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-2022-01810

November 17, 2022

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

Dear Mr. Tillinger:

Thank you for your email of July 26, 2022, 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 Cooke Aquaculture Pacific, LLC. Orchard Rocks Net Pen Repair project in Rich Passage, Kitsap County, Washington.

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

The enclosed document contains a biological opinion (opinion) that analyzes the effects of the United States Army Corps of Engineers (Corps) issuance of a permit for repairs to Cooke Aquaculture, Inc.'s Rich Passage net pen facility. In this opinion, we conclude that the proposed action is not likely to jeopardize the continued existence of Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*), PS steelhead (*O. mykiss*), PS/Georgia Basin (PS/GB) yelloweye rockfish (*Sebastes ruberrimus*) and PS/GB bocaccio (*S. paucispinis*). Further, we conclude that the proposed action is not likely to result in the destruction or adverse modification of the designated critical habitat for any of these listed species.

The opinion includes an incidental take statement that describes reasonable and prudent measures we consider necessary or appropriate to minimize incidental take associated with this action. The take statement also sets forth terms and conditions, including reporting requirements that Corps and applicant must comply with to carry out the reasonable and prudent measures. Incidental take from actions that meet these terms and conditions would be exempt from the ESA take prohibition.

We have included three 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 the final recommendations. If the response is inconsistent with the essential fish habitat conservation recommendations, the Corps 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 essential fish habitat 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 essential fish habitat consultation and how many are adopted by the action agency. Therefore, we request that, in your statutory reply to the essential fish habitat portion of this consultation, you clearly identify the conservation recommendations accepted.

Please contact Dr. Jeff Vanderpham, consulting biologist in the National Marine Fisheries Service Lacey, Washington office at jeff.vanderpham@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: Randel Perry, Project Manager, United States Army Corps of Engineers, Seattle District
Kevin Bright, Permit Coordinator, Cooke Aquaculture Pacific

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

Cooke Aquaculture Pacific, LLC. Orchard Rocks Net Pen Repair
Kitsap County, Washington
(NWS-2018-1125)

NMFS Consultation Number: WCRO-2022-01810

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?
PS steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	NA	NA
PS Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
PS/GB bocaccio rockfish (*Sebastes paucispinis*)	Endangered	Yes	No	Yes	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	Yes	No
Southern DPS Pacific eulachon (*Thaleichthys pacificus*)	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
Pacific Coast Groundfish	Yes	Yes
Coastal Pelagic Species	Yes	Yes

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

Issued By:

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

Date: November 17, 2022

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1. INTRODUCTION

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

1.1. Background

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

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

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 NMFS Lacey, Washington office.

1.2. Consultation History

On May 1, 2019, NMFS received a request for informal consultation from the United States Army Corps of Engineers (Corps) for the proposed action, and a revised informal consultation request letter on May 17, 2022. Upon review of the information provided, we determined that the information did not demonstrate that the effects of the proposed action are either wholly beneficial, discountable, or insignificant. Therefore, NMFS could not concur with the Corps' not likely to adversely affect (NLAA) determinations for PS Chinook salmon, PS steelhead, PS/Georgia Basin (PS/GB) bocaccio and PS/GB yelloweye rockfish, and their designated critical habitat. We electronically provided a non-concurrence letter to the Corps on July 6, 2022, that included a request for additional information about the proposed action should the Corps request formal consultation.

We received the Corps' request for formal consultation on July 26, 2022. The consultation request included the original May 19, 2019, Memorandum for the Services (MFS), the May 17, 2022 revised informal consultation request letter and MFS, and additional project information from Cooke Aquaculture Pacific, LLC (Cooke). The consultation package also included a Biological Evaluation (BE), aerial photos and project drawings. Upon review, we determined that the information provided by the Corps included the necessary information to complete ESA Section 7 and EFH consultation, and formal consultation was initiated on July 26, 2022. Additional information about operations, including Cooke's Fish Escape Prevention Plan were provided to NMFS on September 7, 2022. This formal ESA Section 7 consultation is triggered by likely adverse effects to PS Chinook salmon, PS steelhead, PS/GB bocaccio and PS/GB yelloweye rockfish, and critical habitat for each of these species. The EFH portion of this consultation is triggered because the proposed action may adversely affect EFH for Pacific Coast groundfish, coastal pelagic species, and Pacific Coast salmon.

In emails dated August 1 and 4, 2022, NMFS asked the Corps if it would like to reconsider its 'no effect' determinations for ESA-listed Hood Canal summer-run chum salmon and their designated critical habitat, PS steelhead critical habitat, Southern DPS green sturgeon, and Central America DPS and Mexico DPS humpback whale based on our identification of a larger action area to account for interactions between fish that may escape from net pens and these ESA-listed species and/or designated critical habitat. The Corps confirmed its 'no effect' determination for these species and critical habitat by email on September 8, 2022. NMFS sent a follow-up email to the Corps on October 3 and 12, 2022, clarifying that we do not agree with the 'no effect' determinations, particularly for PS steelhead critical habitat and Hood Canal summer-run chum salmon for which we identified adverse effects of net pen facilities and operations in a previous Biological Opinion[1] that analyzed commercial net pen effects in the PS. On October 14, 2022, the Corps re-confirmed its effects determinations. We have not consulted on any species or critical habitat for which the Corps did not make an effects determination or for which it made a 'no effect' determination.

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. As a result, the 2019 regulations are once again in effect, and we are applying the 2019 regulations here. For purposes of this consultation, 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). The Corps is proposing to permit under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act repair activities at Cooke's Rich Passage net pen facility.

The originally proposed project, as described in the BE and the May 1, 2019, request for informal consultation, includes the replacement of the existing net pen facility with a new facility, including fish pens, perimeter walkways and new anchor/mooring systems. The purpose of the project is to address deteriorating structures, which have been in service at the site since

[1] WCRO-2018-00286; Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Environmental Protection Agency's Approval of Washington State Department of Ecology's Sediment Management Standards (WAC 173-204-412) Regarding Marine Finfish Rearing Facilities.

2001. As described in the modified MFS of May 17, 2022, the applicant completed many portions of the originally proposed action in 2019, prior to initiation of this consultation:

> *"The applicant removed the two existing floating steel net pen structures (20 pens total) in 2021 from the "Orchard Rocks" location and replaced them in 2022 with a net pen structure of smaller size (12 pens), relocated from the "Fort Ward" site. The existing cages were towed away in one piece, then dismantled and disposed of at an approved upland facility. The replacement cages were towed to the project location and the existing anchor lines will be attached to the net cage structure. Nine existing anchors were lifted to the surface, inspected, refitted as needed, and then redeployed. The mooring grid at Orchard Rocks also uses 12 permanent steel pin/piling type anchor points that are imbedded in the seafloor. They remained in place, but the surface mooring line and connections (shackle, thimbles) for those were lifted out of the water to be inspected and refitted as needed. No new pens would be installed at the Fort Ward site. The project resulted in a 1.44 acre net decrease in area of structures in marine waters*."

Since the work described above was completed prior to initiation of this consultation, those aspects of the work are not included in this opinion. However, as clarified in the updated MFS, the proposed action does include work not yet completed—the pulling of four remaining anchors for inspection, refitting and redeployment in the same location. This work is described in the BE and the additional information provided May 17, 2022.

As described in the BE, repair and replacement of the anchoring and mooring components is a necessary part of net pen maintenance. Anchor refitting would occur on the deck of a crane barge or work vessel. Four large (10,000 lb.) Danforth type anchors that remain at the southern end of the mooring grid would be pulled to the surface for inspection, refitted as necessary and then redeployment back into their prior locations. A work barge with a larger capacity crane would quickly lift these four anchors vertically to the surface. The anchors and mooring components would be set onto the deck of the barge where they can be worked on. The crane barge would maintain position over the anchors that are being lifted using GPS coordinates, a tugboat, and possibly lines attached to the other adjacent moorings. New replacement mooring lines, chain, and hardware would be prepped in advance and ready on the deck of the barge for quick replacement work. Worn materials would be disconnected and new line, chain and hardware reconnected to the Danforth anchor while on the deck of the vessel. The crane barge would lower the anchor back into the previous anchoring position using predetermined GPS coordinates. The surface mooring line would then be pulled back to the pen system and reattached to the corresponding attachment point on the pens. One new additional 6,000-pound Danforth anchor would also be deployed at the southwestern corner of the pens per the mooring recommendations of the engineer firm. This would increase the number of mooring attachments located on the southern end of the pen system from five to six.

Removed old line, chain, shackles, and hardware would be stored on the deck of the barge and work vessels for transport back to approved upland disposal and metal recycling facilities. The barge and crane are expected to be needed for approximately four days to perform the work. Tools used would be cranes, small hand tools (hammers and wrenches), pulleys, and cutting torches to perform the mooring refit and maintenance work. Work would be performed on the deck of the vessels using the small hand tools as needed. Most of the work would be done using the company's own work boat which has a crane for lifting the mooring equipment onto the deck of the vessel where it can be worked on. Smaller work skiffs and a tugboat would be used to maneuver the crane barge into position. The depth of the water in this mooring location is approximately 120 to 150 feet.

After completing the remaining anchor refitting work, the predation barrier net panels would be sewn onto the steel pipe net weighting frame and the stock containment nets would then be installed prior to receiving the first stocking of fish.

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).

We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would cause the future operation and maintenance of the net pen facility. The proposed repair of the net pen facility extends the life of the existing facility and allows for continued finfish rearing at the site. Routine and minor maintenance of the nets, pens, perimeter walkways and floats is also anticipated. This includes net repair and replacement, and minor repairs to surface structures and the pens, which does not change environmental conditions at the site, nor disturb the seafloor. With the proposed action and minor routine maintenance, we expect the facility to be present and operating for the next 50 years.

On October 1, 2019, Washington Department of Fish and Wildlife (WDFW) issued a Mitigated Determination of Non-significance for Cooke Aquaculture, Inc.'s proposed action to transition production from Atlantic salmon to all-female, triploid rainbow trout (*Oncorhynchus mykiss*) in existing PS net pen facilities. In January 2020, WDFW approved Cooke Aquaculture, Inc.'s application to farm all-female sterile (triploid) rainbow trout/steelhead in PS (WDFW 2020b). On January 6, 2021, the Washington Department of Ecology (Ecology) issued modified NPDES permits for Cooke Aquaculture, Inc. to raise rainbow trout/steelhead (Ecology 2021).

Rainbow trout and steelhead are both the same species, but with different life histories, non-anadromous and anadromous, respectively (e.g., see Berejikian et al. 2014; Hodge et al. 2016). Although the source stock for the net pens may be non-anadromous rainbow trout, since they are reared in marine net pens they could be referred to as steelhead. For consistency in this Opinion, we refer to the triploid *O. mykiss* proposed for net pen rearing as "rainbow trout/steelhead."

The Orchard Rocks net pen facility is located in Rich Passage at latitude 47.5750 north and longitude -122.5306 west. The nearest shoreline to the fish pens is approximately 1,200 feet eastward of the pens at mean lower low water (MLLW). The area immediately beneath the net pen facility varies in depth from -48 feet to more than -100 feet MLLW. Operations at the facility are described in the additional information provided on July 26, 2022, and summarized in the remainder of this section of the opinion (Section 1.3). The floating fish pen rafts are attached at distinct surface attachment points to the below surface mooring grid to hold them in place. The mooring grid design and pen system have been reviewed by a licensed marine engineering firm with experience in marine aquaculture fish pen designs and operations. Doppler current data was collected at the Orchard Rocks and Fort Ward lease areas and used in a computer modeling system to design the mooring system for the 12-pen structure at Orchard Rocks. The Orchard Rocks facility would be operated for the next growing cycle using the 12 fish pen structure.

Stock growing nets are installed that allow for the containment and culture of juvenile fish to be raised to marketable adult sized fish. A predation barrier net is installed around the entire perimeter of the fish pen structure that protects the fish growing inside the stock growing nets from marine mammal predation. The site is stocked with juvenile rainbow trout/steelhead which have been grown from eggs produced by captive-raised brood fish reared their entire life in a freshwater hatchery. Brood fish are routinely screened for reportable pathogens during their life cycle in the hatchery. Juvenile fish destined for transport to the fish pens are also screened for reportable pathogens at the 2% APPL level.

Each pen is stocked with an electronically counted number of fish which are subsequently grown for the 12 to 16 months until they reach the desired harvest size. Under the proposed action, the maximum number of fish at any time within the Orchard rocks net pens would be 550,000 fish. The fish are then harvested from each pen over several months until the entire cohort of fish is harvested from the site. The site undergoes a fallowing period for a minimum of 42 days after the last stock growing net has been removed from the site. Stock containment nets are shipped to a land based net washing and repair facility for cleaning, inspection, and repair. The length of fallowing periods can vary based on the availability of eggs and juvenile fish production through the freshwater hatchery system and are likely to be longer than the 42-day mandate.

Daily activities at the fish pens include anchor maintenance, pen system maintenance, stock rearing net and predation barrier netting inspections and maintenance, daily feeding of the fish stocks, net washing, water quality monitoring, mortality retrieval diving, maintenance diving, underwater mooring inspections, and the daily monitoring of fish stock health, growth, and welfare. Periodic activities would include harvesting of fish stocks after the population reaches harvestable size, weight sampling for growth rates, removal of stock containment grow nets after fish are harvested, maintenance or replacement of the predation barrier nets between production cycles, mooring maintenance, minor repairs, and replacement of ancillary support equipment used to feed and cultivate the fish.

A steel pipe net weighting frame is installed and used to hold predation barrier nets and stock nets in position. The pipe frame consists of 6-inch and 8-inch diameter steel well casing pipe which is used to weight the predation barrier net and the fish stock containment nets. The steel pipe frame is suspended in place under the walkways by vertical lines tied to the walkways. The bottom panel of the predation barrier net is pulled tightly into place and lashed to the pipe frame using line. The predation barrier net is a polypropylene blend material with a twine diameter of size of 5mm and mesh opening size of four inch on the square (4 inch x 4 inch). The predation barrier net walls are then tightly lashed to the steel pipe and to the outside perimeter of the fish pen raft walkways. The pipe frame is lowered to the depth of 13 meters at which point the predation barrier wall netting material itself is suspending the weight of the pipe frame. This creates a very rigid exterior barrier wall around the outside walkway perimeter that allows water to flow through the 4-inch-wide mesh openings but creates a visual and physical barrier to prevent seal and sea lion attacks on the captive fish stocks inside the stock rearing nets.

Stock rearing containment nets are deployed into the individual fish pen rearing space just prior to the scheduled entry dates of the fish to be transferred from the hatchery. The stock nets are made of the same polypropylene blended twine material with a twine diameter of 2.4 millimeter and a net mesh opening size of 1 inch on the square (1 inch x 1 inch). Stock nets are built specifically for use in the fish pens with reinforced vertical rib lines, bottom panel lines and chafe protection panels around the sea surface perimeter of the net. Each stock net measure 25 meters by 25 meters square at the surface. The rearing nets are 12 meters in depth below the surface and top of the net extends approximately 1 meter above the surface of the water where they are attached to the hand railings located around the perimeter of each pen. The above surface netting is called the "jump net" and prevents the fish from being able to jump out of the pen. The bottom line of the net is attached with "tie down" lines to the steel pipe frame, pulling the bottom panel and four net walls tightly into place. The nets are slightly tapered towards the bottom, a design that keeps both the bottom and side panels flat and tightly suspended when the nets are attached to steel pipe net weighting frame system. The pipe frame acts as both the weight to hold down the stock nets in the tidal currents and to keep the nets taught and in the square rearing shape. Bird netting is suspended above and over the top surface of each stock net. The netting is pulled tight and attached to the hand railings around the perimeter of each individual fish growing pen. The bird netting is black polypropylene twine with a mesh size of approximately 2 inches by 2 inches square. The netting acts as a visual deterrent and physical barrier for both the prevention of bird predation on the small juvenile fish when they first are transferred to the facility and to prevent birds such as sea gulls, from attempting to eat the fish feed pellets when they are being distributed to the fish during the feeding process.

Divers frequently inspect the stock containment nets for signs of any chaffing or holes, and to retrieve fish mortalities from the pens. Divers also perform a weekly net hygiene inspection to numerically score the biofouling growth of the netting surfaces and evaluate the effectiveness of the net washing process. Stock nets are washed using "in-situ" net washers that utilize either pressurized seawater or mechanical methods to dislodge biofouling growth from the netting. The net walls and floors are washed frequently to prevent accumulation of fouling growth that can reduce the water flow through netting. Each stock net is scored weekly on a scale of 1 to 10 and a Weekly Net Hygiene Report is generated for each farm site. The report allows a quick review of the condition of the farm's net hygiene and the report is shared weekly with the Washington Department of Natural Resources (WDNR). Video verification of net hygiene score reports is performed on WDNR randomly selected nets on a monthly basis during the spring, summer and fall months, when biofouling growth is at its peak. During the winter months, net video verification is reduced to once every 2 months. Net hygiene reports are generated 52 weeks per year and reported weekly to WDNR. Increasing score trends at a farm can quickly be identified from these reports and increased net washing equipment and frequency can be quickly directed towards cleaning efforts.

Fish are fed using a feeding machine located in the center walkway of the site and between two pens. Feed is distributed from the feed hoppers into the pens using an air blower and oscillating feed delivery pipe. Measured quantities of feed are put into the hoppers and feed quantity is kept track of on log sheets and subsequently entered to a computer and into the company's fish rearing software system. Underwater cameras are installed in the fish pens and are used to observe the feeding behavior of the fish and to control the feed delivery process. Feeding technicians visually observe the feeding process from the surface of the pen, and by using the underwater camera system. The underwater cameras help to prevent feed pellets from being lost into the environment by overfeeding or delivery the feed pellets at too fast of a feed rate. The cameras allow feeding technicians to observe both the appetite responses of the fish and the overall behavior of each population of fish in a pen. Computer growth models, inventory data, and water temperature are all parameters used to calculate an expected daily feed quantity for optimal growth of each individual fish pen. Fish are fed rations according to the expected feed quantity while the technicians watch for signs of over feeding and appetite. Feed quantities delivered to the pens are adjusted according to the daily appetite of each pen. The daily feed used per pen is recorded in the fish inventory system which calculates the populations biological growth and feed conversion rate. Feed conversion rates are watched closely for signs of both over feeding and under feeding.

Monthly sample weights of the fish population are carried out on representative pens to verify "actual growth" compared to the "calculated growth" of the computer model. Average weights from these size sampling events are input into the fish rearing program to update the growth model input data. Expected optimal feed conversion rates for steelhead trout have been well researched over the years. Anticipated ending biological feed conversion ratio (feed given/animal weight gain; FCR) for the marine net pen all-female triploid rainbow trout/steelhead being reared are expected to be approximately 1.2. Feed fed, month end biomass, medicated feed use, end of month fish inventory numbers, and FCR's for each farm site in Washington are reported monthly to WDFW, WDNR and Ecology. A year end production summary report is also prepared and sent to the state agencies that summarizes these and other metrics.

A starting inventory for each pen is determined at the hatchery by electronic fish counters and the beginning average weight for each population in a pen is also determined by the hatchery sample weights that are taken during the fish transport loading process. A well-boat is loaded with the smolts from the freshwater hatchery and transports the fish in the fish holds to the marine fish pens. The fish are pumped from the holds of the vessel using the on-board fish vacuum pump system that moves the fish into the stock nets. The pens are stocked with the counted number of fish coming from the electronic fish counter at the hatchery. This number becomes the "starting" inventory number of fish for the beginning inventory of each pen being reared. Fish mortalities are collected by divers three or more times per week. The number of dead fish removed during the mortality dive operations is recorded and entered into the fish inventory program which automatically subtracts that number of fish from the pen. This inventory becomes the remaining live fish inventory number for that pen. End of month live fish and dead fish inventory numbers are reported monthly to the state agencies.

A veterinarian of record is retained to perform periodic health screenings at the hatchery and marine sites. The veterinarian monitors the health of the fish populations and provides as needed services for specific health concerns of the fish population. Site Managers and farm staff assess fish health through surface observations, feeding appetite, and the use of field necropsies of collected fish mortalities. Farm employees have professional experience in necropsies and identifying common causes of mortality. Veterinarians from the Washington Department of Fish and Wildlife also make periodic fish health visits and inspections of each farm site facility. Agency veterinarians perform necropsies during a mortality retrieval dive and collect tissue samples to be analyzed by the WDFW for any reportable and regulated fish pathogens.

Diagnosis of a disease is carried out by the licensed veterinary services and is a requirement for the prescription of any antibiotic treatment for a specific disease event. Three antibiotics are approved for use through medicated feed treatments in marine net pens, Aquaflor, Terramycin and Romet. Washington marine net pens are required to report usage, type and the quantity of any medicated feed treatment used the net pen site to Ecology, WDNR and WDFW in the monthly summary reports. Medicated feed use has steadily declined over the past twenty years in marine salmon aquaculture with the advent of both improved fish rearing technology and the development of specific vaccines for common pathogens.

Cooke has the first two populations of marine net pen reared all-female triploid rainbow trout/steelhead growing at two of their four farm sites. Both groups are nearing the end of their production cycles and will be harvested this coming fall and winter. Neither of the farms has had a disease event that required the use of any medicated feed treatments at the marine net pens. No antibiotics were used during the freshwater hatchery rearing phase and these fish are anticipated to be grown without the use of antibiotics. Cooke reports that this is their goal since healthy fish grow faster, medicated feed adds to the cost of production, and "no anti-biotic use" aquaculture products are widely valued by consumers in the seafood marketplace. It is anticipated that the smolts going into the Orchard Rocks facility would also perform similarly and be produced without the use of antibiotics. All pre-marine transfer juvenile fish (smolts) are IP (intraperitoneal) vaccinated by hand at the freshwater hatchery prior to transport to the marine sea cages. The fish are vaccinated against IHNv, *Aeromonas salmoncida*, *Vibrio anguillarum*, *V. ordalii*, *V. salmoncida*, and *Moritella viscosa*.

Cooke's freshwater hatcheries operate on regulated pathogen-free ground and/or spring water for both the brood fish rearing facilities and for the eyed egg incubation hatcheries. Prior and current fish health information is supplied to the WDFW Fish Health Department for review along with any other related information during the Fish Transfer Permit application process. Approval by WDFW of a Fish Transport Permit is necessary for the movement of live eggs and/or fish from one facility to another. The eyed egg production facilities must demonstrate a history of negative test results (i.e., no positive findings) of any of the regulated pathogens over the previous three years.

Regulated pathogen-free ground water is used to incubate the eyed eggs and rear the juvenile fish to the appropriate sizes prior to transfer out to the marine sea cage growing sites. Each lot (cohort) of eyed eggs coming from the ova supplier are disinfected before being entered into the Cooke freshwater incubation facility. Strict compartmentalization and bio-security measures are incorporated at the hatcheries for each lot of fish being raised at the hatchery. Each lot of juvenile fish raised at the freshwater rearing units that is destined for transfer to the marine site is sampled prior transfer to the marine site at the 2% APPL for regulated and reportable fish pathogens. Fish health screening results of pre-transfer smolts must be negative for any regulated and reportable pathogens for the approval by WDFW of the Fish Transport Permit allowing for the movement of fish from the hatchery to the marine sites.

Cooke has worked with WDFW Fish Health and Hatchery Management employees to determine the best method for externally marking the farmed all-female triploid rainbow trout/steelhead trout stocks to make them individually identifiable as commercially reared aquaculture fish. The company uses a ventral fin clip to mark the fish destined for transfer into the marine sea cages. During the pre-transfer vaccination and handling process, the right ventral fin of each fish is removed. The removal of the right ventral fin makes them distinguishable from enhancement hatchery produced steelhead, which have clipped adipose fins, and from naturally produced steelhead, which have all their fins intact.

Ventral fin material from 150 fish from each lot of fish are randomly pulled during the vaccination process and are preserved for genetic analysis by WDFW. The fin tissue is placed on blotter paper provided by WDFW which is subsequently sent to the WDFW Fish Genetics Lab for archival and genotyping.

Species and stock of fish to be grown are all-female triploid rainbow trout/steelhead trout (*Oncorhynchus mykiss*). The source for the rainbow trout eggs is Troutlodge, a Washington-based company that has been producing trout eggs for sale to both public and private aquaculture operations throughout the world since 1945. The Troutlodge rainbow trout/steelhead genetic lines originate from Pacific Northwest region from freshwater rainbow and sea run steelhead trout stocks. Ova production comes from Troutlodge's captive brood stock breeding programs carried out in at their Washington State hatcheries. Breeding populations are grown in regulated pathogen free freshwater during their life cycle to supply the production fish gametes. Troutlodge supplies and ships eyed eggs across the United States and to numerous overseas aquaculture operations. Troutlodge stocks have been selectively bred over the past 40 years to enhance the beneficial commercial production traits for both freshwater and marine aquaculture facilities.

All-female triploid rainbow trout/steelhead trout are widely used because of their improved growth rates, increased uniformity, inability to reproduce, and the overall ease of growing them in artificial rearing environments. The use of all-female stocks of triploid rainbow trout/steelhead trout is recognized as a technological improvement that helps to minimize the risk of genetic interference with natural or hatchery stocks. All-female triploid rainbow trout/steelhead are hormonally and functionally sterile. The likelihood of an escaped all-female triploid rainbow trout/steelhead exhibiting reproductive behavior or instincts in the wild is extremely low, and the risk of colonization by an escapement is substantially diminished because there are no males in the escaped population. Procedures for triploid trout ova production achieve over 99% induction rate and quality control analysis is routinely carried out for verification of the triploid success rate. Results of the ploidy confirmation test for each lot of fish destined for transfer to Cooke marine net pens are sent to WDFW as part of the conditions of the Marine Aquaculture Permit. Post start feeding fry are randomly sampled and sent to the Washington State University (WSU) School of Veterinary Medicine for triploidy analysis. A sample size of 600 fish per lot of eggs is used to test the triploid success rates for each lot of fish destined for transfer to the marine net pens. Results from the WSU lab are supplied to WDFW Fish Health Managers for verification of triploid status as part of the fish transport permit process. The Troutlodge triploid ova production methods have a historical record of achieving a greater than 99% triploid induction rate.

Expected production volume from the 12-pen system when growing the all-female triploid rainbow trout/steelhead is projected to be approximately 3,500,000 pounds per production cycle. Each pen would be stocked with approximately 40,000 fish at a starting average weight between

150 to 190 grams. Projected survival to harvest is 85%. Stocking would occur during August through October of 2022. The fish would reach harvestable sizes the following year (approximately 14 to 16 months post seawater entry). Harvesting would be expected to begin in the September to November 2023 time frame.

Harvests would occur approximately two (2) to three (3) times per week and be carried out during daylight hours. Seafood market conditions can influence harvesting schedules and the volume of fish harvested from the pens each week. Assuming average harvesting rates and 12 volumes of 2-3 harvest per week, the fish harvesting portion of the production cycle would occur over a period of 10 to 16 weeks once the population reaches the targeted harvest size. Each individual fish harvesting operation, where the fish in the pen are seined up and are actively being removed from the pen takes approximately 2-3 hours to complete. During the harvesting process a seine net is deployed inside the fish pen and pulled through the pen to collect and crowd the fish toward one end of the pen. The seine net is pulled up to the surface and a suction hose is lowered into the corner of the seine net to begin pumping the harvest fish into the vessel. The vacuum pump moves both fish and water onto the vessel and into a dewatering box. The dewater box has round aluminum bars spaced approximately 1" apart that dewaters the discharge end of the vacuum pump. The harvest fish slide over the aluminum bar grating and into a chute that directs them into the fish holds of the vessel. Capture of non-target species is expected to be low as any small juvenile non-target fish fall through the grating and be released over the side of the vessel with the excess water from the dewatering box. During the harvesting operation, an employee would monitor and record the number and species of any non-target fish species they observe getting past the dewatering box and entering the fish holds of the vessel.

The number and species of any by-catch captured during the harvest loading process would be reported to WDFW. It should be noted that the fish vacuum pump being used for the harvest process is specifically designed to move live fish without causing damage to them during the transfer process. The same vacuum pump is used to transfer the juvenile hatchery fish coming from the hatchery out of the vessel's fish hold and into the pens during the initial fish stocking of the pens. From experience, very little, if any, mechanical damage and transfer mortality are associated with this vacuum pump in moving juvenile sized and larger sized of fish.

Copies of the Cooke Fish Escape Prevention and Fish Escape Response and Reporting Plans are on file with WDFW, WDOE and WDNR. These plans are periodically reviewed and updated as needed with input from the agencies and area tribes. Updates to the plans are sent to the agencies and tribal resource managers when they occur. The plans and other emergency contact lists are posted at the marine farm site offices and employees are periodically trained on the plans and procedures incorporated into the plans. Any fish escape event from the net pens is to be immediately reported to the agencies. Fish escape prevention, response and reporting procedures are described in the company's Fish Escape Prevention, Fish Escape Response and Fish Escape Reporting Plans. Copies of this plans are available upon request.

The operation of the marine farming facilities incorporates newly updated and substantially increased state agency oversight and routine inspections. Marine aquatic finfish farms have adopted and implemented new procedures and best management practices that meet the new regulations (e.g. those required by Ecology[2] and WDFW[3,4]) and safeguard the facilities. New fish rearing technologies and equipment, along with increased equipment inspections, additional record keeping and reporting, increased communication and transparency with regulatory agencies, computer modeling and mooring analysis, site specific Doppler current studies, structural integrity assessments by approved professional engineering firms, and a significant number of other compliance and mitigation measures that have been developed in the past few years to reduce and eliminate risks of fish escapement. Improved communications with tribal resource managers have also been developed and improved upon over the past several years. The company has invested and will continue to invest in new technologies and new equipment that helps to prevent fish escapes from occurring in the first place. Examples of these investments are new and stronger netting materials, new predator barrier systems, routine structural engineering and mooring analysis, and the replacement of equipment with new equipment all help to increase the margin of safety for these facilities and to reduce escapement risks.

As described in the BE, the facility operates under the conditions of an NPDES permit that is issued by Ecology to the operator of the finfish rearing facility. Routine benthic monitoring and discharge limitations are key requirements of the permit along with many other operational requirements designed to prevent, reduce, or eliminate water quality and benthic impact. Fish feed, metabolic waste, and disease control chemicals are all considered potential water quality pollutants produced by a net pen facility. NPDES permits require permittees to perform sediment, water quality, and fish escape monitoring and reporting, enhanced emergency response planning and training, pollution prevention, net hygiene reporting, regular maintenance, and routine structural assessments performed by licensed professional engineers. Additional information provided by the Corps to NMFS on September 7, 2022, including Cooke's 2021 Escape Prevention Plan, describes maintenance and mitigation measures to prevent escapes.

Net pen facilities undergo routine Water Quality Compliance Inspections that are performed by Ecology staff, which includes in-person inspection of the farm site to review record keeping, storage practices, waste handling and disposal, and the many other pollution prevention procedures that are incorporated into the farming practices at each farm site. The BE describes the Orchard Rocks facility as having an excellent WQ Compliance Inspection record.

The Orchard Rocks site has been in operation since being first permitted around 1986. Benthic monitoring has been carried out around this facility since the start of operations. During the mid-1990's, Ecology developed Sediment Management Standards (SMS) to monitor and regulate for the potential impacts coming from the operation of marine net pens facilities in PS. The SMS prescribe compliance monitoring for benthic impact at the 100-foot perimeter from the outer edge of a farm, which is defined as the sediment impact zone (SIZ). Current sediment impact zone compliance relies on Total Organic Carbon (TOC) as the initial indicator of benthic

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[2] Ecology. 2022. Salmon net pen water quality permits website: https://ecology.wa.gov/Water Shorelines/Shoreline-coastal-management/Aquaculture/Net-pens. Accessed October 14, 2022.
[3] WDFW. 2020a. Justification for the Mitigated Determination of Non-Significance (MDNS) for Washington Department of Fish and Wildlife SEPA 19-056 and for the Approval of Cooke Aquaculture Pacific's Marine Aquaculture Permit Application. WDFW, Olympia, WA. January 21, 2020.
[4] WDFW. 2020b. WDFW approves permit to farm sterile rainbow trout/steelhead in Washington waters. Archived news release. January 22, 2020. Available at: https://wdfw.wa.gov/news/wdfw-approves-permit-farm-sterile-rainbow-troutsteelhead-washington-waters. Accessed October 14, 2022.

impacts. Analysis of the sample station sediment TOC values must be shown to be equal to, or below TOC levels in the SMS criteria for the station to pass the test. Sediment TOC levels found at the 100-foot perimeter of a net pen facility must be no different than naturally occurring TOC levels which are found in PS reference area sediments. Any station statistically exceeding the TOC criteria at the 100' foot SIZ is required to perform follow up exceedance monitoring at the 100' SIZ and an additional 125' station to look for ongoing effects. If the station continues to fail the TOC criteria, mitigation measures such as reduced biomass, reduced feeding, or fallowing can be required to bring the sediments back into compliance.

The BE reports that the benthic environment surrounding the Orchard Rocks facility can be categorized as non-depositional as they are subject to the strong tidal currents of Rich Passage. According to the BE, there have been no observations or reports by the professional consultants that perform the sediment sampling, sediment analysis and report writing for the NPDES monitoring process that indicated signs of excess nutrient loading and anoxic benthic conditions. The Orchard Rocks site has been fallow since late 2020 for production related reasons. No feeding or fish rearing activities have occurred at this location for nearly two years. Routine summer sediment sampling will occur again this August as required, and results reported to Ecology by January 31.

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 Corps determined the proposed action is not likely to adversely affect [*list species*] or their critical habitat. Our concurrence 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 designations of critical habitat for PS Chinook salmon, PS steelhead, PS/GB bocaccio and PS/GB yelloweye rockfish use 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.

The proposed action only includes the remaining portions of the project—the proposed pulling of four remaining anchors for inspection, refitting and redeployment in the same location, as described in Section 1.3 (Proposed Federal Action). However, since the proposed action results in the future presence of the Orchard Rocks net pen facility and finfish rearing operations occurring at the site, we analyze effects of the long-term presence and operation of the facility. Effects of the Orchard Rocks net pen facility presence and its operations, including maintenance activities, are considered in a Biological Opinion (WCRO-2018-00286, signed February 16, 2022[5]) completed for the Environmental Protection Agency's (EPA's) approval of Ecology's

[5] WCRO-2018-00286; Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-

sediment management standards (WAC 173-204-412) regarding marine finish rearing facilities in the PS. The current proposed action by the Corps as well as the previous action by the EPA both result in, and are considered to independently cause the effects of the ongoing presence and operation of the net pen facility. Furthermore, both action agencies (EPA and Corps) have an individual duty under the ESA to consult on their proposed actions. However, because effects of the Orchard Rocks net pen facility presence and operation are assessed in the EPA sediment standards biological opinion, much of our effects analysis in this present biological opinion is by reference to the WCRO-2018-00286 biological opinion. We have described within Section 2.5 (Effects of the Action) where our analyses are by reference.

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

Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Environmental Protection Agency's Approval of Washington State Department of Ecology's Sediment Management Standards (WAC 173-204-412) Regarding Marine Finfish Rearing Facilities.

refuges (both flow and temperature) and improving growth opportunity in both freshwater and marine environments are strongly advocated in the recent literature (Siegel and Crozier 2020).

Climate change is systemic, influencing freshwater, estuarine, and marine conditions. Other systems are also being influenced by changing climatic conditions. Literature reviews on the impacts of climate change on Pacific salmon (Crozier 2015, 2016, 2017, Crozier and Siegel 2018, Siegel and Crozier 2019, 2020) have collected hundreds of papers documenting the major themes relevant for salmon. Here we describe habitat changes relevant to Pacific salmon and steelhead, prior to describing how these changes result in the varied specific mechanisms impacting these species in subsequent sections.

Forests

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

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

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

Freshwater Environments

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

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

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

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

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

Marine and Estuarine Environments

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

Rising ocean temperatures, stratification, ocean acidity, hypoxia, algal toxins, and other oceanographic processes will alter the composition and abundance of a vast array of oceanic species. In particular, there will be dramatic changes in both predators and prey of Pacific salmon, salmon life history traits and relative abundance. Siegel and Crozier (2019) observe that changes in marine temperature are likely to have a number of physiological consequences on fishes themselves. For example, in a study of small planktivorous fish, Gliwicz et al. (2018) found that higher ambient temperatures increased the distance at which fish reacted to prey. Numerous fish species (including many tuna and sharks) demonstrate regional endothermy, which in many cases augments eyesight by warming the retinas. However, Gliwicz et al. (2018) suggest that ambient temperatures can have a similar effect on fish that do not demonstrate this trait. Climate change is likely to reduce the availability of biologically essential omega-3 fatty acids produced by phytoplankton in marine ecosystems. Loss of these lipids may induce cascading trophic effects, with distinct impacts on different species depending on compensatory mechanisms (Gourtay et al. 2018). Reproduction rates of many marine fish species are also likely to be altered with temperature (Veilleux et al. 2018). The ecological consequences of these effects and their interactions add complexity to predictions of climate change impacts in marine ecosystems.

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

Climate change effects on salmon and steelhead

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

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

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

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

At the population level, the ability of organisms to genetically adapt to climate change depends on how much genetic variation currently exists within salmon populations, as well as how selection on multiple traits interact, and whether those traits are linked genetically. While genetic diversity may help populations respond to climate change, the remaining genetic diversity of many populations is highly reduced compared to historic levels. For example, Johnson et al. (2018), compared genetic variation in Chinook salmon from the Columbia River Basin between contemporary and ancient samples. A total of 84 samples determined to be Chinook salmon were collected from vertebrae found in ancient middens and compared to 379 contemporary samples. Results suggest a decline in genetic diversity, as demonstrated by a loss of mitochondrial haplotypes as well as reductions in haplotype and nucleotide diversity. Genetic losses in this comparison appeared larger for Chinook from the mid-Columbia than those from the Snake River Basin. In addition to other stressors, modified habitats and flow regimes may create unnatural selection pressures that reduce the diversity of functional behaviors (Sturrock et al. 2020). Managing to conserve and augment existing genetic diversity may be increasingly important with more extreme environmental change (Anderson et al. 2015), though the low levels of remaining diversity present challenges to this effort (Freshwater 2019). Salmon historically maintained relatively consistent returns across variation in annual weather through the portfolio effect (Schindler et al. 2015), in which different populations are sensitive to different climate drivers. Applying this concept to climate change, Anderson et al (2015) emphasized the additional need for populations with different physiological tolerances. Loss of the portfolio increases volatility in fisheries, as well as ecological systems, as demonstrated for Fraser River and Sacramento River stock complexes (Freshwater et al. 2019, Munsch et al. 2022).

2.2.1 Status of the Species

Table 1, below provides a summary of listing and recovery plan information, status summaries and limiting factors for the species addressed in this opinion. More information can be found in recovery plans and status reviews for these species. Acronyms appearing in the table include DPS (Distinct Population Segment), ESU (Evolutionarily Significant Unit), ICTRT (Interior Columbia Technical Recovery Team), MPG (Multiple Population Grouping), NWFSC (Northwest Fisheries Science Center), TRT (Technical Recovery Team), and VSP (Viable Salmonid Population).

Table 1 Listing classification and date, recovery plan reference, most recent status review, status summary, and limiting factors for each species considered in this opinion.

Species	Listing Classification and Date	Recovery Plan Reference	Most Recent Status Review	Status Summary	Limiting Factors
Puget Sound Chinook salmon	Threatened 6/28/05 (70 FR 37159)	Shared Strategy for Puget Sound 2007	NMFS 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 2019a	NMFS 2017; 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 PS 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 yelloweye Rockfish	Threatened 04/28/10	NMFS 2017c	NMFS 2016b	Yelloweye rockfish within the PS/GB (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Yelloweye rockfish spatial structure and connectivity is threatened by the apparent reduction of fish within each of the basins of the DPS. This reduction is probably most acute within the	• 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
				basins of PS proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range.	
Puget Sound/ Georgia Basin DPS of Bocaccio	Endangered 04/28/10	NMFS 2017c	NMFS 2016c	Though bocaccio were never a predominant segment of the multi-species rockfish population within the PS/GB, 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 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.	• Over harvest • Water pollution • Climate-induced changes to rockfish habitat • Small population dynamics

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 2, below.

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

Species	Designation Date and Federal Register Citation	Critical Habitat Status Summary
Puget Sound Chinook salmon	9/02/05 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/Georgia Basin DPS of yelloweye rockfish	11/13/2014 79 FR68042	Critical habitat for yelloweye rockfish includes 414.1 square miles of deepwater marine habitat in PS, all of which overlaps with areas designated for canary rockfish and bocaccio. No nearshore component was included in the CH listing for juvenile yelloweye rockfish as they, different from bocaccio and canary rockfish, typically are not found in intertidal waters (Love et al., 1991). Yelloweye rockfish are most frequently observed in waters deeper than 30 meters (98 ft) near the upper depth range of adults (Yamanaka et al., 2006). 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.
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 greatest extent of physical, chemical or biological effects stemming from the action is associated with potential movement of fish (biological) that could escape from the net pens into the PS. We assume that released or escaped rainbow trout/steelhead could move anywhere within (PS) and tributary rivers. The reasonably likely geographic extent of escaped fish include all tributary rivers to the PS, up to the lowermost year-round upstream fish passage barrier. Retrieval of escaped fish could occur in any or all of these locations. However, given the vast amount of available habitat for salmonids in the Pacific Ocean, and the relatively small number of escaped fish expected to reach the ocean, we do not expect any measurable or observable physical, chemical or biological effects to be caused by the escaped fish beyond the PS. For this consultation, the action area is all of PS, which is defined as all waters in the PS, including the Georgia Basin and the Strait of Juan de Fuca (SJDF) to the mouth of the Strait (Cape Flattery), and tributary rivers (Figure 1).

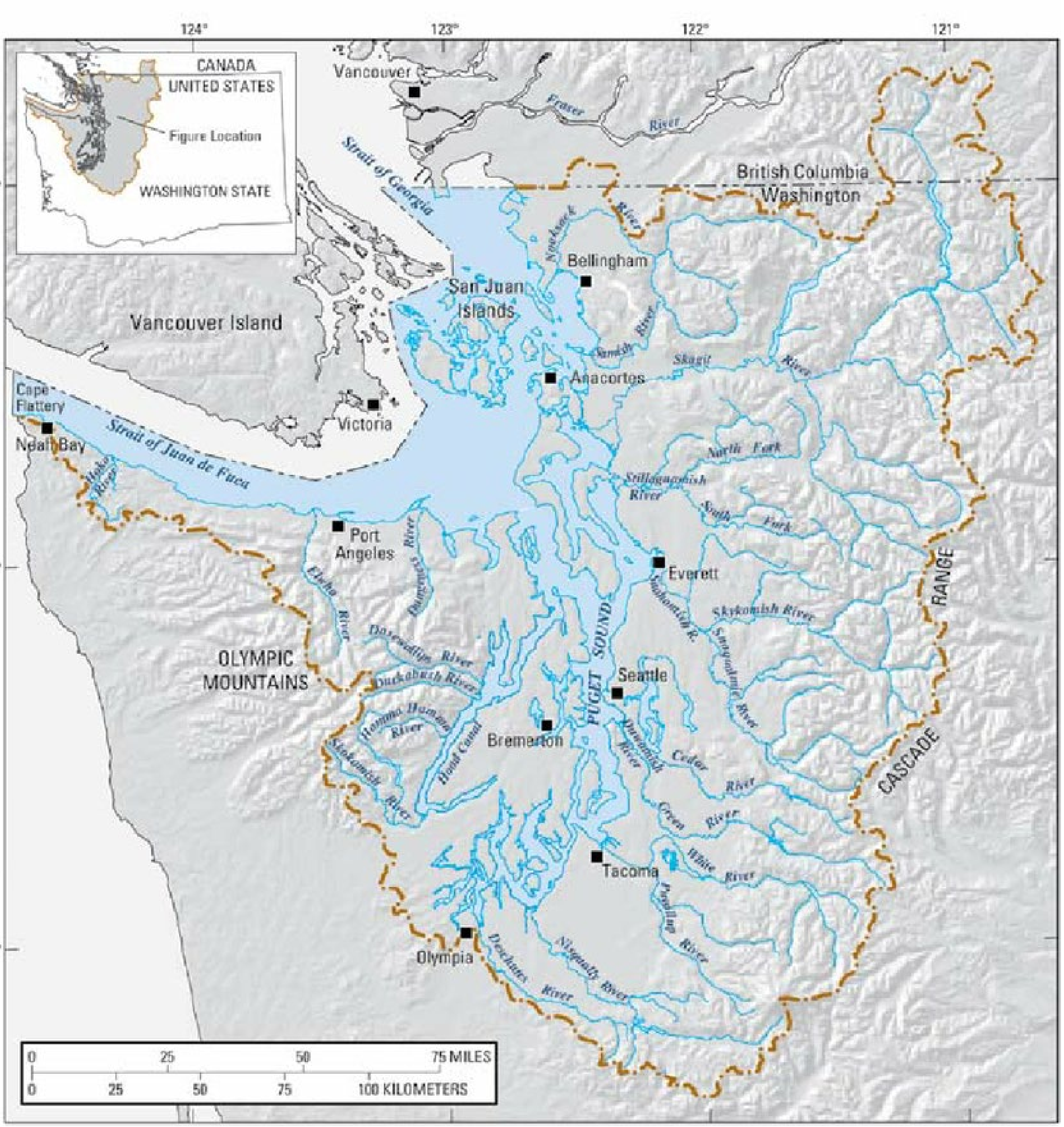

Figure 1. Action Area – Marine waters of PS (as defined to include the SJDF and Georgia Basin) and major tributary rivers, to the westernmost extent of the SJDF that defines the action area. Note that the dashed line delineates the United States - Canada jurisdictional boundary, but does not define the action area. Source: Shipman 2008.

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).

PS is one of the largest estuaries in the United States, having over 2,400 miles of shoreline, more than two million acres of marine waters and estuarine environment, and a watershed of more than 8.3 million acres. In 1987, PS was given priority status in the National Estuary Program. This established it as an estuary of national significance under an amendment to the Clean Water Act. In 2006, the Center for Biological Diversity recognized the PS Basin as a biological hotspot with over 7,000 species of organisms that rely on the wide variety of habitats provided by PS (Center for Biological Diversity 2006). The action area includes all populations of the PS ESU of Chinook salmon and the PS DPS of steelhead.

The State of the Sound biannual report produced by the Puget Sound Partnership (PSP) (PSP et al. 2019) summarizes how different indicators of health of the PS ecosystem are changing.[6] The assessment identifies that PS marine and freshwater habitats continue to face impacts of accelerating population growth, development, and climate change; and that few of the 2020 improvement targets (including habitat for ESA-listed salmonids and rockfish) identified by the PSP are being reached.

Over the last 150+ years, 4.5 million people have settled in the PS region. There is a suite of impacts of human development on aquatic habitat conditions in the PS, including water quality effects of stormwater runoff, industrial pollutants and boats, in-water noise from boats and construction activities, and fishing pressure, to name a few (see SSDC 2007; Hamel et al. 2015). With the level of infrastructure development associated with population growth, the PS nearshore has been altered significantly. Major physical changes documented in the PS include the simplification of river deltas, the elimination of small coastal bays, the reduction in sediment supply to the foreshore due to beach armoring, and the loss of tidally influenced wetlands and salt marsh (Fresh et al. 2011).

The Puget Sound Nearshore Ecosystem Restoration Project (PSNERP), an investigation project between the Corps and the state of Washington, reviewed the historical changes to PS's shoreline environment between 1850-1880, and 2000-2006, and found the most pervasive change to PS to be the simplification of the shoreline and reduction in natural shoreline length (Simenstad et al. 2011). Recent studies have estimated the loss of nearshore habitat in PS at close to 85 percent or more (Brophy et al. 2019). Throughout PS, the nearshore areas have been modified by human activity, disrupting the physical, biological, and chemical interactions that are vital for creating and sustaining the diverse ecosystems of PS. The shoreline modifications are usually intended for erosion control, flood protection, sediment management, or for commercial, navigational, and

[6] The Puget Sound Partnership tracks 52 vital sign indicators to measure progress toward different Puget Sound recovery goals. Of the 6 Puget Sound recovery goals, the most relevant for this Opinion include: Thriving species and food webs, Protected and Restored Habitat, Healthy Water Quality and Quantity.

recreational uses. Seventy-four percent of shoreline modification in PS consists of shoreline armoring (Simenstad et al. 2011), which usually refers to bulkheads, seawalls, or groins made of rock, concrete, or wood. Other modifications include jetties and breakwaters designed to dissipate wave energy, and structures such as tide gates, dikes, and marinas, overwater structures, including bridges for railways, roads, causeways, and artificial fill. An analyses conducted in 2011 though the Puget Sound Nearshore Ecosystem Restoration Project (Fresh et al. 2011; Simenstad et al. 2011) found that since 1850, of the approximately 2,470 miles of PS shoreline:

- Shoreline armoring has been installed on 27 percent of PS shores.
- One-third of bluff-backed beaches are armored along half their length. Roads and nearshore fill have each affected about 10 percent of the length of bluff-backed beaches.
- Forty percent of PS shorelines have some type of structure that impacts habitat quality.
- Conversion of natural shorelines to artificial shoreforms occurred in 10 percent of PS.
- There has been a 93 percent loss of freshwater tidal and brackish marshes. The Duwamish and Puyallup rivers have lost nearly all of this type of habitat.
- A net decline in shoreline length of 15 percent as the naturally convoluted and complex shorelines were straightened and simplified. This represents a loss of 1,062 km or 660 miles of overall shoreline length.
- Elimination of small coastal embayments has led to a decline of 46 percent in shoreline length in these areas.
- A 27 percent decline in shoreline length in the deltas of the 16 largest rivers and a 56 percent loss of tidal wetlands in the deltas of these rivers.

Effects of shoreline armoring on nearshore and intertidal habitat function include diminished sediment supply, diminished organic material (e.g., woody debris and beach wrack) deposition, diminished over-water (riparian) and nearshore in-water vegetation (SAV), diminished prey availability, diminished aquatic habitat availability, diminished invertebrate colonization, and diminished forage fish populations (see Toft et al. 2007; Shipman et al. 2010; Sobocinski et al. 2010; Morley et al. 2012; Toft et al. 2013; Munsch et al. 2014; Dethier et al. 2016). Shoreline armoring often results in increased beach erosion waterward of the armoring, which, in turn, leads to beach lowering, coarsening of substrates, increases in sediment temperature, and reductions in invertebrate density (Fresh et al. 2011; Morley et al. 2012; Dethier et al. 2016).

The reductions to shallow water habitat, as well as reduced forage potential resulting from shoreline armoring may cause juvenile salmonids and juvenile bocaccio to temporarily utilize deeper habitat, thereby exposing them to increased piscivorous predation. Typical piscivorous juvenile salmonid and bocaccio predators, such as flatfish, sculpin, and larger juvenile salmonids, being larger than their prey, generally avoid the shallowest nearshore waters that outmigrant juvenile salmonids and juvenile bocaccio prefer. When juvenile salmonids temporarily leave the relative safety of the shallow water, their risk of being preyed upon by other fish increases. This has been shown in the marine environment where juvenile salmonid consumption by piscivorous predators increased fivefold when juvenile pink salmon were forced to leave the shallow nearshore (Willette 2001).

In addition to beach armoring, other shoreline changes including overwater structures (i.e. piers and floats), marinas, roads, and railroads reduce habitat quantity and quality, and impact nearshore salmonid migrations and juvenile bocaccio rearing. The prevalence of overwater structures (e.g., piers, ramps and floats) in the PS nearshore has also altered nearshore habitat conditions. Schlenger et al. (2011) mapped 8,972 separate overwater structures in the PS, with a total overwater coverage of 9 square kilometers. These structures, as well as turbidity from boat propeller wash typically associated with them, decrease light levels in the water column and reduce primary productivity and growth of submerged aquatic vegetation (Fresh et al. 2001; Kelty and Bliven 2003; Shafer 1999, 2002; Haas et al. 2002; Eriksson et al. 2004; Mumford 2007). This reduces forage potential and cover for juvenile fish, including ESA-listed salmonids and bocaccio. In addition to reduced cover, shading by overwater structures may also delay salmonid migration and further increase predation risk (Heiser and Finn 1970; Able et al. 1998; Simenstad 1988; Nightingale and Simenstad 2001; Willette 2001; Southard et al. 2006; Toft et al. 2013; Ono 2010). The biological opinions completed by NMFS on Regional General Permit 6 (RGP6) for structures in the PS (NMFS 2016a) and on a batch of 39 projects in the nearshore environment of PS (NMFS 2020a) provide detailed summaries of the effects of overwater structures, shoreline armoring and other nearshore structures on ESA-listed species and designated critical habitat in PS.

Benthic habitats within PS, where PS rockfish primarily occur, have been influenced by a number of factors. The degradation of some rocky habitat, loss of eelgrass and kelp, introduction of non-natural-origin species that modify habitat, and degradation of water quality are threats to marine habitat in PS (Palsson et al. 2009; Drake et al. 2010). Some benthic habitats have been impacted by derelict fishing gear that include lost fishing nets, and shrimp and crab pots (Good et al. 2010). Derelict fishing gear can continue “ghost” fishing and is known to kill rockfish, salmon, and marine mammals as well as degrade rocky habitat by altering bottom composition and killing numerous species of marine fish and invertebrates that are eaten by rockfish (Good et al. 2010). Thousands of nets have been documented within PS and most have been found in the San Juan Basin and the Main Basin. The Northwest Straits Initiative has operated a program to remove derelict gear throughout the PS region. In addition, WDFW and the Lummi, Stillaguamish, Tulalip, Nisqually and Nooksack tribes and others have supported or conducted derelict gear prevention and removal efforts. Net removal has mostly concentrated in waters less than 100 feet (33 m) deep where most lost nets are found (Good et al. 2010). The removal of over 4,600 nets and over 3,000 derelict pots have restored over 650 acres of benthic habitat, though many derelict nets and crab and shrimp pots remain in the marine environment. Several hundred derelict nets have been documented in waters deeper than 100 feet deep (Drinkwin and Antonelis 2014). Over 200 rockfish have been documented within recovered derelict gear. Because habitats deeper than 100 feet (30.5 m) are most readily used by adult yelloweye rockfish and bocaccio, there is an unknown impact from deepwater derelict gear on rockfish habitats within PS.

Over the last century, human activities have introduced a variety of toxins into the Georgia Basin at levels that can affect adult and juvenile salmonid and rockfish habitat, and/or the prey that support them. Along shorelines, human development has increased nutrient loads from failing septic systems, and from use of nitrate and phosphate fertilizers on lawns and farms (Shared Strategy for Puget Sound 2007). The combination of runoff from highways and dense residential, commercial and industrial development has further degraded chemical characteristics of the PS marine environment (HCCC 2005; Shared Strategy for Puget Sound 2007; PSEMP 2017;

PSEMP 2019). Toxic pollutants in PS include oil and grease, polychlorinated biphenyls (PCBs), phthalates, polybrominated diphenyl ethers (PBDEs), and heavy metals that include zinc, copper, and lead. In addition to degraded water quality, about 32 percent of the sediments in the PS region are considered to be moderately or highly contaminated (PSAT 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Sanga 2015).

Mackenzie et al. (2018) found that stormwater is the most important pathway to PS for most toxic contaminants, transporting more than half of the PS's total known toxic load (Ecology and King County 2011). During a robust PS monitoring study, toxic chemicals were detected more frequently and at higher concentrations during storm events compared with base flow for diverse land covers, pointing to stormwater pollution (Ecology 2011). The PS basin has over 4,500 unnatural surface water and stormwater outfalls, 2,121 of which discharge directly into the Sound (WDNR 2015).

In general, the pollutants in the existing stormwater discharge are diverse. The discharge itself comes from rainfall or snowmelt moving over and through the ground, also referred to here as "runoff." As the runoff travels along its path, it picks up and carries away natural and anthropogenic pollutants. Pollutants in stormwater discharge typically include the following (Buckler and Granato 1999; Colman et al., 2001; Strecker et al., 1990; Kayhanian et al., 2003; Van Metre et al., 2006; Stokstad 2020; Tian et al., 2021):

- Excess fertilizers, herbicides, insecticides and sediment from landscaping areas.
- Chemicals and salts from de-icing agents applied on sidewalks, driveways, and parking areas.
- Oil, grease, PAHs, tire rubber-derived chemicals and other toxic chemicals from roads and parking areas used by motor vehicles.
- Bacteria and nutrients from pet wastes and faulty septic systems.
- Metals (arsenic, copper, chromium, lead, mercury, and nickel) and other pollutants from the pesticide use in landscaping, roof runoff (WDOE 2014), decay of building and other infrastructure, and particles from street and tire wear.
- Atmospheric deposition from surrounding land uses.
- Metals, PAHs, PBDEs, and phthalates from roof runoff.
- Erosion of sediment and attached pollutants due to hydromodification.

The environmental baseline would also include the projected effects of climate change for the time period commensurate with the effects of the proposed actions. Mauger et al. (2015) predict that circulation in PS is projected to be affected by declining summer precipitation, increasing sea surface temperatures, shifting streamflow timing, increasing heavy precipitation, and declining snowpack. While these changes are expected to affect mixing between surface and deep waters within PS, it is unknown how these changes will affect upwelling. Changes in precipitation and streamflow could shift salinity levels in PS by altering the balance between freshwater inflows and water entering from the North Pacific Ocean. In many areas of PS, variations in salinity are also the main control on mixing between surface and deep waters. Reduced mixing, due to increased freshwater input at the surface, can reduce phytoplankton growth, impede the supply of nutrients to surface waters, and limit the delivery of dissolved oxygen to deeper waters. Patterns of natural climate variability (e.g., El Niño/La Niña) can also influence PS circulation via changes in local surface winds, air temperatures, and precipitation.

All three ESA-listed PS salmonids were classified as highly vulnerable to climate change in a recent climate vulnerability assessment (Crozier et al., 2019). In estuarine environments, the two greatest concerns associated with climate change are rates of sea-level rise and temperature warming (Wainwright and Weitkamp 2013; Limburg et al., 2016). While the effects of climate change-induced ocean acidification on invertebrate species are well known, the direct exposure effects on salmon remains less certain (Crozier et al. 2019).

The world's oceans are becoming more acidic as increased atmospheric CO_2 is absorbed by water. The North Pacific Ocean is already acidic compared to other oceans, making it particularly susceptible to further increases in acidification (Lemmen et al., 2016). Laboratory and field studies of ocean acidification show it has the greatest effects on invertebrates with calcium-carbonate shells, and relatively little direct influence on finfish; see reviews by Haigh et al. (2015) and Mathis et al. (2015). Consequently, the largest impact of ocean acidification on salmon is likely to be its influence on marine food webs, especially its effects on lower trophic levels, which are largely composed of invertebrates such as pteropods, larval crabs, and krill, which play a significant role in some salmon diets (Haigh et al., 2015; Mathis et al., 2015; Wells et al., 2012). Marine invertebrates fill a critical gap between freshwater prey and larval and juvenile marine fishes, supporting juvenile salmon growth during the important early-ocean residence period (Daly et al., 2009, 2014).

Physiological effects of acidification may also impair olfaction, which could hinder homing ability (Munday et al., 2009), along with other developmental effects (Ou et al., 2015). Using the criteria of Morrison et al. (2015) for scoring, PS Chinook salmon and PS steelhead had low-to-moderate sensitivity to ocean acidification (Crozier et al., 2019).

The same document states that "sea level rise is projected to expand the area of some tidal wetlands in PS but reduce the area of others, as water depths increase and new areas become submerged. For example, the area covered by salt marsh is projected to increase, while tidal freshwater marsh area is projected to decrease. Rising seas will also accelerate the eroding effect of waves and surge, causing unprotected beaches and bluffs to recede more rapidly. The rate of sea level rise in PS depends both on how much global sea level rises and on regionally-specific factors such as ocean currents, wind patterns, and the distribution of global and regional glacier melt. These factors can result in higher or lower amounts of regional sea level rise (or even short-term periods of decline) relative to global trends, depending on the rate and direction of change in regional factors affecting sea level" (Mauger et al. 2015).

Human development in the PS region has also had significant impacts on tributary rivers. Loss of riparian habitat, decreased habitat complexity, elevated water temperatures, elevated nutrient levels, increased nitrogen and phosphorus and higher levels of turbidity have been documented in many PS tributaries (Shared Strategy for PS 2007). Increased peak stream flows as a result of increased runoff, simplified and extended drainage networks, loss of wetlands and deforestation causes substrate coarsening and decreases large wood in rivers, reducing habitat quality for spawning and rearing salmonids.

Clearing or other disturbance of riparian vegetation for roads and new developments, as well as for timber further diminishes riverine habitat quality. Often, the species that have recolonized these areas include invasive species like reed canary grass and Himalayan blackberry that provide substantially reduced stream shade and large wood recruitment (Shared Strategy for Puget Sound 2007). In the PS region, forest habitats continue to be lost (PSP et al. 2017). Decreased riparian vegetation typically destabilizes slopes leading to bank erosion, which alters stream channel morphology and can reduce the quality of spawning and rearing habitat for juvenile salmonids (Hartman et al. 1996).

Diking revetments, railroads and roads have caused significant loss of side channel habitats, channel confinement and incision, and reduced floodplain connectivity. Side channel habitats and floodplains create complex and diverse habitats that provide refugia from mainstem high flows, reduce competition for food and space, provide productive feeding areas, improve predator avoidance, and thus improve growth and survival (see Hall et al. 2007; Naiman et al. 2010; Martens and Connolly 2014). Reduced channel complexity, side channel formation and floodplain connectivity results in a significant loss of juvenile salmonid rearing and refuge habitat. Disconnecting the river channel from the floodplain also has negative impacts on nutrient cycling, system productivity, and biodiversity (Winemiller 2004). It also eliminates the recharge function that floodplains ensure by providing a source of cooler water in summer months and warmer water during winter months (Poole and Berman 2001).

Fish passage barriers, including those created by dams, culverts and weirs, have impeded the migration of native species, including access to important salmonid spawning and rearing habitat in many river systems in the PS region (Chapman 1986; Northcote 1998; LeMoine and Bodensteiner 2014). Dams constructed for hydropower generation, irrigation, or flood control have also changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas (Shared Strategy for Puget Sound 2007). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

As described in Section 2.2 (Rangewide Status of the Species and Critical Habitats), climate change is and will continue to alter environmental conditions in the PS and tributary streams, exasperating the impacts of human development on ESA-listed species and critical habitat. Within the PS, sea level is likely to rise by 0.4 to 0.9 feet by 2050, and by 1 to 2.8 feet by 2100 (Miller et al. 2018). This is expected to result in increased coastal bluff erosion, larger storm surge, and groundwater intrusion (Miller et al. 2018). Where shoreline armoring prevents beach formation at these higher sea level elevations, the width of intertidal zones will be reduced, diminishing habitat for intertidal beach spawners, including forage species like surf smelt and sand lance (Krueger et al. 2010). It will also reduce shallow water habitat for juvenile salmonids, including PS Chinook salmon, PS steelhead, and juvenile PS/GB bocaccio.

Increasing average air temperatures will raise average surface water temperatures in the PS and tributary rivers. Coastal waters and the PS are expected to experience increasing but highly variable acidity, and increasing storm frequency and magnitude (Mote et al. 2014). Elevated ocean temperatures already documented for the Pacific Northwest are highly likely to continue during the next century, with sea surface temperature projected to increase by 1.0-3.7ºC by the end of the century (IPCC 2014). Habitat loss, shifts in species' ranges and abundances, and altered marine food webs could have substantial consequences to anadromous, coastal, and marine species in the Pacific Northwest (Tillmann and Siemann 2011, Reeder et al. 2013).

In the PS region, rivers will also be impacted by changes in mountain snowpack. Warming is expected to result in decreased snow pack, increased winter flows, and advanced timing of spring melt (Mote et al. 2014, Mote et al. 2016). We anticipate decreased summer precipitation, with, and more winter precipitation will be rain than snow (ISAB 2007; Mote et al. 2014). Earlier snowmelt will cause lower stream flows in late spring, summer, and fall, and water temperatures will be warmer (ISAB 2007; Mote et al. 2014). We also expect increases in the frequency of severe winter precipitation events (i.e., 20-year and 50-year events), in the western United States (Dominguez et al. 2012)

The combined effects of increasing air temperatures and decreasing spring through fall flows are expected to cause increasing stream temperatures. Overall, about one-third of the current cold-water salmonid habitat in the Pacific Northwest is likely to exceed key water temperature thresholds by the end of this century (Mantua et al. 2009). Higher temperatures will reduce the quality of available salmonid habitat for most freshwater life stages (ISAB 2007). Reduced flows will make it more difficult for migrating fish to pass physical and thermal obstructions, limiting their access to available habitat (Mantua et al. 2010; Isaak et al. 2012). Temperature increases shift timing of key life cycle events for salmonids and species forming the base of their aquatic foodwebs (Crozier et al. 2011; Tillmann and Siemann 2011; Winder and Schindler 2004). Higher stream temperatures will also cause decreases in dissolved oxygen and may also cause earlier onset of stratification and reduced mixing between layers in lakes and reservoirs, which can also result in reduced oxygen (Meyer et al. 1999; Winder and Schindler 2004; Raymondi et al. 2013). Higher temperatures are likely to cause several species to become more susceptible to parasites, disease, and higher predation rates (Crozier et al. 2008; Wainwright & Weitkamp 2013; Raymondi et al. 2013).

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

These changes will likely result in increased erosion and more frequent and severe coastal flooding, and shifts in the composition of nearshore habitats (Tillmann and Siemann 2011, Reeder et al. 2013). Estuarine-dependent salmonids such as chum and Chinook salmon are predicted to be impacted by significant reductions in rearing habitat in some Pacific Northwest coastal areas (Glick et al. 2007). Historically, warm periods in the coastal Pacific Ocean have coincided with relatively low abundances of salmon and steelhead, while cooler ocean periods have coincided with relatively high abundances, and therefore these species are predicted to fare poorly in warming ocean conditions (Scheuerell and Williams 2005; Zabel et al. 2006). This is supported by the recent observation that anomalously warm sea surface temperatures off the coast of Washington from 2013 to 2016 resulted in poor coho and Chinook salmon body condition for juveniles caught in those waters (NWFSC 2015). Changes to estuarine and coastal conditions, as well as the timing of seasonal shifts in these habitats, have the potential to impact a wide range of listed aquatic species (Tillmann and Siemann 2011, Reeder et al. 2013).

Historical harvest of salmon, steelhead and rockfish species has caused declines in PS populations. In the past, fisheries exploitation rates were generally too high for the conservation of many rockfish populations, and for naturally spawning salmon and steelhead populations. In response, over the past several decades, the co-managers have implemented strategies to manage fisheries to reduce harvest impacts and to implement harvest objectives that are more consistent with the underlying productivity of the natural populations. The effect of these overall reductions in harvest has been to improve the baseline condition and help to alleviate the effect of harvest as a limiting factor.

Since 2010, the state and Tribal fishery co-managers have managed Chinook salmon mortality in PS salmon and Tribal steelhead fisheries to meet the conservation and allocation objectives described in the jointly-developed 2010-2014 PS Chinook Harvest RMP (PSIT and WDFW 2010), and as amended in 2014 (Grayum and Anderson 2014; Redhorse 2014), 2015, 2016, and 2017, and 2018 (Grayum and Unsworth 2015; Shaw 2015; 2016; Speaks 2017). The 2010-2014 Puget Sound Chinook Harvest RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan for the PS Chinook ESU (NMFS 2011). Exploitation rates for most of the PS Chinook salmon management units have been reduced substantially since the late 1990s compared to years prior to listing (average reduction = -33%, range = -67 to +30%) (NMFS 2020b).

Fifty percent or more of the harvest of 8 of the 14 PS Chinook salmon management units occurs in salmon fisheries outside the Action Area, primarily in Canadian waters. Salmon fisheries in Canadian waters are managed under the terms of the Pacific Salmon Treaty (PST). Ocean salmon fisheries in contiguous U.S. federal waters are managed by NMFS and the PFMC, under the MSA and are managed under the terms of the PST. For salmon fisheries off of the Southeast coast of Alaska, in federal waters, the North Pacific Fisheries Management Council (NPFMC) delegates its management authority to the State of Alaska. These fisheries are also managed under the terms of the PST. The effects of these Northern fisheries (Canada and SEAK) on PS Chinook salmon were assessed in previous biological opinions (NMFS 2004; 2008; 2019b).

NMFS observed that previous harvest management practices likely contributed to the historical decline of PS steelhead, but concluded in the Federal Register Notice for the listing determination (72 FR 26732, May 11, 2007) that the elimination of the direct harvest of wild steelhead in the mid-1990s has largely addressed this threat. The recent NWFSC biological viability assessment concluded that current harvest rates on natural-origin steelhead continue to decline and are unlikely to substantially reduce spawner abundance of most PS steelhead populations (Ford 2022).

In many PS freshwater areas, with the exception of the Skagit River, the non-treaty harvest of steelhead occurs in recreational hook-and-line fisheries targeting adipose fin-clipped hatchery summer run and winter run steelhead. Washington State prohibits the retention of natural-origin steelhead (those without a clipped adipose fin) in recreational fisheries. Treaty fisheries typically retain both natural-origin and hatchery steelhead. The treaty freshwater fisheries for winter steelhead, with the exception of the Skagit River, target primarily hatchery steelhead by fishing during the early winter months when hatchery steelhead are returning to spawn and natural-origin steelhead are at low abundance. On April 11, 2018, NMFS approved a five-year, joint tribal and state plan for a treaty harvest and recreational catch and release fishery for natural-origin steelhead in the Skagit River basin under the ESA 4(d) rule (NMFS 2018). Average harvest rates on the same natural-origin steelhead populations have demonstrated a reduction to 1.38% in PS fisheries during the 2007/2008 to 2018/2019 time period, a 66% decline. These estimates include sources of non-landed mortality such as hooking mortality and net dropout.

To address impacts of harvest of rockfish populations, in 2010 the Washington State Fish and Wildlife Commission formally adopted regulations that ended the retention of rockfish by recreational anglers in PS and closed fishing for bottom fish in all waters deeper than 120 feet (36.6 m). On July 28, 2010, WDFW enacted a package of regulations for the closure of set net, set line, bottom and pelagic trawl, inactive pelagic trawl and inactive bottom fish pot fisheries by emergency rule for non-tribal commercial fisheries in PS in order to protect dwindling rockfish populations. As a precautionary measure, WDFW closed the above commercial fisheries westward of the listed rockfish DPSs' boundary to Cape Flattery. The WDFW extended the closure west of the rockfish DPSs' boundary to prevent commercial fishermen from concentrating gear in that area. The commercial fisheries closures were enacted on a temporary basis, but were permanently closed in February 2011. The pelagic trawl fishery was closed by permanent rule on the same date.

Hatchery programs have benefitted and harmed native-origin PS Chinook salmon, HCSR chum salmon, and PS steelhead. The central challenge of operating and managing hatchery programs is finding a balance between the risks and benefits of hatchery production for harvest or conservation. Hatchery production of Chinook salmon and steelhead can be an effective tool to increase fish abundance for conservation and harvest. However, hatcheries can also pose demographic, genetic, and ecological risks to these species. Risks and benefits of hatchery production are best evaluated in the context of the purpose of the hatchery program. Conservation of native populations is one purpose. The primary goal of Chinook salmon and steelhead conservation in PS is sustainable natural production of locally adapted fish throughout the accessible watersheds (Hard et al. 2015). Thus, to effectively achieve its goals, a conservation hatchery program must increase the abundance, productivity, spatial structure, and/or diversity of a natural-origin steelhead population. In contrast, some hatchery programs have a different goal: to provide harvest opportunities. These hatchery programs may be either integrated or segregated.

Interactions of hatchery and natural-origin Chinook salmon and steelhead pose different risks to abundance, productivity, genetic diversity, and fitness of fish spawning in the natural environment depending on how hatcheries are operated. A growing body of scientific literature, stemming from improved tools to assess parentage and other close genetic relationships on relative reproductive success of hatchery and natural-origin salmonids, suggests that strong and rapid declines in fitness of natural-produced fish due to interactions with hatchery-produced fish are possible (Araki et al. 2008; Christie et al. 2014). These studies have focused primarily on steelhead, Chinook salmon, coho salmon, and Atlantic salmon. Limited but growing evidence suggests that steelhead may be more susceptible to genetic risk (i.e., domestication) posed by hatchery propagation than other species (Ford et al. 2016). Further, because selective regimes and mortality differ dramatically between natural and cultured populations, some genetic change cannot be avoided (Waples 1999). These changes are difficult to predict quantitatively because there may be considerable variation in relative reproductive success among species, populations, and habitats, as well as temporal variability owing to environmental change.

A new role for hatcheries emerged during the 1980s and 1990s after naturally produced salmon and steelhead populations declined to unprecedented low levels. Because genetic resources that represent the ecological and genetic diversity of a species can reside in fish spawned in a hatchery, as well as in fish that spawn in the wild, hatcheries began to be used for conservation purposes (e.g., HCSR chum salmon). Such hatchery programs are designed to preserve the salmonid genetic resources until the factors limiting salmon and steelhead viability are addressed. Hatchery programs can also be used to help improve viability by increasing the number and spatial distribution of naturally spawning fish with returning hatchery adults. However, hatcheries are not a proven tool for achieving sustained increases in adult production (ISAB 2003), and the long-term benefits and risks of hatchery supplementation remain untested (Christie et al. 2014).

Because most hatchery programs are ongoing, the effects of each program are reflected in the most recent status reviews of the species (NWFSC 2015; NMFS 2017b), which was summarized in Section 2.2 of this opinion. In addition, for those hatchery programs NMFS has completed section 7 consultation on, their effects are included here in the environmental baseline. The review of HGMPs by NMFS ensures that all hatchery programs are consistent with the ESA. For those listed in Table 3, NMFS has concluded that these programs do not appreciably reduce the likelihood of survival and recovery, nor do they adversely modify critical habitat.

Table 3. Completed HGMP bundle consultations in PS and the SJDF.

HGMP Bundle	HGMP Name	Completion Date
Hood Canal Summer Chum	Quilcene NFH Supplementation	July 2002
	Hamma Hamma FH Supplementation	
	Lilliwaup Creek Supplementation	
	Union/Tahuya Supplementation/Reintroduction	
	Big Beef Creek Reintroduction	
	Chimacum Creek Reintroduction	
	Jimmycomelately Creek Reintroduction	
	Salmon Creek Supplementation	
Elwha	Lower Elwha Hatchery Native Steelhead	December 2012; Reinitiation December 2014
	Lower Elwha Hatchery Elwha Coho	
	Elwha Channel Hatchery Chinook	
	Lower Elwha Hatchery Elwha Chum	
	Lower Elwha Hatchery Pink	
Dungeness	Dungeness River Hatchery Spring Chinook	June 2016
	Dungeness River Hatchery Coho	
	Dungeness River Hatchery Fall Pink	
Snohomish	Tulalip Hatchery Chinook Sub-yearling	October 2017
	Wallace River Hatchery Summer Chinook	
	Wallace River Hatchery Coho	
	Tulalip Hatchery Coho	
	Tulalip Hatchery Fall Chum	
	Everett Bay Net Pen Coho	
	Wallace River Hatchery Chum Salmon Rescue Program	
Early Winter Steelhead #1	Kendall Creek Winter Steelhead	April 2016
	Dungeness River Early Winter Steelhead	
	Whitehorse Ponds Winter Steelhead	
Early Winter Steelhead #2	Snohomish/Skykomish Winter Steelhead	April 2016
	Snohomish/Tokul Creek Winter Steelhead	
Hood Canal	Hoodsport Fall Chinook	October 2016
	Hoodsport Fall Chum	
	Hoodsport Pink	
	Enetai Hatchery Fall Chum	
	Quilcene NF Hatchery Coho	
	Quilcene Bay Net Pens Coho	
	Port Gamble Bay Net Pens Coho	
	Port Gamble Hatchery Fall Chum	
	Hamma Hamma Chinook Salmon	
	Hood Canal Steelhead Supplementation	
Duwamish/Green	Soos Creek Hatchery Fall Chinook	January 2020
	Keta Creek Coho (w/Elliott Bay Net pens)	
	Soos Creek Hatchery Coho	
	Keta Creek Hatchery Chum	
	Marine Technology Center Coho	
	Fish Restoration Facility (FRF) Coho	
	FRF Fall Chinook	
	FRF Steelhead	
	Green River Native Late Winter Steelhead	
	Soos Creek Hatchery Summer Steelhead	

HGMP Bundle	HGMP Name	Completion Date
Stillaguamish	Stillaguamish Fall Chinook Natural Restoration	April 2020
	Stillaguamish Summer Chinook Natural Restoration	
	Stillaguamish Late Coho	
	Stillaguamish Fall Chum	

There are several enhancement net pen programs rearing native coho salmon in the PS that are operated by Tribes and WDFW. In these operations, as part of broader hatchery programs, juvenile coho salmon are reared for a short period of time (approximately four months) in marine net pens before being released into the PS to supplement PS coho stocks. These programs provide additional coho salmon for harvest in PS commercial and recreational fisheries, as well as tribal ceremonial harvest. Separate freshwater hatcheries hatch and rear coho salmon for each of these programs before transferring them to the marine net pens. These facilities are regulated by an EPA NPDES General Permit. ESA Section 7 and EFH consultation was completed for the proposed issuance of the General Permit in 2022.[7] Incidental take identified in the biological opinion are described below.

Net pens are also in operation at NOAA's Manchester Research Station in Clam Bay, near Manchester, WA to study aquaculture practices for rearing of sablefish. An ESA Section 7 and EFH consultation was completed in 2019 for proposed structural repairs and modifications being permitted by the United States Army Corps of Engineers.[8] The biological opinion identified incidental take in the form of death, injury or harassment of PS Chinook salmon, PS Steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio as a result of pile driving, over-water and in-water structure presence, and entrainment by pumps. The biological opinion concluded that the proposed action is not likely to jeopardize the continued existence ESA-listed species, or destroy or adversely modify their designated critical habitat.

The federal research net pen in the PS are also regulated by the EPA NPDES General Permit, and effects of operations at the Manchester Research facility were also analyzed in the ESA Section 7 consultation for the issuance of the General Permit described above for tribal enhancement net pens. As a result of tribal enhancement and federal research net pens, the General Permit biological opinion identified incidental take of PS Chinook salmon, PS steelhead, PS/GB bocaccio and PS/GB yelloweye rockfish in the form of death or injury as a result of discharge effects on forage and water quality, competition and predation with escaped fish, pathogen transmission from net pen fish, and entrainment in water pumps. The biological opinion concluded that the proposed action is not likely to jeopardize the continued existence ESA-listed species, or destroy or adversely modify their designated critical habitat. The effects of these federal and tribal facilities are part of the environmental baseline and as such are

[7] WCR-2021-03087; Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the NPDES General Permit for Tribal Enhancement and Federal Research Marine Net Pen Facilities Within Puget Sound, NPDES Permit No. WAG132000.
[8] WCRO-2019-00105; Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Replacement of a Pump Float, Removal and Relocation of Net Pens at NOAA's Manchester Research Lab in Puget Sound (NMFS 2019b).

considered in our jeopardy and adverse modification analysis in the Integration and Synthesis Section 2.7 below, consistent with 50 CFR 402.14(g)(4).

In addition to the sablefish net pen research operations and the coho enhancement programs, there are currently four operational commercial net pen facilities in PS, all operated by Cooke. Cooke also intends to farm all-female triploid rainbow trout/steelhead at all of their net pen facilities. Cooke has not yet applied for permits to rear sablefish in PS net pens, but it has expressed an intent to begin farming sablefish as a secondary crop to rainbow trout/steelhead in the future. An ESA Section 7 and EFH consultation was completed in 2022[9] for EPA's approval of Ecology's Sediment Management Standards (WAC 173-204-412) regarding marine finfish rearing facilities. The effects on ESA-listed species and critical habitat, and on EFH, from maintenance and operation of existing commercial net pens in the PS was assessed in the biological opinion. We consider any consequences caused by EPA's approval of Washington's sediment standards to be part of the baseline of this Opinion and as such, consider those effects, along with the rest of the environmental baseline described in this Section 2.4, in our Integration and Synthesis analysis below in Section 2.7, consistent with 50 CFR 402.14(g)(4). However, since that Biological Opinion (WCRO-2018-00286) was for a consultation on standards pertaining to net pens, but with no applicant (i.e., operator of the aquaculture facilities), the Incidental Take Statement of the biological opinion did not provide a take exemption to third parties that are subject to WAC-173-204, including the owners or operators of commercial marine finfish rearing facilities in the PS. As described in Section 2.1 (Analytical Approach), although effects of PS commercial net pen facility presence and operations, including the Orchard Rocks facility, were analyzed in that Opinion, the current proposed action also causes those effects.

The WCRO-2018-00286 Biological Opinion identified incidental take of PS Chinook salmon, PS steelhead, Hood Canal summer-run chum salmon, PS/GB bocaccio and PS/GB yelloweye rockfish in the form of death or injury as a result of discharge effects on forage and water quality, benthic disturbance effects on cover and forage from a structural failure, competition and predation by farm fish within and escaped from net pens, pathogen transmission from net pen fish, outbreeding depression and hatchery-influenced selection effects, and entrainment during harvest and in response to an escape event. The Biological Opinion concluded that the proposed action is not likely to jeopardize the continued existence ESA-listed species, or destroy or adversely modify their designated critical habitat. The effects of these PS commercial net pens are part of the environmental baseline and as such are considered in our jeopardy and adverse modification analysis in the Integration and Synthesis Section 2.7 below, consistent with 50 CFR 402.14(g)(4). As described later in Section 2.7 (Integration and Synthesis), we have analyzed effects of the current proposed action (a subset of those analyzed in WCRO-2018-00286), but we note here that the effects analyzed here are *not* additive to baseline conditions where the effects are already part of the baseline—i.e., effects of commercial net pen facility presence and operations included in the WCRO-2018-00286 Biological Opinion.

[9] WCRO-2018-00286; Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Environmental Protection Agency's Approval of Washington State Department of Ecology's Sediment Management Standards (WAC 173-204-412) Regarding Marine Finfish Rearing Facilities.

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).

We have based our assumptions about net pen operations on the information provided in this consultation for rainbow trout/steelhead farming at the Orchard Rocks, as well as other Cooke operations and maintenance planning documents, and other documentation required by state permits. For this Opinion, we analyze the short-term construction-related effects associated with the proposed inspection, maintenance and replacement structures. Because the long-term effects associated with the facility presence and its operation are consistent with effects analyzed in the WCRO-2018-00286 Biological Opinion, our analysis of those effects is by reference to that Opinion, as described below. Although effects of PS commercial net pen facility presence and operations are in the baseline, this proposed action for the Orchard Rocks facility also causes those effects by extending the life of the facility and associated operations. Structures, operations and conservation measures proposed at and expected to occur at the Orchard Rocks facility are consistent with the assumptions used in the effects analyses for the WCRO-2018-00286 Biological Opinion. Net pen facility and operation effects identified in that opinion are reasonably likely to result from the Orchard Rocks facility and operations. This is a conservative approach since the effects analysis in the WCRO-2018-00286 Biological Opinion included multiple net pen facilities and the present analysis applies only to the Orchard Rocks facility. Furthermore, the Orchard Rocks facility is smaller (fewer pens) and is proposed within this action to operate with fewer fish than we assumed for the effects analyses in the WCRO-2018-00286 Biological Opinion.

Based on calculations of the risk of large-scale net pen failures provided in the WCRO-2018-00286 Biological Opinion, we consider it reasonably likely that one large-scale failure event would occur at the Orchard Rocks facility over any 50-year period of time. Consistent with that Opinion, a large-scale failure event is defined as the escape and loss (i.e. not recaptured/recovered) of more than 29% of the maximum production number of fish (800,000) at the Orchard Rocks facility. Here we base our assumptions on the number of fish used in the WCRO-2018-00286 Biological Opinion, which was the maximum number of fish permitted (NPDES permit) at the Orchard Rocks facility. Although the facility is now smaller (fewer pens) and the capacity and proposed number of fish reduced, we use the larger number for consistency with the WCRO-2018-00286 Biological Opinion effects analysis integrated by reference in this present Opinion. Additionally, because this is the number permitted at the site, we also consider it reasonably likely that in the future a larger number than currently proposed could be reared at the facility.

This escape event that we consider reasonably likely at the Orchard Rocks facility in this current Opinion is not in addition to a the event considered reasonably likely in the other Opinion. We consider such an event to be reasonably likely to occur not more than once at the facility over any 50-year period of time. As described in the WCRO-2018-00286 Biological Opinion, we also anticipate smaller, but more frequent (episodic) escape events to occur during the life of the Orchard Rocks facility. Consistent with that Opinion, based on our review of literature, and information from Cooke, including practices implemented to prevent escapes, we conservatively estimate an escape rate of 0.3% of all fish reared. Other effects of the proposed action evaluated in this Opinion are those associated with the replacement and maintenance actions, and operations at the Orchard Rocks net pen facility.

2.5.1 Effects on Critical Habitat

We anticipate site-specific effects at the net pen locations associated with ongoing operations, as well as with escape of farmed fish into the environment as a result of large-scale structural failures and smaller leakage/escape events. Infrequent large-scale failures and more frequent smaller escape events are considered an effect of net pen operations in our analysis. As described in Section 2.3 (Action Area), escaped fish can travel throughout PS, as well as into rivers and streams that are tributaries to PS. The habitat effects, therefore, would range from intermittent short-term (e.g., temporary habitat disturbance resulting from net pen structural failures), to long term (e.g., habitat alterations resulting from regular net pen operations). Habitat effects that are reasonably likely to result from the presence and operation of the Orchard Rocks facility include effects on benthic conditions and sediment quality; water quality; and macroalgae. Our analysis of these habitat effects is provided by reference to the WCRO-2018-00286 Biological Opinion, and summarized below. In our analysis of this proposed action we have identified the same effects pathways that we previously identified in the WCRO-2018-00286 Biological Opinion, and we used the same assumptions about the Orchard Rocks facility and operations in our analyses of effects as used in the WCRO-2018-00286 Biological Opinion because, as we just explained above in the introductory text to Section 2.5, we consider those reasonably likely to occur.

As described in the WCRO-2018-00286 Biological Opinion, anticipated effects on habitat of the presence and operation of the Orchard Rocks facility are considered likely to result in the localized diminishment of the quality or quantity of the following PBFs of critical habitat:

- The forage PBF for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio;
- The cover PBF for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio; and
- The water quality PBF for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio.

It is reasonably likely that the proposed pulling of four remaining anchors for inspection, refitting and redeployment, as well as the placement of two additional anchors would result in slight localized reductions to the water quality PBF of critical habitat for PS Chinook salmon, PS/GB bocaccio and PS/GB yelloweye rockfish. We expect disturbance of the benthos by the proposed removal and placement of the anchors to result in suspension of the sediment and slightly elevated turbidity levels. Because the disturbance would be brief (short periods over approximately 4 days) and only at the six anchor locations, we expect any elevated turbidity levels to be highly localized, minor and brief, with water quality quickly returning to pre-disturbance conditions. This level of disturbance is comparative to that identified in the WCRO-

2018-00286 Biological Opinion from turbidity and benthic disturbance caused by replacement or maintenance of anchors and mooring lines, and by a net pen facility failure. We do not anticipate any measurable reduction in the conservation value of critical habitat as a result of this disturbance.

2.5.2 Effects on Listed Species

Effects on listed species may occur when individuals are exposed to changes in environmental conditions in the action area, and also from activities that directly affect individuals. Our analysis of these effects on species is provided by reference to the WCRO-2018-00286 Biological Opinion, and summarized below.

As described in the WCRO-2018-00286 Biological Opinion, anticipated effects on species resulting from the presence and operation of the Orchard Rocks facility (including infrequent failure events and more frequent small-scale escapes) are considered likely to affect species as follows:

- Indirect effects in response to habitat changes:
  - Harm from reduced forage for PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio;
  - Increased predation risk associated with reduced cover for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio; and
  - Harm from exposure to localized reduced water quality PBF for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio.

- Direct effects:
  - Predation of juvenile PS Chinook salmon, PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio by farm fish within net pens;
  - Entrainment of juvenile PS Chinook salmon, PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio during net pen harvest;
  - Entrainment or capture of juvenile and adult PS Chinook salmon, PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio during escape response;
  - Harm of juvenile and adult PS Chinook salmon, PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio by exposure to pathogens;
  - Reduced fitness and survival of PS steelhead from outbreeding depression; and
  - Harm of juvenile and adult PS Chinook salmon, PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio from competition with and predation by escaped farm fish.

We do not anticipate harm to individual PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish or PS/GB bocaccio to result from the proposed pulling of four remaining anchors for inspection, refitting and redeployment, nor the proposed placement of two additional anchors. Although fish may briefly avoid the anticipated highly localized turbidity plumes around anchors being actively displaced from or installed into the sediment, due to the brevity of the disturbance, we do not expect any harm to individual fish. This is consistent with the analysis of effects of turbidity from benthic disturbance during replacement or maintenance of anchors and mooring lines, and during benthic disturbance as a result of any future net pen failure provided in the WCRO-2018-00286 Biological Opinion.

2.5.3 Effects on Population Viability

We assess the importance of effects in the action area to the Evolutionarily Significant Units (ESUs)/Distinct Population Segments (DPS) by examining the relevance of the effects among individuals to the populations they comprise, through evaluating influence on the viability parameters of abundance, population growth rate (productivity), spatial structure, and diversity. While these characteristics are described as unique components of population dynamics, each characteristic exerts significant influence on the others. For example, declining abundance can reduce spatial structure and diversity of a population. Further, if effects were concentrated on individuals from a single population, the abundance in that population could decline sufficiently to reduce productivity, spatial structure, or diversity. When effects are likely to occur at lower levels across multiple populations, then the robustness or weakness of particular populations at a baseline level may yield different level of significance of those effects at the population scale. We expect all effects on population viability to consistent with those identified in the WCRO-2018-00286 Biological Opinion.

We anticipate that, as a consequence of the action, the presence and operation of the Orchard Rocks facility would have persistent negative effect on the habitat and individual fitness of PS Chinook salmon and PS steelhead, and that based on the location of the net pens and patterns of behavior upon the rare instances of escape, no particular population would be more significantly affected than any other. Because exposure is low for almost all of the effects, only minor changes in abundance are expected.

Among PS/GB bocaccio and PS/GB yelloweye rockfish we lack population structure and review at the species scale. However, with the low frequency of exposure to harmful effects of net pens anticipated we expect only small numbers of fish to be harmed.

Abundance

Although numbers cannot be ascertained, we expect very few PS Chinook salmon and PS steelhead to be injured or killed as a result of Orchard Rocks facility structures and operations. Juvenile salmonids are considered the most likely life-stage to be harmed (i.e. entrainment and predation). Juvenile fish killed would represent a decrease in abundance of an even smaller number of adults, based on typical low juvenile to adult survival of Chinook salmon (Duffy and Beauchamp 2011) and steelhead (Moore et al. 2015) in the PS. For example, Gamble et. al (2018) estimated marine survival of subyearling Chinook salmon in the PS to be between 0.18% and 11.7%. Moore et al. (2015) estimated that in the PS, only about 16% of wild and 11% of hatchery steelhead smolts survive the migration from the mouths of their natal rivers to the Pacific Ocean. Once in the ocean, many more would die before reaching adulthood and returning to natal streams to spawn.

A small number of juvenile PS Chinook salmon and PS steelhead are expected to be killed by entrainment, and by predation in net pens or by escaped fish. A very small number of adult PS Chinook salmon and PS steelhead are expected to be harmed or killed as a result of pathogens, competition for resources with escaped fish, genetic interaction, or entertainment during future escape response actions. Therefore, we do not anticipate any discernible effect on abundance of salmonids at the population level.

Similarly, while we cannot ascertain numbers, we anticipate a small number of PS/GB yelloweye rockfish and bocaccio to be harmed or killed as a result of the Orchard Rocks facility and operations. An extremely small number are expected to be killed as a result of changes to forage, cover or water quality, or as a result pathogen exposure, predation by farmed fish or competition with escaped fish. The most likely effect to result in harm or death is the entrainment of larval and juvenile rockfish by vacuum harvest.

We expect a small number of larval, and even smaller number of juvenile PS/GB bocaccio and yelloweye rockfish to be entrained and harmed or killed by vacuum harvest relative to the total population, and total volume of water in the PS that may contain larvae. Depending on size and age, a female yelloweye rockfish produces up to 2,700,000 larvae and bocaccio up to 2,298,000 larvae annually (Love et al. 2002; NMFS 2017a). Mortalities from entrainment would have a proportionally small effect on the overall DPS population abundance and productivity, with generally poor larval survival in the PS, and thus only a small number of larvae becoming reproductive adults (see NMFS 2017a). For example, a study by Canino and Francis (1989) showed that rockfish larvae experienced 70 percent mortality seven to 12 days after birth in a laboratory setting, without the risk of predation. The mean natural mortality rate for rockfish varies by species and environmental conditions. The mean natural mortality rate is approximately three percent per year for yelloweye rockfish and eight percent per year for bocaccio (see NMFS 2017a). Therefore, we do not anticipate any discernible effect of net pen facilities or operations on abundance of rockfish at the population level.

Productivity

As described above, we anticipate a small number of juvenile salmonids, and larval and juvenile rockfish to be harmed or killed as a result of Orchard Rocks facility effects. Given the low larval/juvenile to adult rate of survival for these species (Duffy and Beauchamp 2011; Moore et al. 2015; NMFS 2017a; Gamble et. al 2018), we do not anticipate any measurable effect on adult populations. We expect that an extremely small number of adult PS Chinook salmon and PS steelhead would be harmed or killed as a result of Orchard Rocks facility structures and operations. Therefore, we do not anticipate any discernible effect of the facility and operations on adult spawning and productivity of populations even when accounting for these chronic effects through time and climate change effects.

Spatial Structure and Diversity

With no overall declines in population abundance and productivity anticipated, we do not expect any decline in the spatial extent of habitat utilized for spawning, rearing or migration by PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish or PS/GB bocaccio. Salmonid populations spread across the nearshore and mix when they enter PS (Fresh 2006). Since the Orchard Rock net pens are not immediately at the mouth of any natal river, juvenile fish from multiple different populations may be exposed to localized net pen effects as they migrate through the PS to the Pacific Ocean. Therefore, we expect any effect of net pen facilities and operations on populations to be indiscriminate, with no effect on population spatial structure or diversity.

Although larvae rockfish are widely dispersed by currents, unique oceanographic conditions within the PS likely result in most larvae staying within the basin where they are released (Drake et al. 2010). Unlike ESA-listed salmonids, we have not identified biological populations of each species below the DPS level, instead we use the term "populations" to refer to groups within each of the five identified basins of the action area (See Section 2.2.1 Status of the Species). We expect that any larval and juvenile bocaccio and yelloweye rockfish harmed or killed as a result of net pen effects would primarily be from the PS Main basin since the Orchard Rocks facility is located in that basin. Given the relatively small number of larvae and juveniles expected to be harmed or killed, we do not anticipate a measurable effect of the net pen facility or its operations on population spatial structure or diversity.

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. Cumulative effects are consistent with those assessed in the WCRO-2018-00286 Biological Opinion, and are provided below.

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).

The action area, all waters of PS, the SJDF and tributary rivers, is influenced by actions within PS marine waters, along the shoreline, and in tributary watersheds. Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and PBFs, many of which are activities that have occurred in the recent past and had an effect on the environmental baseline. These can be considered reasonably certain to occur in the future because they occurred frequently in the recent past, especially if authorizations or permits have not yet expired. Within the freshwater portion of the action area, non-federal actions are likely to include human population growth, water withdrawals (i.e., those pursuant to senior state water rights), and land use practices. In marine waters within the action area, state, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives, shoreline growth management, and resource permitting. Private activities include continued resource extraction, vessel traffic, development, and other activities which contribute to poor water quality in the freshwater and marine environments of PS.

Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of a continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, although NMFS finds it likely that the cumulative effects of these activities will have adverse effects commensurate to those of similar past activities, as described in the Environmental Baseline, these effects may occur at somewhat higher or lower levels than those described in the Baseline.

Based on current trends, there will continue to be a net reduction in the total amount of shoreline armoring in PS (PSP 2019). Changes in tributary watersheds that are likely to affect the action area include reductions in water quality, water quantity, and sediment transport. Future actions in the tributary watersheds whose effects are likely to extend into the action area include operation of hydropower facilities, flow regulations, timber harvest, land conversions, disconnection of floodplain by maintaining flood-protection levees, effects of transportation infrastructure, and growth-related commercial and residential development. Some of these developments will occur without a federal nexus, however, activities that occur waterward of the OHWM require a COE permit and therefore involve federal activities, which are not considered in this section.

All such future non-federal actions, in the nearshore as well as in tributary watersheds, will cause long-lasting environmental changes and will continue to harm ESA-listed species and their critical habitats. Especially relevant effects include the loss or degradation of nearshore habitats, pocket estuaries, estuarine rearing habitats, wetlands, floodplains, riparian areas, and water quality. We consider human population growth to be the main driver for most of the future negative effects on salmon and steelhead and their habitat.

The human population in the PS region is experiencing a high rate of growth. The central PS region (Snohomish, King, Pierce and Kitsap counties) has increased from about 1.29 million people in 1950 to over 4.2 million in 2020, and projected to reach nearly 6 million by 2050 (PS Regional Council 2020). Thus, future private and public development actions are very likely 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 likely 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 likely 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.

Several not for profit organizations and state agencies are also implementing recovery actions identified in the recovery plans for PS Chinook salmon, PS steelhead, and PS/GB yelloweye rockfish and bocaccio. The state passed House Bill 1579 that addresses habitat protection of shorelines and waterways (Chapter 290, Laws of 2019 (2SHB 1579)), and funding was included for salmon habitat restoration programs and to increase technical assistance and enforcement of state water quality, water quantity, and habitat protection laws. Other actions included providing funding to the Washington State Department of Transportation to complete fish barrier corrections. Although these measures won't improve prey availability immediately, they are designed to improve conditions in the long-term.

Notwithstanding the beneficial effects of ongoing habitat restoration actions, the cumulative effects associated with continued development are likely to have ongoing adverse effects on all the listed salmonid and rockfish species addressed in this opinion, and abundance and productivity that outpace the effects of restoration activities. Only improved low-impact development actions together with increased numbers of restoration actions, watershed planning, and recovery plan implementation would be able to address growth related impacts into the future. To the extent that non-federal recovery actions are implemented and offset ongoing development actions, adverse cumulative effects may be minimized, but will probably not be completely avoided.

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 Effects to Critical Habitat

Critical Habitat is designated for PS Chinook salmon in freshwater and marine environments. Throughout the designated area, multiple features of habitat are degraded, but despite such degradation, many accessible areas remain ranked with high conservation value because of the important life history role it plays. Limiting factors (impaired or insufficient PBFs) include; riparian areas and LWD, fine sediment in spawning gravel, water quality, fish passage and estuary conditions. Loss of freshwater and nearshore critical habitat quality is a limiting factor for all three species. Current state and local regulations do not prevent much of the development that degrades the quality of nearshore critical habitats. There is no indication these regulations are reasonably certain to change in the foreseeable future.

Critical habitat for PS/GB bocaccio and yelloweye rockfish in the PS includes hundreds of square miles of deep-water and nearshore areas. Habitat has been degraded by, and continues to be threatened by, water pollution and runoff, nearshore development and in-water construction, dredging and disposal of dredged material, climate-induced changes to habitat and population dynamics, degradation of rocky habitat, loss of eelgrass and kelp, and the introduction of non-native species that modify habitat.

Given the rate of expected population growth in the PS area, cumulative effects are expected to result in mostly negative impacts on critical habitat quality for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio. While habitat restoration and advances in best management practices for activities that affect critical habitat could lead to some improvement of PBFs, adverse impacts created by the intense demand for future development is likely to outpace any improvements.

To this degraded baseline, including anticipated cumulative effects and the effects of tribal enhancement and federal research net pen facilities[10], and commercial net pen facilities[11], evaluated previously, we add the habitat effects we expect to result from the proposed action, or in this case, consequences of the action (Orchard Rocks facility structures and operations). However, the effects of the proposed action are not additive to effects associated with the Orchard Rocks facility and its operation previously assessed in the WCRO-2018-00286 Biological Opinion, which are considered part of the baseline. Instead, the proposed action causes the effects analyzed in the WCRO-2018-00286 Biological Opinion that result from the Orchard Rocks facility and its operation. The WCRO-2018-00286 Opinion also analyzed effects of other commercial aquaculture net pen operations (three additional Cooke facilities), which are also part of the baseline. Because the Orchard Rocks site is within and/or in close proximity to critical habitat for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio, we anticipate that the proposed maintenance activities and the long-term presence of the facility and its operation would directly degrade quality of critical habitat for these species. Effects to critical habitat for these three species includes reduced forage resulting from benthic disturbance by structures, sediment quality degradation by bio-deposits and contaminants; reduced cover by benthic disturbance by structures; and degraded water quality by bio-deposits, contaminants and turbidity. Alone, the scale of these adverse effects would be spatially constrained and infrequent, so that the overall consequence on critical habitat would be low. However, the degraded baseline, anticipated cumulative effects added to the effects of the proposed action result in continued degradation of critical habitat and a prolonged period of recovery of listed species. Nevertheless, the conservation value of the critical habitat for PS Chinook salmon, PS/GB yelloweye rockfish and PS/GB bocaccio is largely retained.

The isolated effects of the proposed Orchard Rocks facility maintenance actives, as well as long-term effects of the presence of the facility and its operations on habitat conditions (i.e. water quality, forage and cover) are expected to be minor, and intermittent. Effects would be highly localized relative to the broader action area, and expanse of critical habitat within the action area. Therefore, despite a degraded baseline and anticipated cumulative effects primarily associated with population growth and development, we do not expect the habitat effects of the proposed action, including the long-term presence and operation of the Orchard Rocks facility to appreciably diminish the conservation value of critical habitat for PS Chinook, PS/GB yelloweye rockfish or PS/GB bocaccio.

2.7.2 Effects to Species

PS Chinook salmon are currently listed as threatened with generally negative recent trends in status. Widespread negative trends in natural-origin spawner abundance across the ESU have been observed since 1980. Productivity remains low in most populations, and hatchery-origin

[10] WCR-2021-03087; Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the NPDES General Permit for Tribal Enhancement and Federal Research Marine Net Pen Facilities Within Puget Sound, NPDES Permit No. WAG132000

[11] WCRO-2018-00286; Reinitiation of Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Environmental Protection Agency's Approval of Washington State Department of Ecology's Sediment Management Standards (WAC 173-204-412) Regarding Marine Finfish Rearing Facilities.

spawners are present in high fractions in most populations outside of the Skagit watershed. Although most populations have increased somewhat in abundance since the last status review in 2016, they still have small negative trends over the past 15 years, with productivity remaining low in most populations (Ford 2022). All PS Chinook salmon populations continue to remain well below the TRT planning ranges for recovery escapement levels, and that most populations remain consistently below the spawner-recruit levels identified by the TRT as necessary for recovery.

The most recently completed 5-year status review (NWFSC 2015; NMFS 2017b) for Pacific salmon and steelhead noted some signs of modest improvement in PS steelhead productivity since the previous review in 2011, at least for some populations, especially in the Hood Canal and SJDF MPG. However, several populations were still showing dismal productivity, especially those in the Central and South PS MPG. The 2022 biological viability assessment (Ford 2022) identified a slight improvement in the viability of the PS steelhead DPS since the PS steelhead technical review team concluded that the DPS was at very low viability in 2015, as were all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). Ford (2022) reported observed increases in spawner abundance in a number of populations over the last five years, which were disproportionately found within the South and Central PS, SJDF and Hood Canal MPGs, and primarily among smaller populations. The viability assessment concluded that recovery efforts in conjunction with improved ocean and climatic conditions have resulted in an increasing viability trend for the PS steelhead DPS, although the extinction risk remains moderate (Ford 2022).

PS/GB bocaccio are listed as endangered and abundance of this species likely remains low. PS/GB yelloweye rockfish are listed as threatened but likely persist at abundance levels somewhat higher than bocaccio. Lack of specific information on rockfish abundance in PS makes it difficult to generate accurate abundance estimates and productivity trends for these two DPSs. Available data does suggest that total rockfish declined at a rate of 3.1 to 3.8 percent per year from 1977 to 2014 or a 69 to 76 percent total decline over that period. The two listed DPSs declined over-proportional compared to the total rockfish assemblage. Habitat degradation has limited the carrying capacity of habitat for these species and continued threats inhibit recovery. Other factors, such as overfishing, are more significant threats to PS/GB yelloweye rockfish and bocaccio. While ongoing habitat restoration and advances in best management practices may slow further habitat degradation and reduce direct take, a trajectory for recovery of populations remains uncertain, particularly given anticipated impacts of climate change.

When we evaluate the cumulative effects on these species over the time period of anticipated ongoing net pen operations and their impacts, we anticipate additional stress added to existing stressors in the baseline in both fresh and marine environments from anthropogenic changes in habitat (increased recreational use in fresh and marine waters, increased stormwater inputs in fresh and marine waters), and increasingly modified conditions related to climate change (warmer temperatures, and more variable volume and velocities in freshwater, changing temperature, pH, and salinity in marine waters). All of these are likely to exert negative pressure on population abundance and productivity.

In this context we add the effects of the proposed action. Even considered over multiple years, with highly variable ocean conditions and climate change stressors, only a small number of fish relative to the affected populations would be killed or injured by the effects that result from the Orchard Rocks facility structures and operations, so that the reductions in abundance would not rise to create effects on productivity, diversity and spatial structure at discernible levels. Therefore, the proposed action is unlikely to alter the current or future trends for PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish or PS/GB bocaccio population viability even when cumulative effects and baseline conditions are added to the proposed action.

In other words, we expect that the total effects of the action on individual fish identified in this opinion would be indiscernible at the population level because, although these species are currently well below historic levels, they are distributed widely enough and are presently at high enough abundance levels that the loss of individual fish resulting from the action would not alter their spatial structure, productivity, or diversity. Therefore, when considered in light of species status and existing risk, baseline effects, as described above in Section 2.7.1 (Effects to Critical Habitat) and cumulative effects, the action (and consequences of the action) itself does not increase risk to the affected populations to a level that would reduce appreciably the likelihood for survival or recovery of PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio. This same finding was also made for these species in the WCRO-2018-00286 Biological Opinion.

2.8. Conclusion

When analyzed into the future, with variable ocean conditions and climate change stressors, only a small number of fish relative to the affected populations would be killed or injured by the effects that result from the proposed action. Further, despite a degraded baseline and anticipated cumulative effects primarily associated with population growth and development, we do not expect the habitat effects of the net pens to appreciably diminish the conservation value of critical habitat for PS Chinook salmon, PS/GB yelloweye rockfish or PS/GB bocaccio.

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish or PS/GB bocaccio, or adversely modify their designated 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 Incidental Take Statement (ITS).

The take herein described is also identified in the WCRO-2018-00286 Biological Opinion and accompanying Incidental Take Statement. However, it is documented in this ITS because it is also caused by this proposed action, and because it is relevant to the Reasonable and Prudent Measures (Section 2.9.2) and Terms and Conditions (Section 2.9.4). Because it is the same take identified in the WCRO-2018-00286 Biological Opinion, it overlaps but is not in addition to that take. In other words, this ITS does not expand on the amount of take previously identified in the WCRO-2018-00286 Opinion.

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 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 fish, 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 (by reference to the WCRO-2018-00286 Biological Opinion) NMFS has determined that take is reasonably certain to occur as follows:

- Harm of juvenile and adult PS Chinook salmon, PS steelhead, and adult, juvenile, and larval PS/GB bocaccio and yelloweye rockfish resulting from a large-scale net pen failure;
- Harm of juvenile and adult PS Chinook salmon and PS steelhead resulting from co-occurrence with farmed fish that escape during PS commercial net pen operations (not including escapes resulting from large-scale failures); and
- Harm of juvenile and adult PS Chinook salmon, PS steelhead, and adult, juvenile, and larval PS/GB bocaccio and yelloweye rockfish resulting from habitat effects and direct effects on species of net pen operations.

Specifically, we expect that the following amounts and types of take would occur:

Harm from large-scale net pen failure event

Take in the form of harm is reasonably likely to occur as follows:

- Temporary reduction in forage for juvenile and adult PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio resulting from disturbance of the benthos by the movement and deposition of net pen debris, and clean-up and recovery activities;
- Temporary reduction in cover for juvenile and adult PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio resulting from damage or displacement of subtidal macroalgae by the movement and deposition of net pen debris, and clean-up and recovery activities;
- Entrainment and capture of juvenile and adult PS Chinook salmon, and PS steelhead, larval and juvenile PS/GB bocaccio, and larval yelloweye rockfish during efforts to recover escaped fish. This includes removal with vacuum harvest pumps, seining and other netting;
- Predation and competition of juvenile PS Chinook salmon and PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio by escaped farmed fish in marine and freshwater portions of the action area;
- Reduced reproductive success for adult PS Chinook salmon and PS steelhead from competition for spawning sites and redd superimposition by escaped farmed fish in freshwater portions of the action area; and
- Reduced fitness and survival of PS steelhead from outbreeding depression and hatchery-influenced selection effects by interbreeding with escaped farmed rainbow trout/steelhead in freshwater portions of the action area.

For these take pathways, as a surrogate take indicator we use the expected frequency of large-scale net pen failures as follows:

> *No more than one large-scale failure event [defined as the escape and loss (i.e. not recaptured/recovered) of more than 29% of the maximum production number of fish at the Orchard Rocks facility] over any 50-year period of time.*

This surrogate is representative of take described above resulting from large-scale net pen structural failure and escape of fish, since the magnitude of direct and indirect effects are proportional to the number of large-scale structural failures and the number of escaped fish. It is also in line with the surrogate take indicators used in the WCRO-2018-00286 Biological Opinion for take associated with PS commercial net pens. This take surrogate can be reliably measured and monitored through monitoring of the number of fish within net pens and routine structural inspections of net pens.

Take would be exceeded if *more than one large-scale structural failure event [defined as the escape and loss (i.e. not recaptured/recovered) of more than 29% of the maximum production number of fish at the Orchard Rocks facility] occurred at the site over any 50-year period of time*; such an exceedance would trigger a need for reinitiation of this ESA Section 7 consultation. As described above (Section 2.9), this take overlaps with that identified in the WCRO-2018-

00286 Biological Opinion and accompanying ITS. The present proposed action also causes take identified in that Opinion, but is not in addition to that take. This ITS exempts take resulting from this number and nature of large-scale structural failures.

Harm from net pen operations

Take in the form of harm is expected to occur as follows:

- Reductions in forage production for juvenile and adult a PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish and PS/GB bocaccio from sediment quality degradation occurring as a result of bio-deposits and contaminants;
- Harm to juvenile and adult PS Chinook salmon and PS steelhead, and larval, juvenile and adult PS/GB yelloweye rockfish and PS/GB bocaccio as a result of degraded water quality from bio-deposits, contaminants and turbidity;
- Predation of juvenile PS Chinook salmon and PS steelhead, and larval PS/GB yelloweye rockfish and PS/GB bocaccio by farmed fish within the net pen facility;
- Predation and competition of juvenile PS Chinook salmon and PS steelhead, and larval and juvenile PS/GB yelloweye rockfish and PS/GB bocaccio by farmed fish that escape as a result of small escape and leakage events in marine and freshwater portions of the action area;
- Reduced reproductive success for adult PS Chinook salmon and PS steelhead from competition for spawning sites and redd superimposition by escaped farmed fish (rainbow trout/steelhead) as a result of small escape and leakage events in freshwater portions of the action area;
- Reduced fitness and survival of juvenile and adult PS steelhead from outbreeding depression and hatchery-influenced selection effects by interbreeding with escaped farmed rainbow trout/steelhead as a result of small escape and leakage events in freshwater portions of the action area;
- Entrainment of juvenile PS Chinook salmon and PS steelhead, larval and juvenile PS/GB bocaccio, and larval yelloweye rockfish during harvest (vacuum pump) of farm fish; and
- Reduced fitness and survival from the transmission of pathogens to juvenile and adult PS Chinook salmon, PS steelhead, PS/GB bocaccio and PS/GB yelloweye rockfish from farmed fish.

For the above take pathways associated with the ongoing existence and operations of the Orchard Rocks facility, excluding those resulting from escaped fish, as a surrogate take indicator we use the maximum number of fish reared at the Orchard Rocks facility:

> *No more than 800,000 individual fish or 5,600,000 pounds of fish reared at any time at the Orchard Rocks facility.*

Our analysis, in deference to ESA-listed species, has assumed a maximum of 800,000 individual fish or 5,600,000 pounds of fish reared at the Orchard Rocks facility (based on current permits for the Orchard Rocks facility and consistent with analyses in the WCRO-2018-00286 Biological Opinion). In addition to permit limits, the number of fish/biomass is tied to the size of the facility and effects associated with rearing of fish. Therefore, the absolute number of fish reared within net pens is proportional to take we identified in this opinion resulting from effects of net pen facility presence and operations. This ITS exempts take expected from this level of farming. Counting of fish as they are placed into the net pens and when they are removed for harvest, as well as frequent monitoring of the fish and net pen structures during rearing, provides the information necessary to ensure the take surrogate can be reliably measured and monitored. Take would be exceeded if at any time more than 800,000 individual fish or 5,600,000 pounds of fish are being reared at the Orchard Rocks facility at any given time. This would trigger a need for reinitiation of this ESA Section 7 consultation. As described above, this take is not in addition to take identified in the WCRO-2018-00286 Biological Opinion and accompanying ITS.

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 PS Chinook salmon, PS steelhead, PS/GB yelloweye rockfish or PS/GB bocaccio, or destruction or adverse modification of critical habitat.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" (RPMs) are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02). The following measures are necessary and appropriate to minimize the impact of incidental take of listed species from the proposed action. The Corps or its applicant, Cooke, shall:

1. Monitor to ensure that incidental take surrogates are not exceeded and incidental take pathways are tracked and minimized; and
2. Provide a report documenting the results of such monitoring.

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 Corps and Cooke have a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1) To implement reasonable and prudent measure 1 (monitoring):
   a) The Corps shall require that Cooke routinely and regularly monitor:
      i) All net pen failures/collapses to ensure that no more than one large-scale failure (as defined herein) occurs over any 50-year period of time.
      ii) All stocking and harvest records for each net pen, to ensure that the take surrogate of 800,000 individual fish or 5,600,000 pounds of fish at the Orchard Rocks facility at any one time is not exceeded.

iii) Pathogen infection and disease outbreak records and communication, as well as records of treatment frequency and treatment effectiveness for net pen operations.
iv) Water and sediment quality at the net pen site (as required by Ecology NPDES permits).
v) Net stocking, mortality and harvest information (as required by WDFW; see WDFW 2019) to assess all observed or unobserved escapes. This information shall include:
   (1) the number of fish that leave that hatchery;
   (2) the number and biomass of fish transferred to each net pen;
   (3) the number of known mortalities during net-pen rearing;
   (4) the number and biomass of fish harvested from each net pen;
   (5) the number of fish received by the processing plant; and
   (6) any known escapes of fish during rearing.
vi) Monthly Feed, Biomass and Disease Control Chemical Use Reports required by WDFW (WDFW 2019) and Ecology NPDES permits for review.
vii) All observed escape events, including observed escapes as well as structural failure events that may have resulted in an escape.
viii) All by-catch resulting from efforts to recover escaped fish following a net pen failure within 60 days following conclusion of recapture efforts.
ix) All by-catch of ESA-listed species during harvest of fish from net pens.

2) To implement RPM 2 (reporting):
   a) The Corps shall require Cooke to provide annual reporting no later than January 31 for the first 5 years from the date of this biological opinion. Time of reporting and frequency of reporting may be adjusted as determined necessary.
   b) Reporting of large-scale escape events shall occur within 1 week of detection.
   c) Reports shall be submitted electronically and shall include the WCRO tracking number in the regarding line. Submittal shall be made to:

      ProjectReports.WCR@noaa.gov
      Cc: Jeff.Vanderpham@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).

To address the uncertainty around hydrodynamics and pathogen spread, we recommend that the Corps require Cooke to work with state and federal agencies to implement the following:

- Develop a study plan to better understand the role of net pen site hydrodynamics as they relate to pathogen spread. This information should be considered for any future net pen facility siting. We recommend that any study be coordinated with the NMFS, EPA, WDFW and Ecology, and that the study results be reported to NMFS, EPA, WDFW and the Corps as they become available.

- Document and maintain thorough pathogen infection and disease outbreak records and communication, as well as records of treatment frequency and treatment effectiveness for net pen operations. WDFW has already identified the need for Cooke to report this information. We recommend that any study be coordinated with the NMFS, EPA, WDFW and Ecology, and that the study results be reported to NMFS, EPA, WDFW and the Corps as they become available.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Corps' permitting of the Cooke Aquaculture Pacific, LLC. Orchard Rocks Net Pen Repair in Kitsap County, Washington (NWS-2018-1125).

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

When evaluating whether the proposed action is not likely to adversely affect listed species or critical habitat, NMFS considers whether the effects are expected to be completely beneficial, insignificant, or discountable. Completely beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat. Insignificant effects relate to the size of the impact and should never reach the scale where take occurs. Effects are considered discountable if they are extremely unlikely to occur. When effects are beneficial, insignificant and/or discountable, these species are not likely to be adversely affected by the proposed action and we present our justification for that determination separately from the biological opinion since no take, jeopardy, or adverse modification of critical habitat would reasonably be expected to occur.

We concur with the Corps' NLAA determinations for Southern Resident killer whale (SRKW) and their designated critical habitat, and the southern DPS of eulachon. These species and critical habitat occur within the action area. We describe here those listed resources and critical habitat that we consider not likely to be adversely affected by the proposed action. Or effects analyses of the long-term presence and operation of the Orchard Rocks net pen facility, which are interdependent actions of the proposed action, are provided by reference to the WCRO-2018-00286 Biological Opinion. As described in Section 2.5 (Effects of the Action), Structures, operations and conservation measures proposed at and expected to occur at the Orchard Rocks facility are consistent with the assumptions used in the effects analyses for the WCRO-2018-

00286 Biological Opinion. These effects are summarized below. Any effects of the proposed pulling of four remaining anchors for inspection, refitting and redeployment, as well as the placement of two additional anchors are described below.

2.12.1 Southern Resident Killer Whale and their Designated Critical Habitat

SRKW was listed as endangered on November 18, 2005 (70 FR69903) and critical habitat was designated on November 29, 2006 (71 FR 69054) and expanded on August 2, 2021 (86 FR 41668). A 5-year review under the ESA completed in 2021 concluded that SRKWs should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2021). As reported in the 5-year review, in 2021 there were 73 whales in the population.

Critical habitat is designated throughout the marine portions of the action area, excluding Hood Canal. PBFs for SRKW are:

- Water quality to support growth and development;
- Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and
- Passage conditions to allow for migration, resting, and foraging.

As described in the WCRO-2018-00286 Biological Opinion, anticipated effects on habitat of the presence and operation commercial net pen facilities, including the Orchard Rocks facility are considered not likely to adversely affect SRKW or their designated critical habitat for the following reasons:

- Any changes to water quality are expected to be localized and minor, with no implications on the health of SRKW. We do not anticipate water quality conditions to be degraded to such a degree that SRKW are harmed.
- Potential benthic disturbance is expected to be minor and localized, and to have an insignificant effect on the quantity and quality of salmonids and other potential prey species (e.g., squid, halibut). We do not anticipate a reduction in abundance or quality of prey item to occur at levels or frequency to cause any discernible effect to the forage PBF of SR killer whale critical habitat.
- Based on anticipated vessel use and conservation measures, we do not anticipate interactions between vessels moving to and from net pens to interfere with SRKW movement or behavior.
- The location of the Orchard Rocks facility would not inhibit or interfere with passage of SRKW for migration, resting or foraging because of the small scale of the structures relative to the action area, and because they are not located within any constricted migration corridors.
- Large-scale structural failure events are expected to be very infrequent, and therefore we do not anticipate any entanglement of SRKW in net pen structures.

As described in Section 2.5 (Effects of the Action), it is reasonably likely that the proposed pulling of four remaining anchors for inspection, refitting and redeployment, as well as the placement of two additional anchors would result in slight localized reductions to the water quality PBF of SRKW critical habitat. However, because of the brevity of disturbance and because SRKW are highly mobile, we do not anticipate any measurable reduction in the conservation value of critical habitat as a result of this disturbance, nor any harm to SRKW individuals. This is consistent with the analysis of effects of turbidity from benthic disturbance during replacement or maintenance of anchors and mooring lines, and during any future net pen failure provided in the WCRO-2018-00286 Biological Opinion.

Because all potential effects on PBFs of SRKW critical habitat are expected to be insignificant or discountable, the proposed action is not likely to adversely affect critical habitat for SRKW. Because all indirect effects on SRKW habitat are insignificant, with no measurable direct effects on SRKW, any potential effects on SRKW are expected to be insignificant.

2.12.2 Southern DPS Eulachon and their Designated Critical Habitat

The southern DPS of eulachon was listed as threatened on March 18, 2010 (75 FR 13012) and critical habitat was designated on October 20, 2011 (76 FR 65323). Southern DPS eulachon migrate through the SJDF on their migrations to and from spawning grounds in the Fraser River in British Columbia, and the Elwha River in Washington (NMFS 2017a). The Elwha River is the only known spawning site in the action area, and also the only designated critical habitat within the action area. The river is approximately 80 miles from the Orchard Rocks facility. Eulachon occupy nearshore waters to approximately 1,000 feet in depth. Dealy and Hodes (2019) did extensive eulachon sampling on the Canadian side of the SJDF and found that Strait likely provides important year-round habitat for feeding and growth, as well as being a migration corridor.

Over the continental shelf, it is generally believed that eulachon stay at depth (approximately 100 to 200 m deep) and rarely come to the surface. In the SJDF, Dealy and Hodes (2019) caught eulachon at depths of 81 to 227 m, with the highest catch per unit effort at bottom depths of between 117 and 170 m. However, as demonstrated during night-time surface trawls in the Columbia River plume, they may occur near the surface at natal river mouths and estuaries (Litz et al. 2013). Larval eulachon may also be distributed by prevailing currents in the action area, but would be most concentrated near natal river mouths and estuaries.

As described in the WCRO-2018-00286 Biological Opinion, anticipated effects on habitat of the presence and operation commercial net pen facilities, including the Orchard Rocks facility are considered not likely to adversely affect Southern DPS eulachon for the following reasons:

- Localized water or sediment quality effects of Orchard Rock net pen operations would not extend to the Elwha River or the river mouth in the SJDF.
- Because there are no natal streams in close proximity to the Orchard Rocks facility, the occurrence of eulachon, either adult or juvenile, near the net pens is unlikely.
- Given their depth preference in marine waters, and the distance of their closest natal stream (Elwha River) from the facility, we do not expect any measurable effect of the facility or operations on forage availability.

- We do not expect water quality to be degraded to such a degree that any eulachon that do encounter net pens would be harmed.

As described in Section 2.5 (Effects of the Action), slight localized reductions to the water quality may result from the proposed pulling of four remaining anchors for inspection, refitting and redeployment, as well as the placement of two additional anchors. Because of the brevity of disturbance, because eulachon are highly mobile, and because we do not expect eulachon to be in close proximity to the facility, we do not anticipate any measurable any harm to Southern DPS eulachon. This is consistent with the analysis of effects of turbidity from benthic disturbance during replacement or maintenance of anchors and mooring lines, and during any future net pen failure provided in the WCRO-2018-00286 Biological Opinion. Therefore, we do not anticipate any adverse effects on the southern DPS of eulachon and consider effects to be discountable.

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 Corps and descriptions of EFH for Pacific Coast groundfish (Pacific Fishery Management Council (PFMC 2005), coastal pelagic species (CPS) (PFMC 1998), and Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The environmental effects of the proposed action may adversely affect EFH for Pacific Coast salmon, Pacific Coast groundfish and coastal pelagic species EFH, all of which are present in the action area. The action area also contains Habitat Areas of Particular Concern (HAPC) for Pacific Coast salmon in marine and freshwater portions of the action area, and for Pacific Coast groundfish in marine areas. Impacts to EFH include benthic disturbance by structures, sediment quality degradation by bio-deposits and contaminants, and water quality degradation by bio-deposits, contamination and turbidity.

3.2. Adverse Effects on Essential Fish Habitat

The features of EFH of Pacific Coast salmon, Pacific Coast groundfish and coastal pelagic species would include diminishments in water quality, sediment quality, forage, and kelp which is a vegetation that serves as cover. These effects would occur within PS to varying degrees. Additional effects to EFH could occur in freshwater for Pacific Coast Salmonids, with disruption of spawning areas. These adverse effects are associated with the habitat impacts of net pen structures (from future net pen structural failures) and operations for the commercial rearing of finfish in the PS. The following assessment of effects is consistent with the EFH response completed in the WCRO-2018-00286 Biological Opinion.

As a result of a large-scale net pen structural failure [defined as the escape and loss (i.e. not recaptured/recovered) of more than 29% of the maximum production number of fish at that site (800,000 fish)] we anticipate the following habitat effects:

- Temporary reduction in forage resulting from disturbance of the benthos by the movement and deposition of net pen debris, and clean-up and recovery activities;
- Temporary reduction in cover resulting from damage or displacement of subtidal macroalgae by the movement and deposition of net pen debris, and clean-up and recovery activities; and
- Temporary reduced forage for adult and juvenile PS Chinook salmon, HCSRC and PS steelhead from competition with escaped farmed fish.

As a result of Orchard Rocks net pen facility presence and operation, including maintenance activities, we anticipate the following habitat effects:

- Reductions in forage production from sediment quality degradation occurring as a result of bio-deposits and contaminants; and
- Degraded water quality from bio-deposits, contaminants and turbidity.

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.

1) To address the uncertainty around hydrodynamics and pathogen spread, we recommend that the Corps require Cooke to implement the following:
    a) Develop a study plan to better understand the role of net pen site hydrodynamics as they relate to pathogen spread. This information should be considered for any future net pen facility siting. The results should be reported to NMFS and state agencies with regulatory authorities.
    b) Document and maintain thorough pathogen infection and disease outbreak records and communication, as well as records of treatment frequency and treatment effectiveness for

net pen operations, including the Orchard Rocks facility as well as other Cooke facilities in the PS. This would be immensely helpful in tracking if increased disease severity and mortality trends are occurring. The WDFW has already identified the need for Cooke to report this information. We recommend that the Corps require Cooke to share all records with NMFS.

2) Provide to NMFS annually, summary reports of all PS Cooke net pen facility maintenance and inspection reports; fish stocking, mortality and harvest reports; and sediment and water quality monitoring reports. These should identify any unanticipated habitat effects (e.g. benthic disturbance, or sediment or water quality exceedances) and potential escape events. This is important to have these reports from all of Cooke's net pen facilities to assess any interactions with other facility operations, and to identify potential effects that have not yet been identified at the Orchard Rocks facility, or that could occur in the future.

3) Based on the information collected through the implementation of conservation measures 1 and 2 above, work with state agencies and NMFS to develop new or modified BMPs that further reduce adverse habitat effects of PS commercial net pen structures and operations.

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, Pacific Coast groundfish, and coastal pelagic species.

3.4. Statutory Response Requirement

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

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

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion is the Corps. Other interested users could include permit applicants, citizens of affected areas and others interested in the conservation of the affected ESUs/DPS. Individual copies of this opinion were provided to the Corps. The document will be available at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adhere to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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