment, and sedimentation from harvest and onsite activity, may then reduce prey abundance. This would reduce juvenile Chinook and juvenile bocaccio's prey base as well as increasing their bio-energetic expenditures

to look for other available prey. Additionally, the existence of moving and shade-producing flip-bags in eelgrass may also reduce juvenile Chinook's ability to forage for prey in eelgrass.

Bottom-disturbing activities have the potential to affect the availability of salmonid and juvenile bocaccio forage species. Some of the various hand or mechanical harvest or harrowing methods used in shellfish aquaculture involve a physical disturbance of the bottom that affects sediment and benthic fauna (Johnson 2002). These activities cause minor disturbance of benthic habitat affecting the availability of benthic food resources for listed fish for a short period of time following disturbance. Bottom-disturbing activities that could temporarily reduce or increase benthic resources occur every 1-7 years, depending on the species cultured. In places with normal benthic diversity, with regular flows and normal nutrient balance, benthic items rapidly recolonize after disturbance, making food available again at the disturbed site.

Multiple studies have reported enhanced prey resources for some juvenile salmonids as well as for migratory and resident fish associated with on-bottom culture (Simenstad et al. 1991; Brooks 1995). Thus, prey resources and the ability to forage is unlikely to be reduced where on-bottom culture is located.

Herring, a prey group for adult PS Chinook salmon, use eelgrass as spawning habitat. Herring have also been documented using shellfish culture structures as spawning habitat. NMFS anticipates the loss in eelgrass density would not adversely affect herring's ability to spawn and thus would not adversely affect adult PS Chinook salmon's forage opportunities.

The cycle of shellfish culture can include many small-scale impacts (harvest and maintenance) in a given waterbody that when taken cumulatively, could have real effects (diminishment) on forage that can persist for up to 6 months. As discussed above, and discussed further in WCR-2014-1502, the presence of active aquaculture can also increase some aspects of forage, offsetting potential diminished forage resultant from loss of eelgrass and benthic disturbance. Therefore, forage is not likely to be reduced to such a degree that significant numbers of juvenile salmonids or juvenile bocaccio are displaced or experience reduced growth or survival. As such, these activities are unlikely to modify forage PBF of critical habitat for PS salmonids and PS/GB bocaccio in a manner that reduces the conservation role of the habitat.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 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 (Section 2.4).

Conditions in the action area are affected by upland activities. The human population in the PS region increased from about 1.29 million people in 1950 to about 3.84 million in 2014, and is expected to reach nearly 6 million by 2050 (Puget Sound Regional Council 2020). As of the date of this Biological Opinion, the human population in the Puget Sound Region is 4.2 million, slightly exceeding projections. Thus, future private and public development actions are reasonably certain to continue in and around PS. 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.

The most common activities reasonably certain to occur in or affect the action area are agricultural activities, urban and suburban development, recreational activities, and road construction and maintenance. We also expect recreational use to increase in Puget Sound. These activities are often not Federal actions and are likely to result in adverse effects on salmon critical habitat, systemically, including the action area. These adverse effects can include water quality impairments that lead to pre-spawn mortality or poor survivability, loss of food source from habitat destruction, migration barriers, overfishing, and others. Some of the activities, such as development, are subject to regulation under state programs, and the effects on fish and stream habitats are reduced to varying degrees under these programs compared to past effects reflected in the environmental baseline.

When considered together, these cumulative effects are likely to have some negative impacts on the quality and conservation value of critical habitat of PS Chinook salmon, PS Steelhead, and juvenile PS/GB bocaccio in the action area.

2.7. Integration and Synthesis

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

2.7.1 ESA Listed Species

PS Chinook salmon and PS steelhead are both listed as threatened, based on declines from historic levels of abundance and productivity, loss of spatial structure and diversity, and these are driven in part by an array of limiting factors throughout their range, and as a baseline habitat condition. The environmental baseline within the action area has been degraded by the effects of nearby and upstream industry, urbanization, agriculture, forestry, water diversion, and road building and maintenance.

Within the action area, both species would be affected over time by cumulative effects, some positive – as recovery plan implementation and regulatory revisions increase habitat protections and restoration, and some negative – as climate change and unregulated or difficult to regulate sources of environmental degradation persist or increase. Overall, to the degree that habitat trends are negative, the effects on viability parameters of each species are also likely to be negative. In this context we consider how the proposed action's impacts on individuals would affect the listed species at the population and ESU/DPS scales.

In this context we evaluate the addition of the effects of the proposed action.

<u>PS Chinook salmon</u>
The PS Chinook salmon abundance and productivity have decreased in recent years. All extant populations are considered to be at high risk, and all PS Chinook salmon populations are still well below planning ranges for recovery escapement levels. The most recent 5-year status review reported a general decline in natural-origin spawner abundance across all PS Chinook salmon MPGs over the most-recent fifteen years. It also reported that escapement levels remain well below the PSTRT planning ranges for recovery for all MPGs, and concluded that the PS Chinook salmon ESU remains at "moderate" risk of extinction (Ford 2022).

The proposed farms would be located in Samish Bay, with the unlisted PS Chinook salmon to be the most likely population to pass through the project areas although other populations of PS Chinook may still be present. The project areas serve primarily as a migration route for adult and juvenile PS Chinook salmon, as well as estuarine rearing habitat for juveniles. The environmental baseline at and adjacent to the project site has been degraded by point and non-point stormwater discharges from upland agriculture and urbanization.

As described in section 2.5.1. In each year of the proposed action, we expect some individual juveniles will experience behavioral responses that increase the risk of injury or death, and in rare instances, injurious responses (e.g. gill abrasion) or death (e.g. from entrapment in cover nets) may be a direct response. We add this expected annual effect to the baseline, and consider the cumulative effects (described above). We consider that some positive effects may also occur that may improve growth and survival of some individuals. Based on the best available information, the scale of the direct and indirect effects of the proposed action, even when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable effects on any of the characteristics of a viable salmon population (abundance, productivity, distribution, or genetic diversity) for the affected PS Chinook salmon populations. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

<u>PS steelhead</u>
The long-term abundance trend of the PS steelhead DPS is negative, especially for natural spawners. Growth rates are currently declining at 3 to 10% annually for all but a few DIPs. The

extinction risk for most DIPs is estimated to be moderate to high, and the DPS is currently considered “not viable”. Reduced or eliminated accessibility to historically important habitat, combined with degraded conditions in available habitat due to land use activities appear to be the greatest threats to the recovery of PS steelhead. Fisheries activities also continue to impact this species.

The PS steelhead most likely to occur in the action area would be the winter-run population. Samish Bay serves as a migration route to and from marine waters for adult and juvenile PS steelhead. As PS steelhead complete much of their early life history in freshwater and spend a short amount of time in estuaries during their migration out to the ocean. As they spend less time in the estuaries, the duration of their potential exposure to shellfish aquaculture related activities and structures decreases, but does not remove the possibility of exposure entirely. While they have the potential to have the same exposure and response as juvenile Chinook, as steelhead enter salt water as older/larger juveniles the likelihood of such exposure is reduced.

NMFS finds it likely that over the course of the proposed actions’ indefinite existence, a very small number of juvenile PS steelhead would have behavioral response that increases the likelihood of injury or death, and fewer still would experience direct injury or death. Considering the potential impacts together with the status of the species, the baseline, and cumulative effects, the proposed actions would not have any measurably alter PS steelhead population abundance, productivity, spatial structure, or diversity. Therefore, the proposed action would not appreciably reduce the likelihood of survival and recovery of this listed species.

2.7.2 Critical Habitat

Critical habitat was designated PS Chinook salmon, PS steelhead, and PS/GB bocaccio rockfish to ensure that specific areas with PBFs that are essential to the conservation of those listed species are appropriately managed or protected. The action area is within designated critical habitat for PS Chinook salmon, PS steelhead, and juvenile PS/GB bocaccio rockfish. The salmonids’ designated critical habitat share the same physical and biological features for estuarine areas. The PBFs for juvenile bocaccio’s nearshore critical habitat share similar traits to that of the aforementioned salmonids. We consider how the proposed action’s impacts on the attributes of the action area’s PBFs would affect these designated critical habitats’ ability to support the conservation of the respective species as a whole.

The quality of critical habitat for PS salmonids and juvenile PS/GB bocaccio, as mentioned above, and has been diminished by several factors unrelated to shellfish culture. The most notable impairments to salmonid CH are in freshwater environments are due to land use practices, manmade fish passage barriers, and water use, and the nearshore marine component of critical habitat suffers from pervasive systemic reductions in function caused by nearshore development, such as bank armoring, overwater structures, dredging, and upland sources of water pollution. Similar to PS salmonids, PS/GB bocaccio’s CH is impaired by invasive/nonindigenous species, contaminants, nutrient addition, and nearshore development (NMFS, 2017).

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

In the future, non-federal land and water use practices and climate change are likely to increase. The intensity of those influences on salmonid and rockfish critical habitat is uncertain, as is the degree to which those impacts may be tempered by adoption of more environmentally acceptable land use practices, by the implementation of non-federal plans that are intended to benefit salmonids and rockfish, and by efforts to address the effects of climate change. Also in the baseline, and also with a degree of uncertainty, is the possibility that the loss of eelgrass from the near-bottom culture structures will be exacerbated by the destruction of eelgrass beds from invasive European green crab should they continue to populate within the estuary. As PS steelhead are not known to rely on eelgrass for cover or forage, they would not be directly affected by this loss.

The PBF for PS salmonids critical habitat at and adjacent to the project site is limited to nearshore marine areas free of obstruction and excessive predation. The attributes of the PBF that would be affected by the action are obstruction and excessive predation, water quality, forage, and natural cover. The PBF for PS/GB bocaccio critical habitat at and adjacent to the project site is limited to nearshore areas comprised of sand, rock and/or cobbles with eelgrass or kelp. The attributes of the PBF that would be affected by the action are water quality, forage, and reduction of SAV that supports predator avoidance.

The project site is located within a partially impaired estuary that concurrently has 31 percent of its tidelands used for aquaculture; and all of these attributes currently function at reduced levels as compared to undisturbed estuarine areas. Additionally, the installation and existence of near-bottom structure would degrade salmonid critical habitat by creating artificial obstructions to free passage within the estuary. As described in the effects section, the proposed action would cause short- and long-term minor adverse effects on all of those attributes.

Based on the best available information, the scale of the proposed action’s effects, when considered in combination with the degraded baseline, cumulative effects, and the impacts of climate change, would be too small to cause detectable long-term negative changes in the quality or functionality of the estuarine areas PBF in the action area. Therefore, this critical habitat would maintain its current level of functionality and conservation role for PS salmonids and PS/GB bocaccio.

2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent actions, and cumulative effects, it is NMFS’ opinion that the proposed action is not likely to jeopardize the continued existence of Puget Sound Chinook salmon or PS steelhead and would not destroy or adversely modify their critical habitat or PS/GB bocaccio’s critical habitat. Conclusions of effects on critical habitat and species effects on SRKW, PS/GB yelloweye rockfish, and adult PS/GB bocaccio rockfish can be found in Section 2.12.

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 the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon and PS steelhead or destroy or adversely modify their designated critical habitat or juvenile PS/GB bocaccio's critical habitat.

2.9. Incidental Take Statement

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

2.9.1 Amount or Extent of Take

When take is in the form of harm from habitat degradation, it is often impossible to enumerate the take that would occur because the number of fish and marine mammals likely to be exposed to harmful habitat conditions is highly variable over time, influenced by environmental conditions that do not have a reliably predictable pattern, and the individuals exposed may not all respond in the same manner or degree. Where NMFS cannot quantify take in terms of numbers of affected individuals, we instead consider the likely extent of changes in habitat quantity and quality to indicate the extent of take as surrogates. The best available indicators for the extent of take, proposed actions are as follows.

As described in our effects analysis, NMFS has determined that incidental take is reasonably certain to occur as follows:

- Harm of juvenile PS salmonids from increased predation risk and reduction in ability to forage associated with existence of flip-bag culture and related equipment.
- Harm of juvenile PS salmonids from increased predation risk associated with existence of near bottom culture and related equipment.
- Harm of PS Chinook salmon from the loss of cover due to suppression of eelgrass in Samish Bay.
- Injury or death of juvenile PS salmonids from loose cover nets.

For take of juvenile of PS Chinook salmon and PS steelhead resulting from general disturbance and reduced ability to avoid predators and detect forage created by the flip-bags we use the area (acres) of flip-bag culture as the surrogate take indicator - this area is approximately 13 acres. This area functions as a surrogate because harm caused by the flip-bags' general disturbance is expected within this acreage.

For take of juvenile of PS Chinook salmon and PS steelhead resulting from increased predation risk associated with existence of near-bottom culture we use the area (acres) of all culture types as the surrogate take indicator - this area is approximately 97 acres. This area functions as a surrogate because harm (increased likelihood of predation in response to near-bottom culture) is expected within this acreage.

For take of juvenile PS Chinook resulting from loss of cover we use the area (acres) of flip-bag culture as the surrogate take indicator - this area is approximately 15 acres. This area functions as a surrogate for take because it is the location where suppression of eelgrass/loss of cover can increase the risk of predation.

For take of PS Chinook salmon and PS steelhead from loose cover nets we adopt the number used in the WA Shellfish Aquaculture Programmatic Biological Opinion (WCR-2014-1502). As noted in the effects section, this source of take is only documented to have happened one time, killing surf smelt. For this reason we reasonably expect this type of injury or death to happen no more than 5 times over the life of the permit. As such, a total of five entanglements of PS salmonids is the limit of take, and any visually confirmed entanglements beyond five will trigger reinitiation.

2.9.2 Effect of the Take

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

2.9.3 Reasonable and Prudent Measures

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

The Corps and/or its applicant shall:

1. Minimize take (harm) of PS Chinook salmon, and PS steelhead from flipbags and related reduction of eelgrass.
2. Minimize take (harm) of PS Chinook salmon and PS steelhead and from entanglement with shellfish cover nets.
3. Monitor and report as incidents occur, any loose nets, and any entangled fish, regardless of species, and collect specimens of the entangled fish.

2.9.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USACE 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. This term and condition implements reasonable and prudent measure 1: Flip bags must be suspended above the substrate so they do not rest on substrate at low tide.
2. The following terms and conditions implement reasonable and prudent measures 2 & 3:
    a. Ensure clam and other shellfish cover nets are secured to the extent practicable.
    b. Report and loose cover nets regardless of whether fish were entangled.
    c. If fish are entangled, record and report species, time, and location of entanglement.
    d. Collected dead specimens of fish entangled shall be preserved in a freezer, and reporting shall be to the NMFS' Lacey Office in order to determine appropriate steps to ascertain the entangled species.
    e. Reports should be provided to projectreports.wcr@noaa.gov

2.10. Conservation Recommendations

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

1. The COE should support research on eelgrass in Samish Bay.
2. The COE should support research on ESA-listed fish species interactions with the culture gear, with increased consideration for projects focused on interactions with flip-bag culture.
3. The COE should recommend that the applicant provide to NMFS (projectreports.wcr@noaa.gov) an annual report which should include the number of European green crab captured on their plots within Samish Bay as well as any observations regarding loss of eelgrass due to the crab's presence.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Morgan Living Trust Lease and Clark Lease batched opinion.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed 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."

2.12. "Not Likely to Adversely Affect" Determinations for Species and Critical Habitats

The NMFS anticipates the proposed action will have only insignificant or discountable effects on the species named in Table 4. Additionally, the proposed action will not take any of the species listed in Table 4. To reach this determination we reviewed the potential effects of all aspects of the proposed activity.

The applicable standard to find that a proposed action is NLAA listed species or critical habitat is that all of the effects of the action are expected to be discountable, insignificant, or completely beneficial.[1] Discountable effects cannot be reasonably expected to occur. Insignificant effects are so mild that the effect cannot be meaningfully measured, detected, or evaluated. Beneficial effects are contemporaneous positive effects without any adverse effect to the listed species or critical habitat, even if the long-term effects are beneficial. NMFS concurs with the COE's NLAA determinations to the species in Table 5.

Table 5. NLAA Species

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?
PS/GB Bocaccio Rockfish(*Sebastes paucispinis*)	Endangered	Species - No Adult CH - No
PS/GB Yelloweye Rockfish (*S. ruberrimus*)	Threatened	No
Southern Resident Killer Whale (*Orcinus orca*)	Endangered	No

As discussed above in Section 2.5, potential effects to listed species from the proposed action include disturbance of and suppression of eelgrass beds, bottom disturbance that may affect forage for listed species, elevated noise, entrainment in cover nets, impaired ability to migrate, and impacts to water quality from bottom disturbance. As also discussed above, most of these effects are expected to be relatively minor.

Bocaccio and its Critical Habitat (for adult life stage)

When bocaccio reach a size of 1 to 3.5 in or 3 to 6 months old, they settle into shallow, intertidal, nearshore waters in rocky, cobble and sand substrates with or without kelp (Love et al. 1991; Love et al. 2002). Larval and juvenile stages of some rockfishes typically move from more open-

[1] U.S Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS). 1998. Endangered Species Act Consultation Handbook: Procedures for Conducting Section 7 Consultations and Conferences. March, 1998. Final. pp. 315.

water habitats to nearshore habitats as they grow. Larvae are readily dispersed by currents after they are born, making the concentration or probability of presence of larvae in any one location extremely small. Juvenile bocaccio occur in very low densities in Puget Sound decreasing the possibility that any juvenile bocaccio rockfish would occur in the intertidal area and be exposed to mechanical harvest or cover nets. The likelihood of juvenile presence coextensive with the 100 acres of the proposed action is very low. Adult life stages of this species typically occupy waters deeper than 120 feet with high rugosity and are therefore this lifestage is also unlikely to be within the relatively shallow waters of the shellfish culture area. We consider, based on very low abundance of bocaccio in Puget Sound, that the exposure of this rockfish at either lifestage is discountable.

Critical habitat for adult bocaccio is designated in deepwater areas with complex bathymetry at depths greater than 30 meters. Effects of the action are unlikely to extend to these areas of critical habitat, and therefore we consider the effects on deepwater critical habitat discountable.

Yelloweye Rockfish and its Critical Habitat

Similar to bocaccio, yelloweye rockfish larvae are produced 2 times per year in Puget Sound, and float within the water column for approximately 2 months. Unlike bocaccio, juvenile yelloweye rockfish are not typically found in intertidal waters (Love et al. 1991; Studebaker et al. 2009), but are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al. 2006). The depths at the project site, which are shallower than preferred by adult and juvenile yelloweye rockfish, it is unlikely that adult or juvenile rockfish would be found in the project vicinity. Based on this, exposure of yelloweye rockfish is considered discountable.

Critical habitat for yelloweye is in areas deeper than the proposed action. Effects of the action are unlikely to extend to areas of critical habitat, and therefore we consider the effects on critical habitat discountable.

Southern Resident Killer Whales and their Critical Habitat

The final rule listing SR killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. The final recovery plan includes more information on these potential threats to SR killer whales (73 FR 4176).

Southern Resident killer whales do not inhabit the intertidal area where the proposed shellfish cultivation would occur. As such, the only potential effect would be from noise impacts related to aquaculture. The activities associated with the proposed action are not expected to create a noise impact on the listed species. In-water noise impacts from the proposed action are expected to be discountable because the work in water entails nothing louder than motorized boat noise or a small pressurized water sprayer on occasion, with most work being completed with hand tools. Further, the project will have minimal take on PS Chinook salmon, the primary forage base of SRKW. The effects to Chinook salmon will not cause population-level effects that will measurably reduce the quantity and availability of SRKW forage. Based on the information contained above, the potential for effects SRKW from the action is insignificant.

Southern Resident killer whale has designated critical habitat within Samish Bay, but at depths greater than 20 feet. The proposed projects would be located at an average depth of 6.7 feet, excluding them from being considered as designated critical habitat. While some effects may extend to areas of critical habitat, effects would be either discountable or insignificant. This includes effects on prey (predominantly PS Chinook salmon) which will occur (see section 2 of this document) but at a level that is not expected to significantly affect any Chinook populations overall viability.

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

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

This analysis is based, in part, on the EFH assessment provided by the COE and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council (PFMC 2005), coastal pelagic species (CPS) (PFMC 1998), Pacific Coast salmon (PFMC 2014); and highly migratory species (HMS) (PFMC 2007) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

As part of the information provided in the request for ESA concurrence, the USACE determined that the proposed action may have an adverse effect on EFH designated for PS Chinook salmon. The effects of the proposed action of EFH are the same as those described above in the ESA portion of this document. The action area also contains Habitat Areas of Particular Concern (HAPC) for Pacific Coast salmon.

Designated Habitat Areas of Particular Concern in the Action Area

Estuaries

Estuaries are protected nearshore areas such as bays, sounds, inlets, and river mouths, influenced by ocean and freshwater. Because of tidal cycles and freshwater runoff, salinity varies within estuaries and results in great diversity, offering freshwater, brackish and marine habitats within close proximity (Haertel and Osterberg 1967). Estuaries tend to be shallow, protected, nutrient rich, and are biologically productive, providing important habitat for marine organisms, including groundfish.

Seagrass

Seagrass species found on the West Coast of the U.S. include eelgrass species (*Zostera spp*.), widgeongrass (*Ruppia maritima*), and surfgrass (*Phyllospadix spp.*). These grasses are vascular plants, not seaweeds, forming dense beds of leafy shoots year-round in the lower intertidal and subtidal areas. Eelgrass is found on soft-bottom substrates in intertidal and shallow subtidal areas of estuaries and occasionally in other nearshore areas, such as the Channel Islands and Santa Barbara littoral. Studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993; Hoss and Thayer 1993).

3.2. Adverse Effects on Essential Fish Habitat

The proposed action is issuance of a programmatic permit that will enable new, expansions, and continuation of ongoing shellfish aquaculture activities whose past effects already inform, in part, the condition of EFH throughout the affected area. Review of the literature during consultation revealed divergent findings on many relevant issues such that there remains some uncertainty regarding the likelihood of the effects of these activities on the environment and whether or not likely effects would bear on EFH and managed fish. In cases of such uncertainty, NMFS considers the breadth of findings in the literature before concluding consultation.

We believe the proposed action will affect EFH within the action area via the following mechanisms:

- Suspended Sediments effects on Water quality – Harrowing on oyster grounds and dredge harvest of oysters delivers suspended sediment to the water column. Hand raking for the harvest of hard shell clams also has the potential for a minor pulse of turbidity upon tidal inundation.
- Temporary Reduction in prey resources – Localized and temporal effects on HAPC designated eelgrass beds and to benthic communities can be caused by harvest activities of shellfish species, shading, and entanglement.

Impacts to Food Resources—Submerged Aquatic Vegetation

Effects on SAV (eelgrass), a HAPC designated habitat and to benthic communities can be caused by bed preparation and harvest activities of shellfish species, and will occur over the time frame of the proposed action. Various aquaculture activities described under the proposed action can directly interact with eelgrass by decreasing its extent or density within estuarine shellfish beds. However, interactions with eelgrass are generally going to occur in areas of perennial shellfish aquaculture that were providing previously altered eelgrass habitat function prior to the proposed action. Furthermore, some aquaculture activities have been shown to enhance habitat characteristics for eelgrass colonization through water clarifying filtration or provide a substitute or replacement of eelgrass habitat function. (Dumbauld et al. 2001) Additionally, through the removal of suspended particles, shellfish improve water clarity and therefore light penetration, which can enhance the photosynthesis of eelgrass (Newell 2004).

Eelgrass beds provide cover for some species of juvenile salmonids, and structure for the spawning of species on which juvenile salmonids prey. Eelgrass and eelgrass patches are a foundational element in the inter-tidal environment, throughout the action area, supporting the base of the food web. Throughout most of the Puget Sound region, eelgrass is of primary importance as a herring spawning substrate (WDNR 2015; Blackmon et al. 2006). Eelgrass patches also cover and forage for growth of herring (and other forage fish species) (Blackmon 2006) on which juvenile salmon and steelhead feed. In a small fraction of documented herring spawning areas, atypical spawning substrates are used (Mumford 2007), including shellfish aquaculture apparatus

The existence of continuing active footprints impairs the development of dense beds of eelgrass. And although eelgrass growth recovers following disturbance, the proposed action is likely to maintain conditions limiting dense eelgrass beds within the footprint. Eelgrass spreads from seed source or from rhizome growth. Where sufficient rhizome nodes remain intact following disturbance, eelgrass can recover (Cabaço et al. 2005), although recovery may take an extended period of time and eelgrass density may be initially lower. Eelgrass typically regrows on a shellfish bed following aquaculture activities that have removed existing eelgrass, but cyclical management activities probably limit the functional condition of eelgrass in managed sites. Depletion or decreased function of eelgrass in shellfish beds is also probable for near-bottom culture as well, as it limits conditions favorable to eelgrass growth. Near-bottom, stake (Griffin 1997), and rack culture can cause erosion or sedimentation in some places, which appears to be the primary cause of eelgrass depletion in areas where this type of aquaculture is practiced (Everett et al. 1995). Since the effects of the action include the persistence of these types of conditions within the footprint of managed sites, the recovery of dense eelgrass in managed sites in unlikely.

Rumrill and Poulton (2003), in Humboldt Bay, CA, investigated the effects of long-line culture on eelgrass. Generally, when line spacing reached 5 feet they found an increase in cover and density of eelgrass. They did caution that a longer study period should be considered to understand the differences in annual and monthly variability.

Juvenile salmonids utilize a variety of habitats during their emigration through Puget Sound. Chinook salmon often use eelgrass because it provides cover, refuge and a prey base for small fish at this vulnerable life stage. While we expect shellfish activities to maintain low density of eelgrass within the continuing active and fallow footprints, we believe the magnitude is not likely to be of such an extent, either individually or cumulatively to impair forage production or cover within these areas. Nothing about the proposed action impairs or prevents the presence of eelgrass beds adjacent to, or near shellfish activity footprints.

Dumbauld et al. (2001) found that when comparing oyster bottom culture to eelgrass beds and mud bottom habitat, both eelgrass and oyster culture provide species richness and habitat utilization by salmonids at an equivalent scale. These studies suggest that decreased extent or density of eelgrass at culture sites does not ensure a net negative ecological result. NMFS notes that eelgrass habitats are ecologically important and that studies have shown seagrass beds to be among the areas of highest primary productivity in the world (Herke and Rogers 1993; Hoss and Thayer 1993). While it is reasonable to presume some reduction in the ecological value of EFH from aquaculture at the site and immediate vicinity, it is less obvious to presume EFH impacts, positive or negative, beyond such a scale.

Benthic disturbance generally refers to the various activities that lead to physical interaction with the bottom. Activities that interact with the bottom under the proposed permit include site and plot preparation, grow-out, and harvest. One issue for each of these activities and the benthic environment is whether and to what extent they influence the functional condition of the nearshore marine bottom environment, and whether any influence is significant enough to impair normal EFH utilization. Some activities have contact with the bottom, which at least implies some effect on benthic processes; specifically those processes that contribute to the productions of food for EFH species, salmonids, groundfish, and coastal pelagics. In addition to contact with the bottom, the presence of managed shellfish aquaculture at a site can slightly affect the chemistry in the water and bottom sediments (Straus et al. 2008) in ways that imply effects on benthic communities. Despite interaction with the bottom environment over hundreds or thousands of acres in each sub-region, there is no evidence that such disturbance interferes with benthic productivity or decreases the availability of forage for EFH species on such a temporal to allow for a determinant conclusion of the effects.

Another issue for EFH concerning the effects of shellfish activities on benthic communities is whether or not bottom interactions from any source change conditions affecting the availability food. The effects of those interactions on benthic forage for listed fish are variously reported. Straus et al. (2008) reported increased benthic species at mussel culture sites, decreased benthic species richness at oyster culture sites, and no significant differences in benthic species (infauna) between mussel farms, oyster farms, and reference sites. Dumbauld (1997) in a review of studies on the impacts of oyster aquaculture reported that species abundance, biomass, and diversity are often enhanced in areas where oysters are cultured.

Some of the various hand or mechanical harvest methods used in shellfish aquaculture each involve a physical disturbance of the bottom that affect sediment and benthic fauna (Johnson 2002). In some cases, bottom disturbance reduces the number and abundance of benthic species in the disturbed area, although the extent of such reductions has been reported variously, including no effect at all. For example, hand raking and digging for various shellfish in Yaquina Bay, Oregon, did not impact infaunal species number and abundance (Straus et al. 2008).

The complex surface area provided by oysters and mussels offers habitat for over 100 different benthic species (CRMC 2008). The CRMC review also found that large biomasses of cultured mussels or oysters and fouling organisms suspended from lines attached to buoys or rafts have a major beneficial effect on phytoplankton, benthic, and hydrographic conditions within the immediate area of culture activities. For example, because suspended rope culture in high current waters results in dispersal of pseudofeces, there are favorable increases in macrofaunal biomass in the vicinity of the culture operation. However, areas with low diversity (usually due to pollution from non-culture activities) and decreased flow demonstrate organic sedimentation under long lines up to two times that found in adjacent uncultivated areas (CRMC 2008).

As mentioned above, benthic recovery typically follows disturbances for shellfish aquaculture. The stability and recolonization rates of benthic fauna can range dramatically depending on physical conditions (sediment type and stability, wave action, current), season, location, scale of disturbance, and whether recolonization occurs primarily through adult movement or larval settlement (Straus et al. 2008). Small benthic invertebrates produce more than one generation per year, considered rapid recolonization rates. Intertidal species have adapted to habitat changes, and so chronic low intensity or sporadic medium intensity intertidal substrate disturbances are within the range of "behavioral or ecological adaptability" (Jamieson et al. 2001).

Intertidal and nearshore shellfish aquaculture activities cause some disturbance of benthic habitat and mortality of non-target species. The factors that may have the greatest effect on benthic invertebrates relate to the timing and duration of the disruption, the shift in community structure, and the availability of other foraging habitat within migrating distance. Based on the currently available evidence, the level of benthic disturbance from existing shellfish aquaculture in Washington State is well within the range of normal sediment-disturbing processes (e.g. storm/wave activity) and that adverse effects are likely to be quite limited in space (the footprint of the shellfish bed plus some buffer to account for current) and duration (from a few hours to a few days to a few months depending on the benthic assemblages in question). Therefore, we believe that the effects of these existing, new, and expanded aquaculture activities on benthic communities unlikely to cause large scale impacts to EFH. Impacts to prey resources of EFH species would be quite limited in time and space.

Water Quality – Turbidity

The harrowing of bottom culture beds may occur at approximately annual increments. Harrowing normally involves work boats dragging a short tooth rake across the oyster beds, disturbing not more than two inches of the surface substrate. This activity normally occurs on beds with softer sediments or burrowing shrimp at high densities in Willapa Bay and Grays Harbor to ensure that the oyster crop stays on the surface. The mechanical or mechanical harvest on bottom culture beds also may occur at an interval of one to four years. Mechanical harvest is done at high tide and typically occurs on beds with a sandy bottom thus producing less turbidity plume when compared to beds with finer substrates that are more typically hand-picked during low tides (Dumbauld, Pers. Comm. 17/09/14). Dumbauld also related that when mechanical harvesting, operators attempt to keep the dredge from engaging deeply into the substrates, preferring to operate as efficiently as possible by just skimming the surface and harvesting the oyster crop. An additional element of this operational method is the effect on SAV.

During the harvest of bed reared hard shell clams, the beds are raked with hand-held rakes, or occasionally a mechanical harvester. A small amount of turbidity may be generated on the subsequent tidal inundation, with habitat effects small and generally contained to the immediate vicinity of the harvest site.

Each of these activities is likely to produce a short-term increase in turbidity and to re-suspend sediments, including particulate nutrients into the water column. Because these activities are performed infrequently at any particular site, they have limited potential to impair water quality and effects are typically observed only within the footprint of the activity and immediately adjacent waters for a single tidal cycle.

These short-term effects on water quality can also be measured in contrast to the effects on water clarity that is occurring as a result of filter-feeding activity of the cultured mollusks. Phytoplankton and other water column particulates are being filtered from the water in the vicinity of the various mollusk aquaculture sites contributing to improved water clarity and to increased opportunity for SAV (eelgrass) to establish. The ammonia released by the shellfish is taken up by phytoplankton, renewing the cycle. These bio-deposits provide support to invertebrates, macroalgae, and seagrasses, including eelgrass (Newell et al. 2005). A net removal of a portion of the nutrients consumed by the shellfish occurs when they are harvested.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.
Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, for Pacific Coast salmon.

1. Water Quality – The COE/permittees should utilize the conservation measures as needed to minimize TSS/turbidity contributions to the water column. Examples would be: to ensure that dredge harvest activities minimize sediment contributions by adjusting the bag to ‘skim’ the surface.
2. Impacts to Prey Resources - Similar to number 1 above the COE/permittees should minimize negative impacts to important HAPC habitats of native eelgrass by locating operations to avoid native eelgrass beds or patches. The COE/practitioners can also minimize impacts by avoiding activities during full foliage growth (spring and summer) or in a manner that destroys foliage or severely impacts eelgrass rhizomes.

3.4. 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)].

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

3.5. Supplemental Consultation

The 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)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is the USACE. Other interested users could include the applicant, the WDFW, the governments and citizens of Skagit County, Samish Island, and the town of Edison Individual copies of this opinion were provided to the USACE. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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