National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation

Consultation on the Issuance of Four ESA Section 10(a)(1)(A) Scientific Research Permits and One ESA Section 10(a)(1)(B) permit affecting Salmon, Steelhead, Rockfish, and Eulachon in the Pacific Northwest

NMFS Consultation Number: 2012/F/NWR/2012/01984

Action Agencies: The National Marine Fisheries Service NMFS

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No
PS/GB canary rockfish (*S. pinniger*)	Threatened	Yes	No	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No
Puget Sound (PS) Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
PS steelhead (*O. mykiss*)	Threatened	Yes	No	No
Hood Canal summer-run chum salmon (*O. keta*)	Threatened	Yes	No	No
Southern green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No
Southern eulachon (*Thaleichthys pacificus*)	Threatened	Yes	No	No
Southern Resident killer whales (*Orcinus orca*)	Threatened	No	No	No
Steller sea lions (*Eumetopias jubatus*)	Threatened	No	No	No
Leatherback sea turtles (*Dermochelys coriacea*),	Endangered	No	No	No
Humpback whales (*Megaptera novaeangliae*)	Endangered	No	No	No

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

Consultation Conducted By: National Marine Fisheries Service, Northwest Region

Issued By: [signature] for William W. Stelle, Jr., Regional Administrator

Date: 10-2-12 (Expires on: October 2, 2017)

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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 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.*), and implementing regulations at 50 CFR 402. It constitutes NMFS' review of section 10(a)(1)(B) and 10(a)(1)(A) applications and is based on information provided in the applications for the proposed permits, published and unpublished scientific information on the biology and ecology of listed species in the action area, and other sources of information. A complete administrative record for this consultation is on file with the NMFS Protected Resources Division in Seattle, Washington.

NMFS also completed an Essential Fish Habitat (EFH) consultation. It was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 *et seq.*) and implementing regulations at 50 CFR 600.

The opinion, incidental take statement, and EFH conservation recommendations are each in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1) *et seq.*), and they underwent pre-dissemination review.

1.2 Consultation History

On April 23, 2009, NMFS proposed to list the Puget Sound/Georgia Basin DPSs of yelloweye rockfish and canary rockfish as threatened, and bocaccio as endangered species under the ESA (74 Fed. Reg. 18516). The proposal went final on April 27, 2010 and the species listings were effective on July 27, 2010. In November of 2009, WDFW initiated discussions with NMFS on pursuing ESA take coverage for state-authorized fisheries and research activities that are likely to encounter yelloweye rockfish, canary rockfish, and bocaccio (ESA-listed rockfish) in state waters within the range of the DPSs. Because of those discussions, and over the ensuing months and years, NMFS worked with WDFW to advise them on development of a Fishery Conservation Plan (FCP)[1] and an application for an Incidental Take Permit (ITP) that covers ESA-listed rockfish and other listed and non-listed species taken by certain state-authorized fisheries and state-conducted research efforts.

The WDFW manages fisheries in Puget Sound. ESA-listed rockfish and Puget Sound (PS) Chinook salmon are incidentally caught in the commercial shrimp trawl fishery and the recreational bottom fish fishery authorized by the state. Eulachon and green sturgeon can also be

[1] Section 10(a)(2)(A) of the ESA states that a "conservation plan" must be submitted to the Secretary by the applicant as part of an application for an ITP. In the Northwest region, "conservation plans" are often termed "habitat conservation plans" (HCP). WDFW has submitted a plan titled a "fishery conservation plan," which more accurately reflects the intent of the plan and in all other respects is comparable to an HCP.

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incidentally caught in the commercial shrimp trawl fishery. ESA-listed rockfish and PS Chinook salmon are also caught in Puget Sound commercial, recreational, and tribal salmon fisheries. Takes from Puget Sound commercial, recreational, and tribal salmon fisheries are authorized by NMFS under other authorities[2] and are described in this opinion in the environmental baseline section (Section 2.3).

While developing the FCP, WDFW identified several active and inactive fisheries that posed a high risk to ESA-listed rockfish. To protect rockfish, the Washington State Fish and Wildlife Commission formally adopted regulations in 2010 that prevent the retention of rockfish by recreational anglers in Puget Sound, and closed fishing for bottom fish in all waters deeper than 120 feet. On July 28, 2010, WDFW completed a package of regulations by emergency rule for the following commercial fisheries in Puget Sound in order to protect dwindling rockfish populations (WDFW 2010a):

1) Closure of the set net fishery
2) Closure of the set line fishery
3) Closure of the bottom trawl fishery
4) Closure of the inactive pelagic trawl fishery
5) Closure of the inactive bottom fish pot fishery

As a precautionary measure, WDFW closed the above commercial fisheries west of the ESA-listed rockfish DPS boundaries to Cape Flattery. The WDFW extended the closure west of the rockfish DPSs boundary to prevent commercial fishermen from concentrating gear in that area. WDFW initially closed the commercial fisheries listed above on a temporary basis (up to 240 days), and then permanently closed them in February 2011.

On March 30, 2012, WDFW submitted a final ITP application for two fisheries and four scientific research permit applications to conduct research actions that would take ESA-listed rockfish and other listed species in the Puget Sound. To support the applications, WDFW also submitted the FCP to the Northwest Region's Protected Resources Division (PRD).

For the two fisheries, WDFW applied for an ITP under section 10(a)(1)(B) of the ESA. The section 10(a)(1)(B) permit would authorize the incidental take of ESA-listed rockfish and PS Chinook salmon in the recreational bottom fish fishery, and ESA-listed rockfish, PS Chinook salmon, green sturgeon, and eulachon in the commercial shrimp trawl fishery, for a period of 5 years.

In addition, WDFW has applied for scientific research permits for their Puget Sound fish research program under section 10(a)(1)(A) of the ESA. Each application is for a duration of five years. The section 10(a)(1)(A) permits would authorize researchers to take limited numbers of ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, eulachon, and green sturgeon.

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[2] NMFS authorizes take of ESA-listed rockfish and Chinook salmon in the Chinook salmon fisheries through consultations under ESA section 7 or approvals under ESA section 4(d) (see, for example, NMFS Biological Opinion F/NWR/2010/06051).

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The applications were incomplete to varying extents when they arrived. The applicant revised the applications based on NMFS' comments. We determined the applications were complete on March 30. For each permit request, we published notice in the Federal Register. NMFS published a notice on March 30, 2012 asking for public comment (77 Fed. Reg. 19225); we extended public comment to May 11, 2012 (77 Fed. Reg. 26514, May 4, 2012). A complete record for permit issuance, including this consultation, is on file with the Northwest Region's PRD in Seattle, WA.

Issuing an ITP or scientific research permits is a Federal action that triggers NMFS' responsibility to comply with ESA section 7(a)(2). In addition, authorizing incidental take enables activities that are likely to adversely affect Essential Fish Habitat (EFH) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSA). Therefore, NMFS has completed consultations under both the ESA and MSA, and this document contains the results of both consultations. In addition, this document includes NMFS' Statement of Findings (Findings) on each of the ITP issuance criteria stated in ESA section 10(a)(2)(B).

This biological opinion (opinion) considers the combined effects of issuance of section 10(a)(1)(B) and 10(a)(1)(A) permits to WDFW, each for a period of five years.

The consultations and Findings are based on NMFS' review of the FCP, as it describes the underlying fisheries and research programs that WDFW administers which have risk of taking listed species. The FCP covers the Puget Sound, the Strait of Juan de Fuca, and areas north to the Canadian border. This area corresponds to the range of the yelloweye rockfish, canary rockfish, and bocaccio Distinct Population Segments (DPSs). This area is also within the geographic range of several Evolutionarily Significant Units (ESUs) of threatened fish species. They include Puget Sound (PS) Chinook salmon (*Oncorhyncus tshawytscha*) and Hood Canal summer-run (HCS) chum salmon (*O. keta*), the DPSs of threatened PS steelhead (*O. mykiss*), threatened Southern (S) DPS of North American green sturgeon (*Acipenser medirostris*), and threatened S DPS of eulachon (*Thaleichthys pacificus*). The FCP area also overlaps with the range of threatened Steller sea lions (*Eumetopias jubatus*), endangered humpback whales (*Megaptera novaeangliae*), and endangered Southern Resident killer whales (*Orcinus orca*). The covered area also contains critical habitat (CH) for PS Chinook salmon, HCS chum salmon, green sturgeon, and Southern Resident (SR) killer whales; and EFH for a number of groundfish, coastal pelagic, and Pacific salmon species (refer to Table 1).

Because the permit requests are similar in nature and duration and are expected to affect the same listed species, we combined the proposed actions into a single consultation pursuant to 50 CFR 402.14(c). The affected species are Puget Sound/Georgia Basin yelloweye rockfish, canary rockfish, bocaccio, PS Chinook salmon, PS steelhead, HCS chum salmon, green sturgeon, and eulachon. The proposed actions also may affect SR killer whales and their critical habitat by diminishing the whales' prey base. We concluded that the proposed activities are not likely to adversely affect SR killer whales or their critical habitat, and the full analysis is found in the "Not Likely to Adversely Affect" Determination, Section 2.9.1.

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This biological opinion is based on information provided in WDFW's FCP and ITP application, each dated March 30, 2012, as well as NMFS' Environmental Assessment prepared under the National Environmental Policy Act for the proposed permit issuance and scientific research applications, and other sources of information.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration. In this instance, we found no actions that are interrelated to or interdependent with the proposed actions. Thus, the proposed actions here are the activities proposed as part of NMFS' issuance of four section 10(a)(1)(A) permits and one section 10 (a)(1)(B) permit to WDFW.

The proposed action is for NMFS to issue the requested permits and for WDFW to implement the proposed FCP and the Puget Sound fish research program. The section 10(a)(1)(A) permits would authorize researchers to annually take limited numbers of ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, eulachon, and green sturgeon. The section 10(a)(1)(B) permit would authorize the incidental take of ESA-listed rockfish and PS Chinook salmon in the recreational bottom fish fishery, and ESA-listed rockfish, PS Chinook salmon, green sturgeon, and eulachon in the commercial shrimp trawl fishery[3]. "Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect [a listed species] or to attempt to engage in any such conduct. This opinion constitutes formal consultation, and includes an analysis of effects solely for the ESUs and DPSs that are the subject of this opinion.[4]

1.3.1 Section 10(a)(1)(A) Permits

For many years, the WDFW has been conducting four annual research projects that target Puget Sound fishes. NMFS has previously approved this research through the salmon and steelhead 4(d) rule[5]. As part of the proposed action NMFS would issue four new permits under section

[3] The ITP would cover take of bocaccio, PS Chinook salmon, and green sturgeon. Take authorization would become effective for covered species without take prohibitions currently in place (yelloweye rockfish, canary rockfish, and eulachon), concurrent with the issuance of a rule prohibiting their take. The issuance of the ITP would be a Federal action that affects the species currently listed as threatened under the ESA, but without prohibited take. Therefore, we analyze the effects of the proposed action on these species as well in accordance with section 7(a)(2) of the ESA.

[4] An ESU of Pacific salmon (Waples 1991) and a DPS of steelhead (71 Fed. Reg. 834, January 5, 2006) are considered to be "species" as the word is defined in section 3 of the ESA. In addition, it should be noted that the terms "artificially propagated" and "hatchery" are used interchangeably in the opinion, as are the terms "naturally propagated" and "natural."

[5] On July 10, 2000, NMFS issued a 4(d) rule for 14 threatened salmon and steel head (65 Fed. Reg. 42422; 50 CFR 223.203) (salmon and steelhead 4(d) rule). The rule applies the take prohibitions of section 9 of the ESA to the threatened salmonid species listed in the rule, but imposed certain limits on those prohibitions. Limit 7 states that the prohibitions of section 9(a)(1) of the ESA (16U.S.C. 1538(a)(1)) do not apply to scientific research activities (50 CFR 223.203(b)(7)) that are submitted by a state fishery agency as a "research program" (Program), provided that

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10(a)(1)(A) of the ESA, that would cover the take of ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, green sturgeon, and eulachon resulting from WDFW research activities on Puget Sound fishes. These actions are (a) a bottom fish trawl census that has occurred on an annual basis since the late 1980s; (b) the Puget Sound Assessment and Monitoring (PSAMP) bottom trawl surveys; (c) a midwater trawl survey; and (d) biological sampling by hook-and-line/tagging studies of non-listed rockfish. Each research project is described below. As noted, the WDFW is now seeking research permits for these activities. The permits would be in place for 5 years. The requested annual take for each research type and listed species are in Table 1 and for each permit in Appendix A. The researchers do not intend to kill any of the captured listed fish, but some may die as an unintended result of the activities.

Table 1. Total WDFW research take requests for covered species.

			Total for all research permits	
SPECIES	PRODUCTION /ORIGIN	LIFE STAGE	Expected total take	Mortality from total take
Eulachon	Natural	Adult	400	400
		Juvenile	220	220
Bocaccio	Natural	Adult	4	4
		Juvenile	4	4
Canary rockfish	Natural	Adult	12	12
		Juvenile	12	12
Yelloweye rockfish	Natural	Adult	5	5
		Juvenile	5	5
Chinook salmon	Listed Hatchery Adipose Clip	Adult	10	5
		Juvenile	60	23
	Natural	Adult	8	4
		Juvenile	30	11
Chum salmon	Natural	Adult	3	3
		Juvenile	8	3
Steelhead	Listed Hatchery Adipose Clip	Adult	4	2
		Juvenile	8	3
	Natural	Adult	4	2
		Juvenile	8	3
Green sturgeon	Natural	Adult	2	0

See appendix A for proposed takes for each species and research types.

The collective purpose of this research is to provide information that will enable the WDFW to determine the fishes' overall abundance, and determine their species assemblages, distribution, and health. The benefits to ESA-listed fish from this research include increasing the

the Program complies with the six factors specified in the rule (see Part III. Evaluation and Determination) and is authorized in writing by NMFS' Northwest Regional Administrator.

understanding of where they reside (particularly rockfish), the amount of bio-accumulative toxins in their prey base, and overall health of the ecosystem in which they reside.

Permit 15848 for research on population trends

Under Permit 15848, the WDFW would conduct annual bottom trawl surveys in Puget Sound. For the index survey (which occurs annually at pre-chosen locations), researchers would deploy a bottom trawl twice each year at 51 pre-selected, permanent stations (between 102 and 200 trawls annually). The stations are categorized by depth, and were selected at random within one of four depth zones. The depth zones are 30 to 120 feet (9 to 36.7 meters), 120 to 240 feet (36.7 to 73 meters), 240 to 358 feet (73 to 109 meters), and greater than 358 feet (109 meters). The bottom trawl is an eastern trawl fitted with a 1.8-inch (3-centimeter) mesh liner. The net is attached to heavy steel doors on each side and the entire assembly is towed along the seafloor for a distance of approximately 0.46 miles (0.74 kilometers) at a speed of 2.3 miles per hour (2 knots). The trawl is towed for 5 to 20 minutes at each station.

The trawls provide data to help the WDFW monitor population trends among Pacific cod, flatfishes, spotted ratfish, and other economically or ecologically important marine fishes in Puget Sound. The information they generate would help managers determine the status of groundfish stocks, the biology and distribution of key and minor groundfish species, food web and ecosystem model inputs, and guide commercial and recreational fishery management. The researchers would measure the captured fish and sample them for otoliths and bones, stomach content samples, and genetic tissues.

Permit 16091 for chemical contamination research

Under Permit 16091, the WDFW would conduct bottom trawl surveys for the PSAMP during odd-numbered years of the 5-year permit duration throughout the Puget Sound. The trawl gear the researchers would employ is generally similar to that described for Permit 15848, above.

The purpose of this research is to monitor and assess the chemical contamination in Puget Sound fishes, invertebrates, and plankton. The researchers would look for tissue contamination levels, pathological disorder frequencies, and other biological effects in selected biota throughout the Puget Sound. This survey would use a bottom trawl deployed by a chartered fishing vessel to collect English sole (*Parophrys vetulus*) and other species of interest at fixed locations throughout the Sound. The WDFW uses English sole to measure and model the toxic contamination in Puget Sound. The researchers would take internal organ tissue samples from the captured specimens and use them to determine contaminant types, concentrations, and pathologies in the Sound's indigenous species.

Permit 15890 for herring and hake abundance

Under Permit 15890, the WDFW would use acoustic-midwater trawls to estimate abundance of Pacific herring and Pacific hake (whiting, *Merluccius productus*) throughout the Puget Sound. They would conduct the trawls from a 58-foot (17.68-meter) vessel used to tow a midwater rope trawl. The rope trawl has meshes ranging in size from 2.6 feet (0.8 meters) at the throat, to mesh sizes that decrease to 1.5 inches (3.8 centimeters) at the cod end of the net. There is a liner in the cod end that consists of 0.4 inch (1 cm) knotless mesh. The net is towed for a duration of 10 minutes to 2 hours, depending upon the needed sample amount.

Permit 16021 for groundfish behavior research

Under Permit 16021, the WDFW would use hook-and-line angling equipment to capture groundfish such as unlisted rockfish in the Puget Sound and obtain biological samples . The WDFW would capture groundfish to examine behavior upon their release by tagging them and tracking their movements, feeding, maturity, growth, and species composition. WDFW would use genetic samples to analyze the fishes' stock identities and population structure and identify any local adaptations. This information, in turn, would assist in focusing fishery management actions at the appropriate geographic scale.

The WDFW would conduct hook-and-line angling with rods-and-reels or hand-lines fitted with monofilament or other synthetic lines and rigged with baited hooks or lures and a weight. The gear would be lowered to the desired depth and jigged or worked up and down the water column. Hooks and lines would be matched to the expected size and weight of the specimens being sought and the hooks would be barbless. The researchers would take tissue samples from the fish, or sacrifice them for more in-depth analysis such as diet, age structure, or genetics. The primary species of interest are lingcod, greenlings, flatfishes, wolf-eels, non-listed rockfishes, and codfishes. Hook-and-line gear would be used to sample the adult and juvenile phases of non-listed rockfishes, lingcod, Pacific cod, flatfishes, and other groundfish species. No yelloweye rockfish, canary rockfish, or bocaccio would be targeted, and sampling would occur in water depths less than 120 feet (39 meters) to increase the likelihood of avoiding them because they typically occur deeper than 120 feet.

Common Elements among the Proposed Research Actions

Research permits lay out the conditions that must be followed before, during, and after the research activities are conducted. These conditions (a) manage the interaction between scientists and listed fish by requiring that research activities be coordinated among permit holders[6], and between permit holders and NMFS, (b) minimize impacts on listed species, and (c) ensure that NMFS receives information about the effects the permitted activities have on the listed species. All four research permits that NMFS issues to WDFW would have the following conditions:

1. WDFW must ensure that all ESA-listed species are taken only at the levels, by the means, in the areas, and for the purposes stated in the permit; and according to the terms and conditions of the permit.
2. WDFW must not intentionally kill or cause to be killed any ESA-listed species covered by the permit (after the species is encountered with sampling gear).

[6] "Permit holder" means the permit holder or any employee, contractor, or agent of the permit holder. In addition, NMFS may include conditions specific to the proposed research and monitoring activities in the permit.

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3. WDFW must handle all ESA-listed fish with extreme care and keep them in cold seawater to the maximum extent possible during sampling and processing. When fish are transferred or held live, a healthy environment must be provided; e.g., the holding units must contain adequate amounts of well-circulated seawater. When using gear that captures a mixture of species, ESA-listed fish must be processed first in order to minimize handling stress.

4. If WDFW anesthetizes ESA-listed fish to avoid injuring or killing them during handling, the fish must be allowed to recover completely before being released. Fish that are only counted, and not otherwise handled, must remain in seawater and not be anesthetized.

5. WDFW will use sterilized instruments for all invasive sampling, tissue excisions, and tag insertions for ESA-listed fish.

6. If WDFW unintentionally captures any ESA-listed adult fish while sampling for juveniles, the adult fish must be released without further handling and the take must be reported to NMFS.

7. WDFW must obtain approval from NMFS before substantially changing sampling locations or research protocols.

8. WDFW will notify NMFS as soon as possible, but no later than two days, after any authorized level of take is exceeded, or if such an event is judged likely to occur. WDFW will submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

9. WDFW will retain possession of any biological samples collected from ESA-listed species. WDFW will not transfer biological samples to anyone (aside from NMFS personnel) not listed in the application without prior written approval from NMFS.

10. A copy of the permit must accompany any WDFW designee who conducts any activities authorized by the permit.

11. WDFW will allow any NMFS employee or NMFS-designated representative to accompany field personnel while they conduct the research and monitoring activities.

12. WDFW will, upon request, allow any NMFS or NMFS-designated representative to inspect any records or facilities related to the permit.

13. WDFW will not transfer or assign this permit to any other person(s) as defined in section 3(12) of the ESA. The permit ceases to be in effect if transferred or assigned to any other person(s) without NMFS' written authorization.

14. NMFS may amend the provisions of this permit after giving the permit holder reasonable notice of the amendment.

15. WDFW will obtain all other Federal, state, and local permits/authorizations needed for the designated activities, as applicable.

16. On or before January 31 of every year, the permit holder must submit to NMFS a post-season annual report in the prescribed format describing the research and monitoring activities, the number of listed fish taken, the location, the type of take, the number of fish intentionally and unintentionally killed, the take dates, and a brief summary of the research and monitoring results. The report must be submitted electronically on our permit website,

and the forms can be found at https://apps.nmfs.noaa.gov/. Falsifying reports or permit records is a violation of this permit.

17. If WDFW violates any permit condition, they will be subject to any or all appropriate penalties provided by the ESA. NMFS may revoke this permit if the authorized activities are not conducted in compliance with the permit and the requirements of the ESA.
18. When ESA-listed rockfish are captured while conducting the research, and cannot be returned to the water alive, WDFW would provide NMFS with the following:
    - length of fish
    - precise location of the encounter
    - tissue for genetic analysis
    - preservation of the entire fish or selected organs or tissues
    - otoliths for age analysis (unless otherwise processed by WDFW)

In addition to the permit conditions listed above, all ESA-listed salmonids, eulachon, and sturgeon would be immediately released at the capture site. If a captured listed rockfish is viable, a small portion of fin tissue would be removed for genetic analysis and the fish would be returned to the water via rapid submersion techniques. If an individual of these species dies, the whole fish would be retained for genetic and other analysis.

In addition, the take numbers for each permit have been purposefully set at what are likely to be the maximum possible annual amounts. The reason for this is that unforeseen circumstances can arise on occasion, and NMFS has determined it is best in these instances to include modest overestimates of expected take. By doing this, NMFS gives researchers enough flexibility to make in-season adjustments in response to changing conditions without having to shut down the research because of take levels that are higher than anticipated. In addition, elevated take estimates are useful for conservatively analyzing the effects of the actions because it allows for accidents that could cause higher-than-expected take levels to be taken into account during the analysis.

Finally, NMFS would use the annual reports to monitor the actual number of listed fish taken annually in the scientific research activities, and would adjust permitted take levels if they are deemed to be excessive or if cumulative take levels rise to the point where they are detrimental to the listed species.

1.3.2 Section 10(a)(1)(B) Permit

Under the section 10(a)(1)(B) Incidental Take Permit, including the WDFW's FCP, WDFW would be covered for incidental take of ESA-listed rockfish and PS Chinook salmon in the recreational bottom fish fishery, and ESA-listed rockfish, PS Chinook salmon, eulachon, and green sturgeon in the commercial shrimp trawl fishery. Both fisheries occur in the Puget Sound. As part of the FCP, WDFW would implement the following measures:

1. Continue the closure by permanent regulation of the set net, set line, bottom fish trawl, bottom fish pot, and scallop trawl fisheries.
2. Continue to prohibit fishing for rockfish in Marine Catch Areas 5 through 13 (Figure 1).

3. Continue to prohibit retention of rockfish caught in any fishery in Marine Catch Areas 5 through 13.

4. Continue to prohibit bottom fishing in waters deeper than 120 feet throughout the range of any of the rockfish DPSs.

5. Require permit holders in the shrimp trawl fishery to have on-board observers on 10 percent of all trips to track bycatch.

6. Continue to allow only beam trawls in the shrimp trawl fishery (no rockhopper gear).

7. Report to NMFS annually on the above activities and adapt future fisheries and research efforts as necessary.

In addition, WDFW would continue long-standing regulations to reduce hooking mortalities for released fish that include a prohibition on barbed hooks, and limiting fishing gear to two individual hooks (no treble hooks) (WDFW 2010b).

The section 10(a)(1)(B) permit would be effective for a period of 5 years, and its issuance would authorize the amounts of take displayed in Table 2.

Table 2. Requested maximum annual and 5-year takes for ESA-listed rockfish, Chinook salmon, green sturgeon, and eulachon by the commercial shrimp trawl and recreational fisheries for bottom fish and other fish in the Puget Sound.

Species	Recreational		Shrimp Trawl		Combined Annual Takes		5-Year Takes	
	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal	Lethal
Bocaccio	26	12	0	5	26	17	130	85
Canary rockfish	81	47	0	10	81	57	405	285
Yelloweye rockfish	87	55	0	10	87	65	435	325
Chinook salmon*	30	12	0	50	30	62	150	310
Green sturgeon	0	0	0	1	0	1	0	5
Eulachon	0	0	0	3,240	0	3,240	0	16,200

*Number of Puget Sound Chinook salmon in the Recreational columns is estimated based on 2008-2010 creel data. These numbers assume a 20 percent sample rate and a 20 percent mortality rate for released Chinook salmon.

Description of Covered Fisheries

The types of fishing that would be covered include recreational bottom fishing with hook-and-line gear, and commercial shrimp trawling using bottom trawls. The fishing activities would be similar in duration and intensity to those that have occurred in the past several years in the action area.

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Recreational Bottom Fishing

Under the ITP, the WDFW would manage recreational bottom fish fisheries for a period of 5 years. For the 5 year period of the permit, fisheries management would be similar to the last several years, including overall levels of fishing, seasons, gear restrictions, and monitoring programs to estimate catch. From 2004 through 2009, the number of angler trips targeting bottom fish ranged between 68,000 and 105,000 annually (compared to approximately 350,000 angler trips targeting salmon), and anglers caught an average of 113,000 fish annually (WDFW 2012). Because fisheries management did not change significantly between 2009 and 2012, and would not change significantly in the foreseeable future, NMFS expects similar fishing efforts and catches to occur under the proposed action.

Under the permit, WDFW would continue to manage fisheries with similar requirements and seasons as in the last few years. The WDFW divides state waters into Marine Catch Areas (MCAs) in order to manage recreationally-caught fish and shellfish. There are nine MCAs in the Puget Sound region (Figure 1). The prohibition on bottom fishing would continue in waters deeper than 120 feet (36.6 m) in all nine MCAs throughout the ranges of all the DPSs, and anglers could not keep or target rockfish of any species in this area.

Anglers target a variety of bottom fish in the Puget Sound, including lingcod (*Ophiodon elongates*), cabezon (*Scorpaenichthys marmoratus*), kelp greenling (*Hexagrammos decagrammus*), and various flatfish (family Pleuronectidae) species. A few species, such as flatfish (other than halibut) and surfperch, can be legally harvested year-round in most areas of the Puget Sound, but other fisheries have defined seasons. During May and the first half of June, anglers would be permitted to fish for lingcod throughout most of Puget Sound. The lingcod fishery is the most popular bottom fish fishery in the Puget Sound (Pacunski and Palsson 2001). Anglers use large jigs, artificial worms, and live bait such as herring, flatfish, and kelp greenling while targeting lingcod and other bottom fish (Olander 1991; Martinis 2008). All hooks must be barbless. Currently, fishing for cabezon in MCAs 6 to 13 is only permitted from May 1 to November 30, and fishing for codfishes is allowed year-round in MCAs 6 and 7, but prohibited in MCAs 8 to 13. Hood Canal (MCA 12) has been closed to bottom fishing since 2002 because of the adverse impacts from periodic hypoxia events.

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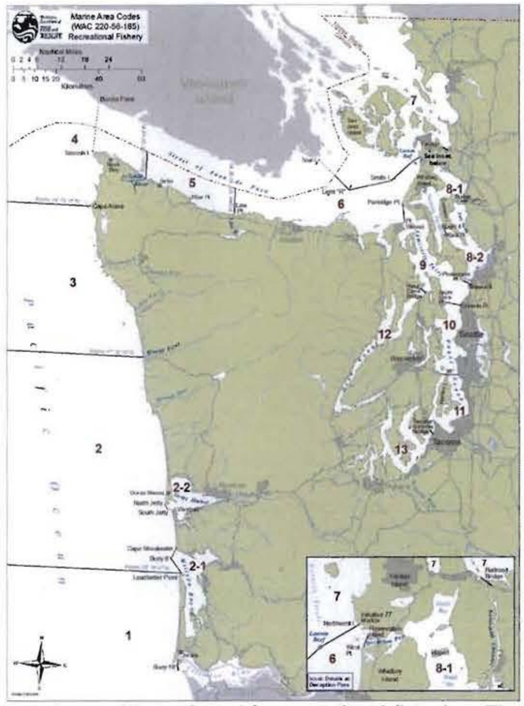

Figure 1. WDFW Marine Catch Areas of Puget Sound for recreational fisheries. These areas are used for regulation settings and catch reporting purposes. A portion of Marine Catch Area 6 is outside of the ESA-listed Rockfish DPSs.

To estimate catch in recreational bottom fishing, WDFW would monitor recreationally-caught bottom fish in Puget Sound as part of a larger marine fish catch estimation program that has been in place for several years (Chang et al. 2010). There are two survey components to the sampling design: an estimate of fishing effort (angler trips) and estimates of catch per unit effort ("CPUE," i.e., catch-per-angler-trip). Fishing effort (numbers of licensed angler trips) is estimated by telephone surveys of licensed anglers. CPUEs and the factor for expanding licensed trips to the total number of trips are estimated via intercept (creel) surveys (termed intercept surveys) at sites selected throughout Puget Sound. Catch from charter/party, beach/bank, and manmade structures (e.g., piers, docks, etc.) is not included in these estimates; however, effort from these modes is monitored. The WDFW also conducts regular hook-and-line surveys to mimic the behavior of recreational boat-based fisheries. These surveys independently document the catch rates for various fish species and obtain biological information. The WDFW estimates catch as the product of angler trips and CPUE (by species and catch area of harvest) for each catch area, month, fishing season, and day type.

The estimation procedure follows these four steps:

1. Recreational saltwater trips occurring in Puget Sound during a given wave (defined as a two-month period), are classified into trip classes by MCA and target species (salmon, halibut, bottom fish, and other).

2. For a given trip class, the following parameters are estimated from the intercept survey: catch per angler trip for each landed species (analogous to CPUE), release per angler trip for each reported species, and the ratio of total angler trips to total licensed angler trips.

3. For each reported trip class, the following parameter is estimated from the telephone survey: mean angler trips per licensed angler (so-called trip-rate).

4. Final estimates of total number of angler-trips are calculated for each trip class as the product of trip-rate, total licensed anglers during a given wave, and the ratio of total angler trips to total licensed angler trips. Final estimates for total catch and total release for each species are calculated as the product of the catch/release per angler trip and the estimated total angler trips. The final estimates for effort and catch are calculated for each trip class reported in the telephone survey. The WDFW bycatch (incidental take) estimates for rockfish are highly variable—ranging from zero to several hundred in one year.

The WDFW would determine the ratio of lethal and non-lethal takes for rockfish using methods developed by the Pacific Fishery Management Council to manage fisheries in coastal waters (PFMC 2008) to estimate the number of mortalities associated with bycatch of ESA-listed rockfish because of the recreational bottom fish fishery.

Commercial Shrimp Trawl Fishery

Under the ITP for fisheries, the WDFW would manage the commercial shrimp trawl fishery for a period of 5 years. For the 5 year period of the permit, fisheries would be managed using similar quotas, seasons, and gear restrictions, as in the last several years, so as to not meaningfully increase the risk of bycatch. The WDFW uses Management and Catch Reporting Areas to track and report commercial fisheries (Figure 2). The shrimp trawl fishery occurs in the San Juan and Strait of Juan de Fuca Basin of the Puget Sound in areas 23A, 23B, 25A, 20B, 21A, and 22A. Fishers use a beam trawl, consisting of a bag-shaped trawl net that uses a beam to spread the mouth of the net horizontally as it is towed; it does not have weighted otter frames or otter doors. Only beam trawls are legal trawl gear in the Puget Sound commercial shrimp fishery. The minimum mesh size for Puget Sound beam trawl nets is 1.5 inches (3.8 cm) stretch measure. The maximum beam width is 60 feet in the eastern Strait of Juan de Fuca, and 25 feet in the San Juan Islands. Beam trawls are towed for several minutes in waters restricted to deeper than 120 feet. Beam trawls can only be operated effectively over relatively level bottoms consisting of mud, sand, and gravel (Roberts 2008). The WDFW does not allow rockhopper trawl gear.

The shrimp beam trawl season generally runs from April 15 to October 31 in the Strait of Juan de Fuca, and from May 16 to October 15 in the San Juan Islands unless the quotas are attained first

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(which often happens in some of the areas). Shrimp quotas for 2010 were 697,000 pounds in the Strait of Juan de Fuca east of Port Angeles and 75,000 pounds in the San Juan Islands. From 2005 to 2010, the shrimp trawl fishery averaged 193 individual trips, with an average of 5 tows per trip (WDFW 2012).

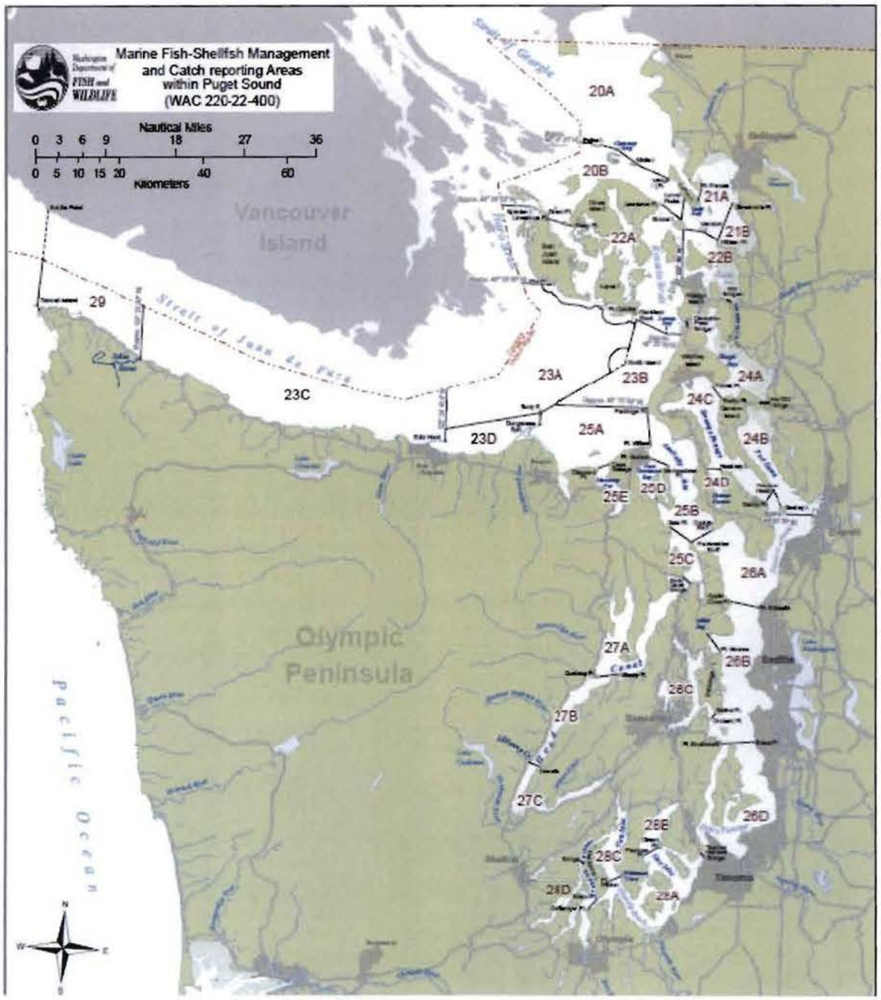

Figure 2. WDFW Management and Catch Reporting Areas for commercial fisheries in Puget Sound.

Over the past 10 years the WDFW observed several trips, which allows for estimates and composition of bycatch. From this data, bycatch is estimated by WDFW to be approximately 15,759 pounds of fish and invertebrates annually. Observers were not regularly deployed in this fishery prior to 2011. Under the ITP, WDFW would monitor bycatch in the shrimp trawl fishery with several methods. All shrimp trawl fishers would be required to maintain a logbook of their fishing activities and observers would be required on at least 10 percent of their individual fishing trips. Completed logs would give detailed information on the amount and location of shrimp trawling. WDFW observers would also conduct direct catch monitoring on commercial fishing vessels in order to sample the retained harvest and released bycatch. The WDFW selected a minimum target-monitoring rate of 10 percent by examination of similar monitoring efforts for section 10 Incidental Take Permits (Pate 2005). As part of an adaptive management program, which is described below, the target monitoring rates may be adjusted up or down, in coordination with NMFS.

Adaptive Management

WDFW would conduct an adaptive management program for the ITP that would entail monitoring, research, evaluations, and adjusting management actions for the recreational bottom fish fishery and the commercial shrimp trawl fishery. The WDFW's Puget Sound fish research program would also inform the adaptive management program.

On an annual basis, WDFW would:

- Monitor the bycatch of yelloweye rockfish, canary rockfish, and bocaccio (as well as other species) in the fisheries described above.
- Research Puget Sound marine biota. Research would focus on producing estimates of abundance, understanding demographics, and determining spatial distribution for all listed DPSs.
- Provide a report to NMFS that includes: (1) estimates of bycatch for each species within the marine catch areas from covered commercial and recreational fisheries; (2) incidental bycatch numbers of each species from research efforts; (3) any new research results for each species; and (4) an assessment of the potential need to modify fisheries regulations or reporting methodology or other management measures to protect these species.
- Adjust management actions (primarily fisheries regulations) to reduce bycatch. Such decisions have legal force and WDFW has the capacity to enforce regulations.

Adjusting Management Actions

As described in the FCP, the WDFW would produce an annual report containing results of monitoring and new research results; this report would be due to NMFS at the end of March following the year of the fishery. For example, the report for 2013 would be available by the end of March 2014. NMFS and the WDFW would plan and hold coordination meetings during the spring months of each year. This coordination would be based on the contents of the reports. The purpose of annual coordination would be to assess any new information about listed species status and viability risks. Updated bycatch numbers would also be assessed by WDFW. In addition, WDFW and NMFS would discuss future research efforts as well as any potential management actions to further reduce bycatch.

Management actions to further conserve ESA-listed fish would be put into place by WDFW if (1) additional scientific information regarding species status comes to light indicating that a change is needed; (2) bycatch numbers exceed certain thresholds (as discussed below); or (3) unforeseen or changed circumstances arise with regard to the fish or the fisheries. Unforeseen or changed circumstances could include natural or human-induced changes to the environment (such as oil spills) that place covered fish species at greater risk.

One management action that WDFW could take as part of this adaptive management program would be adjusting the observer coverage in the commercial shrimp trawl fishery. As part of an adaptive management program, the target monitoring rates may be adjusted up or down from the 10 percent target range, in coordination with NMFS. A possible reason for increasing the target-monitoring rate would be that the 10 percent rate does not provide sufficiently precise results to meet management needs. A possible reason for decreasing the rate would be that monitoring results indicate a lower sampling rate would produce satisfactory data. Any adjustment would occur only after at least one full year of monitoring, and with the approval of NMFS. The amount of listed species taken in the fishery would be monitored by WDFW examining completed logbooks, commercial fish tickets, and catch rates of listed species taken from observed catches and trips.

As noted above, WDFW has the authority to enact fishing regulations to conserve ESA-listed fish species. This authority includes specifying the time, place, and manner by which ESA-listed rockfish and other listed species may be protected from incidental take. There are two types of rule making authority: emergency and permanent. An emergency rule addresses emerging, urgent situations. The Director has the authority to issue an emergency rule, which can be completed within a few days. Emergency rules last a maximum of 120 days, but may be renewed for an additional 120 days under certain circumstances. A permanent rule deals with long-term, foreseeable issues and has no set expiration date. The Fish and Wildlife Commission[7] reviews permanent rules, and typically requires at least three months to make rule changes. Usually, WDFW considers changes in permanent rules for recreational fishing on a biennial basis, and WDFW staff prepares suggestions for rule changes and requests ideas from stakeholders during the spring and summer. WDFW evaluates these suggestions and provides an opportunity for public comment prior to the Fish and Wildlife Commission taking action on any proposal.

The primary driver of any adaptive management action (such as a change in regulation) is the amount of bycatch incurred by the two fisheries. The estimated annual bycatch of ESA-listed rockfish in the recreational bottom fish fishery has varied greatly in recent years. For example, yelloweye rockfish bycatch annual estimates ranged from 0 to 566 fish from 2003 to 2009 (WDFW 2011b). No such systematic estimates have occurred for the shrimp trawl fishery. Nonetheless, the bycatch of ESA-listed rockfish and eulachon in the shrimp trawl fishery is likely to be variable as well. In order to accommodate this variability, WDFW would manage

[7] The Washington Fish and Wildlife Commission consists of nine members serving six-year terms. Members are appointed by the governor and confirmed by the senate. While the Commission has several responsibilities, its primary role is to establish policy and direction for fish and wildlife species and their habitats in Washington and to monitor the Department's implementation of the goals, policies, and objectives established by the Commission. The Commission also classifies wildlife and establishes the basic rules and regulations governing the time, place, manner, and methods used to harvest or enjoy fish and wildlife.

the take of ESA-listed rockfish from recreational bottom fish fisheries and commercial shrimp trawls, and eulachon take from commercial shrimp trawls both on an annual and on a cumulative five-year basis. That is, the FCP would go forward with two thresholds to trigger a change in management (see Table 3).

If estimated annual take exceeded the projected annual take by 20 percent during any of the first three years of the ITP, an adaptive management response could occur. The WDFW and NMFS would assess the circumstances of the exceedance and determine if WDFW would need to make changes to its fishery management to reduce future bycatch. During years four and five of the ITP, the WDFW and NMFS would assess the potential that the five-year cumulative take could be exceeded and determine if WDFW would need to implement changes to fishery management to reduce bycatch. Total take for the 5-year period is capped at 215 bocaccio, 690 canary rockfish, 760 yelloweye rockfish, and 16,200 eulachon. The effects of any bycatch exceeding these numbers are not analyzed in this opinion and would not be covered by the ITP.

Table 3. Annual rockfish and eulachon takes and adaptive management.

Species	Projected Annual Take for Recreational Bottom Fish and Shrimp Trawl Fisheries	Year 1, 2, & 3 Adaptive Management Trigger	5-Year Cumulative Take Limit
Bocaccio	43 (including 5 from shrimp trawl)	50	215
Canary Rockfish	138 (including 10 from shrimp trawl)	166	690
Yelloweye Rockfish	152 (including 10 from shrimp trawl)	180	760
Eulachon	3,240 (all from shrimp trawl)	3,889	16,200

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). Because the actions considered here are so widespread and may take place in randomly determined sites from year to year throughout Puget Sound and the Straits of Juan de Fuca, they encompass the entire geographic ranges inhabited by yelloweye rockfish, canary rockfish, and bocaccio DPSs in the Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill. Thus, the action area for this opinion covers the entirety of the area displayed in Figure 3 (shaded)[8]. In addition, some portions of the research activities conducted by WDFW would extend beyond the range of the ESA-listed rockfish DPSs, westward to the town of Sekiu.

[8] As enumerated in Table 2, the proposed action would take some eulachon, salmonids, and green sturgeon in the action area. Some of those fish could conceivably have moved out of the action area had they not been killed, but these numbers are so small as to be insignificant relative to their total numbers. Therefore, delineating the action area to include some portion of waters outside of that displayed in the Figure 3 would be inappropriate.

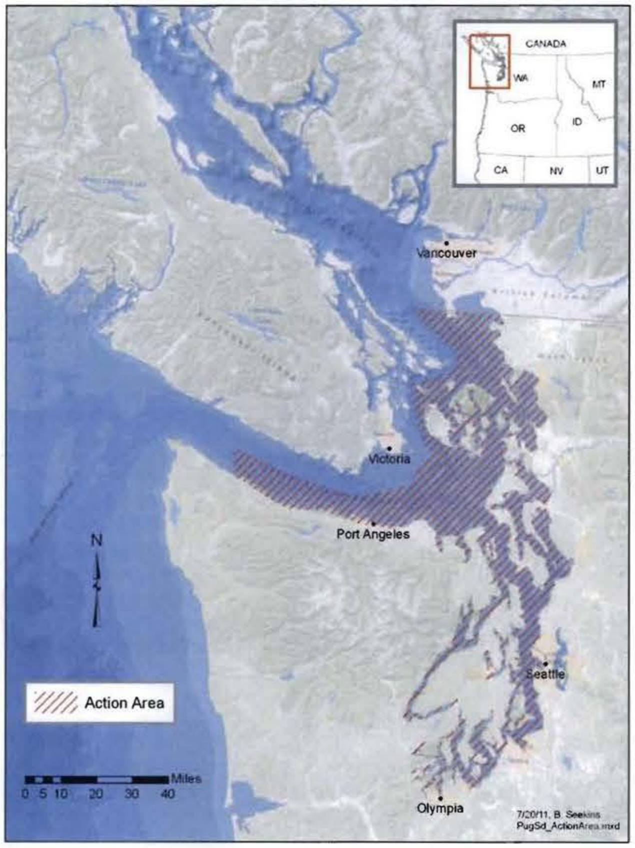

Figure 3. Action area.

2. ENDANGERED SPECIES ACT BIOLOGICAL OPINION

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat on which they depend. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions would affect listed species or their critical habitat. If incidental take is expected, section 7(b)(4) requires the provision of an incidental take statement (ITS) specifying the impact of any incidental taking, and including reasonable and prudent measures to minimize such impacts.

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts to the conservation value of the designated critical habitat.

"To jeopardize the continued existence of a listed species" means to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02).

As noted above, the species under consideration in this opinion are PS/GB yelloweye rockfish PS/GB canary rockfish, PS/GB bocaccio, PS Chinook salmon, PS steelhead, HCS chum salmon, green sturgeon, and eulachon (and their critical habitat where designated). The proposed actions also have the potential to affect SR killer whales and their critical habitat by diminishing the whales' prey base or from vessel interactions. We concluded that the proposed activities are not likely to adversely affect SR killer whales or their critical habitat and the full analysis is found in the "Not Likely to Adversely Affect" Determination in Section 2.9.1.

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[9] That is, we will determine whether critical habitat would remain functional (or retain the current ability for the primary constituent elements (PCEs) to be functionally established) and fulfill its conservation role for the species.

[9] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

We will use the following approach to determine whether the proposed action described in Section 1.3 is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.* This section describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" (VSP) paper (McElhany et al. 2000). NMFS used similar criteria to analyze the status of ESA-listed rockfish, eulachon, and green sturgeon because these parameters are applicable for a wide variety of species. The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For each listed species, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. For species with critical habitat designated, we determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called PCEs in some designations), which were identified when the critical habitat was designated. Species and critical habitat status are discussed in Section 2.2.
- *Describe the environmental baseline for the proposed action.* The environmental baseline includes the past and present impacts of Federal, state, or private actions and other human activities *in the action area*. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process. The environmental baseline is discussed in Section 2.3 of this opinion.
- *Analyze the effects of the proposed actions.* In this step, NMFS considers how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP characteristics. NMFS also evaluates the proposed action's effects on critical habitat features. The effects of the action are described in Section 2.4 of this opinion.
- *Describe any cumulative effects.* Cumulative effects, as defined in NMFS' implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation. Cumulative effects are considered in Section 2.5 of this opinion.
- *Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.* In this step, NMFS adds the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) to assess whether the action could reasonably be expected to: (1) appreciably reduce the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species. These

assessments are made in full consideration of the status of the species and critical habitat (Section 2.2). Integration and synthesis occurs in Section 2.6 of this opinion.

- *Reach jeopardy and adverse modification conclusions.* Conclusions regarding jeopardy and the destruction or adverse modification of critical habitat are presented in Section 2.7. These conclusions are based on, and flow from, the logic and rationale presented in the Integration and Synthesis section (2.6).

2.2 Rangewide Status of the Species and Critical Habitat

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

The ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." NMFS adopted a policy for identifying a salmon DPS in 1991 (56 Fed. Reg. 58612, November 20, 1991). The policy equates an ESU with a DPS, and states that a population or group of populations is considered an ESU if it is "substantially reproductively isolated from conspecific populations," and if it represents "an important component of the evolutionary legacy of the species." Hence, the Chinook salmon and chum salmon listing units in this biological opinion are ESUs of the species *O. tshawytscha* and *O. keta*, respectively, and the steelhead listing units in this biological opinion are DPSs of the species *O. mykiss*. The ESUs and DPSs of salmon and steelhead include natural-origin populations and hatchery populations, as described below. The DPSs of ESA-listed rockfish, eulachon, and green sturgeon are all natural-origin fish.

Section 4(d) protective regulations prohibit the take of naturally spawned salmonids and of listed hatchery fish with an intact adipose fin, but do not prohibit take of listed hatchery fish that have their adipose fins removed prior to release into the wild (70 Fed. Reg. 37160, June 28, 2005; 71 Fed. Reg. 834, January 5, 2006; 73 Fed. Reg. 7816, February 11, 2008). As a result, researchers do not need a permit to take hatchery fish that have had their adipose fin removed, but do need a permit if they encounter listed fish with an intact adipose fin in the course of that research. This document evaluates impacts on both all natural and hatchery fish to allow a full examination of the effects of the action on the species as a whole.

Climate Change

One factor affecting the status of listed fishes and aquatic habitat is climate change. As reviewed in ISAB (2007), the current status of salmon and steelhead species, and their critical habitat in the Pacific Northwest, has been influenced by climate change over the past 50 to 100 years and this change is expected to continue into the future. Average annual Northwest air temperatures

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have increased by approximately 1.8°F (1°C) since 1900, which is nearly twice that for the last 100 years, indicating an increasing rate of change. Summer temperatures, under the A1B emissions scenario (a "medium" warming scenario), are expected to increase 3°F (1.7°C) by the 2020s and 8.5°F (4.7°C) by 2080 relative to the 1980s in the Pacific Northwest (Mantua et al. 2010). This change in surface air temperature has already modified, and is likely to continue to modify, freshwater, estuarine, and marine habitats of salmon and steelhead, including designated critical habitat. Consequently, abundance, productivity, spatial distribution, and diversity of salmonid life stages occupying each type of affected habitat is likely to be further modified, generally in a detrimental manner. There is still a great deal of uncertainty associated with predicting specific changes in timing, location, and magnitude of future climate change. It is also likely that the intensity of climate change effects on salmon and steelhead will vary by geographic area.

As described in ISAB (2007), climate change effects that have, and will continue to, influence the habitat and species in the action area include increased ocean temperature, increased stratification of the water column, and intensity and timing changes of coastal upwelling. These continuing changes will alter primary and secondary productivity, marine community structures, and in turn, salmonid growth, productivity, survival, and migrations. A mismatch between earlier smolt migrations for salmon (because of earlier peak spring freshwater flows and decreased incubation period) and altered upwelling may reduce marine survival rates (including larval rockfish). Increased concentration of CO^2 reduces carbonate availability for shell-forming invertebrates, including some juvenile salmonid and rockfish prey items.

2.2.1 Status of Listed Species

As noted above in Section 2.1, when discussing a species' status, we organize the discussion in terms of the VSP criteria: abundance, productivity, spatial structure, and diversity. Abundance is a direct measure of a species' absolute numbers—the bigger the number, the more fish there are. Productivity is a measure of how well each succeeding generation of fish is able to replace the one that came before—if productivity is greater than 1.0 for a given time period, the population, population group, or species is on the increase; if productivity is below 1.0, it is on the decrease (for that time period). A population's spatial structure is made up of both the geographic distribution of individuals in the population and the processes that generate that distribution, such as oceanic currents, migration of individuals, etc., discussed in McElhany et al. (2000). Diversity in salmon populations is represented by differences within and among populations in morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, and molecular genetic characteristics (McElhany et al. 2000). In the subsections that follow we discuss the species' status in terms of these VSP parameters. The estimated abundance for each species is listed in Section 2.4.1, Table 7.

2.2.1.1 Status of Rockfish Species

We describe the status of each species with nomenclature referring to specific areas of the Puget Sound. The Puget Sound is the second-largest estuary in the United States, located in northwest Washington State and covering an area of about 900 square miles (2,330 square km), including

2,500 miles (4,000 km) of shoreline. Puget Sound is part of a larger inland waterway, the Georgia Basin, situated between southern Vancouver Island, British Columbia, Canada and the mainland coast of Washington State. Puget Sound can be subdivided into five interconnected basins separated by shallow sills: (1) The San Juan/Strait of Juan de Fuca Basin (also referred to as "North Sound"), (2) Main Basin, (3) Whidbey Basin, (4) South Sound, and (5) Hood Canal. We use the term "Puget Sound proper" to refer to all of these basins except the San Juan/Strait of Juan de Fuca Basin.

The Puget Sound/Georgia Basin DPSs of yelloweye rockfish and canary rockfish are listed under the ESA as threatened, and bocaccio are listed as endangered (75 Fed. Reg. 22276, April 28, 2010). These DPSs include all yelloweye rockfish, canary rockfish, and bocaccio found in waters of the Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill (Figure 4). Unlike ESA-listed salmonids, we have not identified biological populations of each species below the DPS level, and thus use the term "populations" to refer to groups of fish within a particular basin of the DPSs. Yelloweye rockfish, canary rockfish, and bocaccio are three of 28 species of rockfish in Puget Sound (Palsson et al 2009).

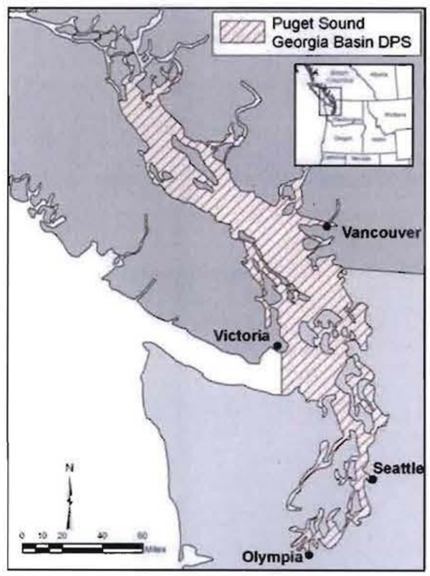

Figure 4. ESA-listed rockfish DPS.

The life-histories of yelloweye rockfish, canary rockfish, and bocaccio include a larval/pelagic juvenile stage followed by a nearshore juvenile stage, and sub-adult and adult stages. Much of the life-history and habitat use for these three species is similar, with differences noted below.

Rockfish fertilize their eggs internally, and the young are extruded as larvae. Yelloweye rockfish, canary rockfish, and bocaccio produce from several thousand to over a million eggs

(Love et al. 2002). Larvae can make small local movements to pursue food immediately after birth (Tagal et al. 2002), but are likely passively distributed with prevailing currents (NMFS 2003). Larvae are observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995) but are also distributed throughout the water column (Weis 2004). Unique oceanographic conditions within Puget Sound proper likely result in most larvae staying within the basin where they are released (e.g., the South Sound) rather than being broadly dispersed (Drake et al. 2010).

When bocaccio and canary rockfish reach sizes of 1 to 3.5 inches (3 to 9 cm) (approximately 3 to 6 months old), they settle onto shallow nearshore waters in rocky or cobble substrates with or without kelp (Love et al. 1991, 2002). These habitat features offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Areas with floating and submerged kelp species support the highest densities of most juvenile rockfish (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Matthews 1989). Unlike bocaccio and canary rockfish, juvenile yelloweye rockfish do not typically occupy intertidal waters (Love et al. 1991; Studebaker et al. 2009), but settle in 98 to 131 feet (30 to 40 m) of water near the upper depth range of adults (Yamanaka and Lacko 2001).

Sub-adult and adult yelloweye rockfish, canary rockfish, and bocaccio typically utilize habitats with moderate to extreme steepness, complex bathymetry, and rock and boulder-cobble complexes (Love et al. 2002). Within Puget Sound proper, each species has been documented in areas of high relief rocky and non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Yelloweye rockfish remain near the bottom and have small home ranges, while some canary rockfish and bocaccio have larger home ranges, move long distances, and spend time suspended in the water column (Love et al. 2002). Adults of each species are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000).

Yelloweye rockfish are one of the longest lived of the rockfishes, with some individuals reaching more than 100 years of age. They reach 50 percent maturity at sizes around 16 to 20 inches (40 to 50 cm) and ages of 15 to 20 years (Rosenthal et al. 1982; Yamanaka and Kronlund 1997). Maximum age of canary rockfish is at least 84 years (Love et al. 2002), although 60 to 75 years is more common (Caillet et al. 2000). They reach 50 percent maturity at sizes around 16 inches (40 cm) and ages of 7 to 9 years. The maximum age of bocaccio is unknown, but may exceed 50 years, and they are first reproductively mature near age 6 (FishBase 2010).

The timing of larval release for each species varies throughout the geographic range. In Puget Sound, there is some evidence that larvae are extruded in early spring to late summer for yelloweye rockfish (Washington et al. 1978). In British Columbia, parturition (larval birth) peaks in February for canary rockfish (Hart 1973; Westrheim and Harling 1975). Along the coast of Washington State, female bocaccio release larvae between January and April (Love et al. 2002).

In the following section, we summarize the condition of yelloweye rockfish, canary rockfish, and bocaccio at the DPS level according to the following demographic viability criteria: abundance and productivity, spatial structure/connectivity, and diversity. These viability criteria are

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outlined in McElhaney et al. (2000) and reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species. These criteria describe demographic risks that individually and collectively provide strong indicators of extinction risk (Drake et al. 2010). There are several common risk factors detailed below at the introduction of each of the viability criteria for each listed rockfish species. Information on species and habitat limiting factors can affect abundance, spatial structure and diversity are also described.

Abundance and Productivity

There is no single reliable historic or contemporary population estimate for yelloweye rockfish, canary rockfish, or bocaccio within the Puget Sound/Georgia Basin DPS (Drake et al. 2010). Despite this limitation, there is clear evidence each species' abundance has declined dramatically (Drake et al. 2010). The total rockfish population in the Puget Sound region is estimated to have declined around three percent per year for the past several decades, which corresponds to an approximate 70 percent decline from the 1965 to 2007 time period (Drake et al. 2010). Catches of yelloweye rockfish, canary rockfish, and bocaccio have declined as a proportion of the overall rockfish catch (Drake et al. 2010; Palsson et al. 2009). Yelloweye rockfish were 2.4 percent of the harvest in North Sound during the 1960s, occurred in 2.1 percent of the harvest during the 1980s, but then decreased to an average of one percent from 1996 to 2002 (Palsson et al. 2009). In Puget Sound proper, yelloweye rockfish were 4.4 percent of the harvest during the 1960s, only 0.4 percent during the 1980s, and 1.4 percent from 1996 to 2002 (Palsson et al. 2009). Canary rockfish occurred in 6.5 percent of the North Sound recreational harvests during the 1960s and then declined to 1.4 percent and to 0.6 percent during the subsequent two periods (Palsson et al. 2009). During the 1960s, canary rockfish were 3.1 percent of the Puget Sound proper rockfish harvest and then declined to one percent in the 1980s and 1.4 percent from 1996 to 2002 (Palsson et al. 2009).

Bocaccio consisted of 8 to 9 percent of the overall rockfish catch in the late 1970s and declined in frequency, relative to other species of rockfish, from the 1970s to the 1990s (Drake et al. 2010). From 1975 to 1979, bocaccio averaged of 4.63 percent of the catch. From 1980 to 1989, they were 0.24 percent of the 8,430 rockfish identified (Palsson et al. 2009). In the 1990s and early 2000s bocaccio were not observed by WDFW in the dockside surveys of the recreational catches (Drake et al. 2010). In 2008 and 2009, some fish were reported by recreational anglers in the Central Sound (WDFW 2011b).

Present-day abundance is influenced by bycatch from several commercial and recreational fisheries. Though rockfish may no longer be retained in these fisheries, released fish are often injured or killed by barotrauma. When rockfish are brought from depths of deeper than 60 feet (18.3 m) the rapid decompression causes over-inflation and/or rupture of the swim bladder (termed barotrauma), which can result in multiple injuries (Jarvis and Lowe 2008; Palsson et al. 2009; Parker et al. 2006). These injuries cause various levels of disorientation among rockfish species, which result in fish remaining at the surface after they are released (Hannah and Matteson 2007). Rockfish at the surface are susceptible to predation by birds, sharks, or marine mammals, damage from solar radiation, and gas embolisms (Palsson et al. 2009).

Fishery-independent estimates of population abundance come from spatially and temporally limited research trawls, drop camera surveys, and underwater remotely operated vehicle (ROV) surveys conducted by WDFW. These population estimates included in Table 4 should be interpreted in the context of the sampling design and gear. The trawl surveys were conducted on the bottom to assess marine fish abundance for a variety of species. These trawls generally sample over non-rocky substrates where yelloweye rockfish, canary rockfish, and bocaccio are less likely to occur compared to steep-sloped, rocky habitat (Drake et al. 2010). The drop camera surveys sampled habitats less than 120 feet (36.6 m), which is potential habitat for juveniles, but less likely habitat for adults of the three listed species. Similarly, because juvenile yelloweye rockfish are less dependent on rearing in shallow nearshore environments, the likelihood of documenting them with drop camera surveys in water shallower than 120 feet (36.6 m) is less than for canary rockfish and bocaccio.

The WDFW ROV surveys were conducted exclusively within the rocky habitats of the San Juan Basin in 2008, and represent the best available abundance estimates for one basin of the DPS for each species to date because of their survey area, number of transects, and stratification methods. Rocky habitats have been mapped within the San Juan Basin, which allows a randomized survey of these areas to assess species assemblages and collect data for abundance estimates. WDFW conducted 200 transects and stratified each rocky habitat survey as either "shallower than" and "deeper than" 120 feet (36.6 m). The total area surveyed within each stratum was calculated using the average transect width multiplied by the transect length. The mean density of yelloweye rockfish, canary rockfish, and bocaccio was calculated by dividing the species counts within each stratum by the area surveyed. Population estimates for each species were calculated by multiplying the species density estimates by the total survey area within each stratum (WDFW unpublished data). Because WDFW did not survey non-rocky habitats of the San Juan Basin with the ROV, these estimates do not account for ESA-listed rockfish in non-rocky habitat in 2008. WDFW expanded the survey data to estimate total abundance in the San Juan Basin (Table 4). From the midwater trawl and drop camera surveys, WDFW has reported population estimates in the North Sound and Puget Sound proper (Table 4).

Though the bottom trawl and drop camera surveys did not detect canary rockfish or bocaccio in Puget Sound proper, each species has been historically present there and each has been caught in recent recreational fisheries. The lack of detected canary rockfish and bocaccio from these sampling methods in Puget Sound proper is probably due to the following factors: 1) populations of each species are depleted; 2) the general lack of rocky benthic areas in Puget Sound proper may lead to densities of each species that are naturally less than the San Juan Basin; and 3) the study design or effort may not have been sufficiently powerful to detect each species. Though yelloweye rockfish were detected in Puget Sound proper with bottom trawl surveys, we do not consider the WDFW estimate of 600 fish to be a complete estimate, for the same reasons given above. Thus, there are no reliable abundance estimates of yelloweye rockfish, canary rockfish, or bocaccio within Puget Sound proper sufficient to definitively quantify the analysis of effects of the proposed action.

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Table 4. WDFW population estimates for yelloweye rockfish, canary rockfish, and bocaccio.

WDFW Survey Method	Yelloweye Population Estimate		Percent Standard Error (or Variance)	
	North Sound	Puget Sound proper		
Bottom Trawl	Not detected	600	NA	400 (variance)
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	47,407 (San Juan Basin)		29	
WDFW Survey Method	**Canary Population Estimate**		**Percent Standard Error**	
	North Sound	**Puget Sound proper**		
Bottom Trawl	16,100	Not detected	260.6 (variance)	NA
Drop Camera	2,751	Not detected	89.3	NA
Remotely Operated Vehicle	1,697 (San Juan Basin)		100	
Total Population Estimate	20, 548		na	
WDFW Survey Method	**Bocaccio Population Estimate**		**Percent Standard Error**	
	North Sound	**Puget Sound proper**		
Bottom Trawl	Not detected	Not detected	NA	NA
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	4,606 (San Juan Basin)		100	

Productivity is the measurement of a population's growth rate through all or a portion of its life-cycle. Life-history traits of yelloweye rockfish, canary rockfish, and bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Drake et al. 2010; Tolimieri and Levin 2005). Historic over-fishing can have dramatic impacts on the size or age structure of the population, with effects that can influence ongoing productivity. When the size and age of females decline, there are negative impacts to reproductive success. These impacts, termed maternal effects, are evident in a number of traits. Larger and older females of various rockfish species have a higher weight-specific fecundity (number of larvae per unit of female weight) (Bobko and Berkeley 2004; Boehlert et al. 1982; Sogard et al. 2008). A consistent maternal effect in rockfishes relates to the timing of parturition. The timing of larval birth can be crucial in terms of corresponding with favorable oceanographic conditions because most larvae are released on only one day each year, with a few exceptions in southern coastal populations and in yelloweye rockfish in Puget Sound (Washington et al. 1978). Several studies of rockfish species have shown that larger or older females release larvae earlier in the season compared to smaller or younger females (Nichol and Pikitch 1994; Sogard et al. 2008). Larger or older females provide more nutrients to larvae by developing a larger oil globule released at parturition, which provides energy to the developing larvae (Berkeley et al. 2004; Fisher et al. 2007), and in black rockfish enhances early growth rates (Berkeley et al. 2004).

Contaminants such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and chlorinated pesticides appear in rockfish collected in urban areas (Palsson et al. 2009). While the highest levels of contamination occur in urban areas, toxins can be found in the tissues of fish throughout Puget Sound (West et al. 2001). Although few studies have investigated the effects of toxins on rockfish ecology or physiology, other fish in the Puget Sound region that have been studied do show a substantial impact, including reproductive dysfunction of some sole species (Landahl et al. 1997). Reproductive function of rockfish is also likely affected by contaminants (Palsson et al. 2009) and other life-history stages may be as well (Drake et al. 2010).

Future climate-induced changes to rockfish habitat could alter their productivity (Drake et al. 2010). Harvey (2005) created a generic bioenergetic model for rockfish, showing that productivity of rockfish is highly influenced by climate conditions. For instance, El Niño-like conditions generally lowered growth rates and increased generation time. The negative effect of the warm water conditions associated with El Niño appear to be common across rockfishes (Moser et al. 2000). Recruitment of all species of rockfish appears to be correlated at large scales. Field and Ralston (2005) hypothesized that such synchrony was the result of large-scale climate forcing. Exactly how climate influences rockfish in Puget Sound is unknown; however, given the general importance of climate to rockfish recruitment, it is likely that climate strongly influences the dynamics of ESA-listed rockfish population viability (Drake et al. 2010), although the consequences of climate change to rockfish productivity during the course of the proposed action will probably be small.

Yelloweye Rockfish Abundance and Productivity

Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin of the DPS. Though there is a lack of a reliable population census (ROV or otherwise) within the basins of Puget Sound proper, the San Juan Basin has the most suitable rocky benthic habitat (Palsson et al. 2009) and historically was the area of greatest numbers of angler catches (Moulton and Miller 1987; Olander 1991). Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Wallace 2007; Yamanaka and Kronlund 1997). Productivity may also be particularly impacted by Allee effects, which occur as adults have been removed by fishing, and the density and proximity of mature fish has decreased. Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and may not move to find suitable mates.

Canary Rockfish Abundance and Productivity

Historically, the South Sound may have been a population stronghold within the DPS, but it appears to be greatly depleted (Drake et al. 2010). Natural annual mortality ranges from 6 to 9 percent (Methot and Stewart 2005; Stewart 2007). Life-history traits suggest intrinsically slow growth rate and low rates of productivity for this species, specifically its age at maturity, long generation time, and its maximum observed age (84 years) (Love et al. 2002). Past commercial and recreational fishing may have depressed the DPS to a threshold beyond which optimal productivity is unattainable (Drake et al. 2010).

Bocaccio Abundance and Productivity

Bocaccio in the Puget Sound/Georgia Basin were historically most common within the South Sound and Central Sound Basins (Drake et al. 2010). Though bocaccio were never a predominant segment of the multi-species rockfish population within the Puget Sound/Georgia Basin (Drake et al. 2010), their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Bocaccio abundance may be very low in significant segments of the Puget Sound/Georgia Basin. From 1998 to 2008, fish were reported by anglers in only one basin of the DPS range. Productivity is driven by high fecundity and episodic recruitment events, largely correlated with environmental conditions. Thus, bocaccio populations do not follow consistent growth trajectories and sporadic recruitment drives population structure (Drake et al. 2010). Natural annual mortality is approximately eight percent (Palsson et. al 2009). Tolimieri and Levin (2005) found that the bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of failed recruitment being the norm (Tolimieri and Levin 2005). Given their severely reduced abundance, Allee effects may be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates.

In summary, though abundance and productivity data for each species is relatively imprecise, both have been reduced largely by fishery removals within the range of the DPSs.

<u>Spatial Structure and Connectivity</u>

Spatial structure consists of a population's geographical distribution and the processes that generate that distribution (McElhaney et al. 2000). A population's spatial structure depends on habitat quality, spatial configuration, and dynamics as well as dispersal characteristics of individuals within the population (McElhaney et al. 2000). Prior to contemporary fishery removals, each of the major basins in the range of the DPSs likely hosted relatively large populations of yelloweye rockfish, canary rockfish, and bocaccio (Moulton and Miller 1987; Washington 1977; Washington et al. 1978). This distribution allowed each species to utilize the full suite of available habitats to maximize their abundance and demographic characteristics, thereby enhancing their resilience (Hamilton 2008). This distribution also enabled each species to potentially exploit ephemerally good habitat conditions, or in turn receive protection from smaller-scale and negative environmental fluctuations. These types of fluctuations may change prey abundance for various life stages and/or may change environmental characteristics that

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influence the number of annual recruits. Spatial distribution also provides a measure of protection from larger scale anthropogenic changes that damage habitat suitability, such as oil spills or hypoxia that can occur within one basin, but not necessarily the other basins. Rockfish population resilience is sensitive to changes in connectivity among various groups of fish (Hamilton 2008). Hydrologic connectivity of the basins of the Puget Sound is naturally restricted by relatively shallow sills located at Deception Pass, Admiralty Inlet, the Tacoma Narrows, and in Hood Canal (Burns 1985). The Victoria Sill bisects the Strait of Juan de Fuca and runs from east of Port Angeles north to Victoria, and regulates water exchange (Drake et al. 2010). These sills regulate water exchange from one basin to the next, and thus likely moderate the movement of rockfish larvae (Drake et al. 2010). When localized depletion of rockfish occurs it can reduce stock resiliency (Hamilton 2008; Hilborn et al. 2003; Levin 1998). The effects of localized depletions of rockfish are likely exacerbated by the natural hydrologic constrictions within Puget Sound.

Yelloweye Rockfish Spatial Structure and Connectivity

Yelloweye rockfish spatial structure and connectivity is threatened by the reduction of fish within each of the basins of the DPS. This reduction is most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range (Drake et al. 2010). Yelloweye rockfish are probably most abundant within the San Juan Basin, but the likelihood of juvenile recruitment from this basin to the adjacent basins of Puget Sound proper is naturally low because of the generally retentive circulation patterns that occur within each of the major basins of Puget Sound proper. Combined with limited adult movement, yelloweye rockfish population viability may be highly influenced by the probable localized loss of populations within the DPS, which decreases spatial structure and connectivity.

Canary Rockfish Spatial Structure and Connectivity

Canary rockfish were present in each of the major basins of the DPS in the 1970s (Moulton and Miller 1987), yet were not detected in any WDFW trawl or drop camera survey in Puget Sound proper within the past several years. Several historically large populations in the canary rockfish DPS may be severely reduced, including an area of distribution in South Sound, which has declined because of harvest and perhaps because of low dissolved oxygen (Drake et al. 2010). The apparent steep reduction of fish in Puget Sound proper leads to concerns about the viability of these populations (Drake et al. 2010). The ability of adults to migrate hundreds of kilometers could allow the DPS to re-establish spatial structure and connectivity in the future under favorable conditions (Drake et al. 2010).

Bocaccio Spatial Structure and Connectivity

Most bocaccio within the DPS may have been historically spatially limited to several basins within the DPS. They were historically most abundant in the Central and South Sound (Drake et al. 2010) with no documented occurrences in the San Juan Basin until 2008 (WDFW 2011b). Positive signs for spatial structure and connectivity come from the propensity of some adults and pelagic juveniles to migrate long distances, which could re-establish aggregations of fish in

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formerly occupied habitat (Drake et al. 2010). 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.

In summary, spatial structure and connectivity for each species have been adversely impacted, mostly by fishery removals. These impacts to species viability are probably most acute for yelloweye rockfish because of their sedentary nature as adults.

Diversity

Characteristics of diversity for rockfish include fecundity, timing of the release of larvae and their condition, morphology, age at reproductive maturity, physiology, and molecular genetic characteristics. In spatially and temporally varying environments, there are three general reasons why diversity is important for species and population viability: 1) diversity allows a species to use a wider array of environments; 2) it protects a species against short-term spatial and temporal changes in the environment; and 3) genetic diversity provides the raw material for surviving long-term environmental changes. Though there are no genetic data for the ESA-listed rockfish DPSs, the unique oceanographic features and relative isolation of some of its basins may have led to unique adaptations, such as timing of larval release (Drake et al. 2010).

Yelloweye Rockfish Diversity

Yelloweye rockfish size and age distributions have been truncated. Recreationally caught yelloweye rockfish in the 1970s spanned a broad range of sizes. By the 2000s, there was some evidence of fewer older fish in the population (Drake et al. 2010). However, overall numbers of fish in the database were also much lower, making it difficult to determine if clear size truncation occurred within the U.S. portion of the DPS. (An example of age truncation because of fishery removals can be found from fished and unfished habitats within British Columbia waters as shown in Figure 5.) No adult yelloweye rockfish have been observed within the WDFW ROV surveys. As a result, the reproductive burden may be shifted to younger and smaller fish. This shift could alter the timing and condition of larval release, which may be mismatched with habitat conditions within the range of the DPS, potentially reducing the viability of offspring (Drake et al. 2010).

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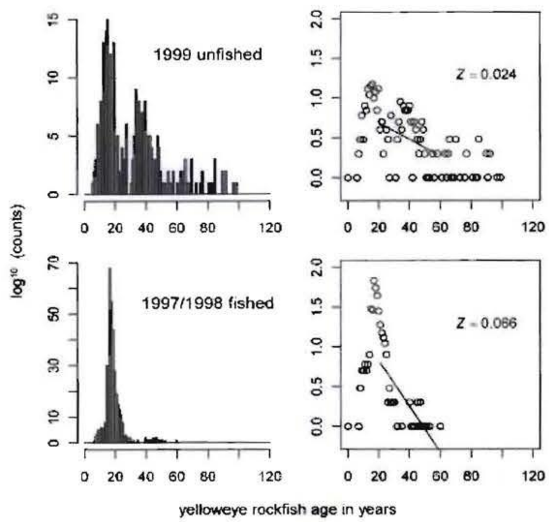

Figure 5. Yelloweye rockfish age frequencies (left images) and catch curves (right images, z = total mortality rate) from largely unfished (top left) and fished (bottom left) habitats in British Columbia. From Yamanaka and Logan 2010. Figure used with permission of the authors.

Canary Rockfish Diversity

Canary rockfish size and age distributions have been truncated (Drake et al. 2010). As a result, the reproductive burden may be shifted to younger and smaller fish. The population of canary rockfish in the 1970s exhibited a broad range of sizes. However, by the 2000s there were far fewer size classes represented and no fish greater than 21.65 inches (55 cm) were recorded in the recreational data (Drake et al. 2010). Although some of this truncation may be a function of the overall lower number of sampled fish, the data in general suggest few older fish remain in the population. This shift could alter the timing and condition of larval release that may be mismatched with habitat conditions within the DPS, potentially reducing the viability of offspring (Drake et al. 2010).

Bocaccio Diversity

Size-frequency distributions for bocaccio in the 1970s indicate a wide range of sizes, with recreationally caught individuals from 9.8 to 33.5 inches (25 to 85 cm). This broad size distribution suggests a spread of ages, with some successful recruitment over many years. A similar range of sizes is also evident in the 1980s catch data. The temporal trend in size distributions for bocaccio also suggests size truncation of the population, with larger fish becoming less common over time. By the decade of the 2000s, no size distribution data for bocaccio were available. Bocaccio in the Puget Sound/Georgia Basin may have physiological or behavioral adaptations because of the unique habitat conditions in the range of the DPS. The potential loss of diversity in the bocaccio DPS, in combination with their relatively low productivity, may result in a mismatch with habitat conditions and further reduce population viability (Drake et al. 2010).

In summary, diversity for each species has likely been adversely impacted by fishery removals. In turn, the ability of each fish to fully utilize habitats within the action area may be compromised.

Limiting Factors

The yelloweye rockfish DPS abundance is much less than it was historically. The fish face several threats including bycatch in commercial and recreational harvest, non-native species introductions, and habitat degradation. NMFS has determined that this DPS is likely to be in danger of extinction in the foreseeable future throughout all of its range.

Several factors, both population- and habitat-related, have caused the DPS of canary rockfish to decline to the point that NMFS has listed them as threatened. The general outlook in terms of all five criteria (habitat, spatial structure, diversity, abundance, and productivity) is that the DPS is likely to become in danger of extinction in the foreseeable future throughout all of its range.

The bocaccio DPS exists at very low abundance, and observations are rare. Their low intrinsic productivity, combined with continuing threats from bycatch in commercial and recreational harvest, non-native species introductions, loss and degradation of habitat, and chemical contamination, increase the extinction risk. NMFS has determined that this DPS is currently in danger of extinction throughout all of its range.

In summary, despite some limitations on our knowledge of past abundance and specific current viability parameters, characterizing the viability of yelloweye rockfish, canary rockfish, and bocaccio includes their abundance that has been severely reduced from historic times, which in turn hinders productivity and diversity. Spatial structure for each species has also likely been compromised because of the lack of mature fish of each species distributed throughout their historic range within the DPSs (Drake et al. 2010).

2.2.1.2 Status of Puget Sound Chinook Salmon

On June 28, 2005, NMFS affirmed the previous listing of PS Chinook salmon—both natural and some artificially-propagated fish—as a threatened species (70 Fed. Reg. 37160). There are 22 populations of PS Chinook within the ESU, including all naturally-spawned populations from rivers and streams flowing into Puget Sound including the Straits of Juan de Fuca from the Elwha River eastward. This includes rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington. Fish produced from twenty-two artificial propagation programs are also listed. There is a total of approximately 19 million clipped

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adipose fin hatchery releases, and 5 million intact adipose fin hatchery releases each year that are included as part of the ESU. There are 15 other hatchery Chinook salmon programs in the region that annually produce a total of 20.43 million juvenile fish that are not included as part of the listed PS Chinook salmon ESU. Under the final listing in 2005, the section 4(d) protections (and limits on them) apply to natural and hatchery PS Chinook salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed.

Adult PS Chinook salmon typically return to fresh water from March through August, and spawn from July through December. Early-timed Chinook salmon tend to enter fresh water in the spring, migrate far upriver, and finally spawn in the late summer and early autumn. Late-timed Chinook salmon enter fresh water in the fall. Most PS Chinook salmon tend to mature at ages 3 and 4 years, but the range is from 2 to 6 years.

Spawning females deposit between 2,000 and 5,500 eggs in a shallow nest, or redd, that they dig with their tail. Depending on water temperatures, the eggs hatch between 32 and 159 days after deposition. Alevins, newly hatched salmon with attached yolk sacs, remain in the gravel for another 14 to 21 days before emerging as fry. Juvenile Chinook salmon may migrate downstream to salt water within 1 to 10 days and spend many months rearing in the estuary, or they may reside in fresh water for a full year, spending relatively little time in the estuary area, before migrating to sea. Most PS Chinook salmon leave the freshwater environment during their first year. Most juvenile PS Chinook salmon use the nearshore of Puget Sound upon their emigration from local estuaries. Nearshore habitats provide food, such as small fish, aquatic invertebrates, and insects that are essential for juvenile growth. Juveniles will use the nearshore from several days to several weeks. Juvenile and sub-adult Chinook salmon will use deeper waters as they grow.

While most PS Chinook salmon eventually emigrate to Pacific Ocean coastal waters, some remain in the Puget Sound throughout their life cycle. While in the Puget Sound, sub-adult Chinook salmon often feed near the bottom on small fish, such as sand lance (Martinis 2008). Adult Chinook salmon return to waters of the Puget Sound beginning in spring, with most fish returning in the summer and early fall. Adult Chinook salmon continue to feed in the Puget Sound, targeting fish such as herring, sand lance, and smelt. Puget Sound Chinook salmon are impacted by degraded habitat conditions that range from spawning grounds, lost and isolated rearing habitats, and nearshore development along the action area.

Abundance

Historical abundance PS Chinook salmon is estimated to be as high as 690,000 adult spawners (Myers et al. 1998). NMFS concluded in 1998 (Myers et al. 1998), 2005 (Good et al. 2005), and 2011 (Ford et. al. 2010) that the Puget Sound ESU was likely to become endangered in the foreseeable future. In the first status review, the Puget Sound Biological Review Team (BRT) estimated the total PS Chinook salmon run size[10] in the early 1990s to be approximately 240,000 Chinook salmon, with the vast majority as hatchery-origin, and on current estimates, 67,000 of those fish were naturally-produced Chinook salmon (unpublished data, Norma Sands, NWFSC,

[10] Run size is calculated by combining harvest estimates and spawner estimates.

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March 5, 2010). During 2000-2004, ESU escapement increased to 45,214, but has since declined to 37,409 during the most recent 5-year period (2005-2009) (Ford et al. 2010).

Juvenile PS Chinook salmon abundance estimates come from escapement data, the percentage of females in the population, and fecundity. Fecundity estimates for the ESU range from 2,000 to 5,500 eggs per female, and the proportion of female spawners in most populations is approximately 40 percent of escapement. By applying a conservative fecundity estimate (2,000 eggs/female) to the expected female escapement (both natural-origin and hatchery-origin spawners; 14,964 females), fish of the ESU are estimated to produce approximately 30 million eggs annually. With an estimated survival rate of 10 percent, fish of the ESU should produce roughly 3.0 million natural outmigrants annually to aid recovery.

Abundance estimates for listed, hatchery-origin juvenile PS Chinook salmon come from the annual hatchery production goals. Hatchery production varies annually because of several factors including funding, equipment failures, human error, disease, and adult spawner availability. The combined hatchery production goal for listed PS Chinook salmon is 24,074,000 adipose-fin-clipped and non-clipped juvenile Chinook salmon.

In summary, abundance of PS Chinook salmon has been reduced from historic times, and has been largely influenced by the input of hatchery releases.

Productivity

Productivity trends of PS Chinook salmon have been positive for 10 of the 22 populations while short-term trends (1995 to 2009) were positive for 14 of 22 populations (Ford et al. 2010). Short-term trends were worse than long-term trends in six populations: Suiattle, SF Stillaguamish, Duwamish/Green, Puyallup, Nisqually, and mid-Hood Canal populations. Currently, for every natural-origin juvenile that migrates to Puget Sound nearly seven listed hatchery juveniles are released into Puget Sound watersheds. Thus, recent productivity is generally mixed, based on the particular population, with short-term productivity positive for most populations.

Spatial Structure

The PS Chinook salmon ESU contains 31 "historically independent populations," of which 9 are believed to be extinct (Ruckelshaus et al. 2006). The extinct populations were mostly composed of early-returning fish from the mid- and southern parts of Puget Sound and in the Hood Canal/Strait of Juan de Fuca.

Losing these nine historical populations reduced the species' spatial structure. The two Chinook salmon run-types (early- or late-timed) tend to spawn in different parts of the watershed (Myers et al. 1998). Early-timed Chinook salmon tend to migrate farther upriver and farther up into tributary streams, whereas late-timed fish spawn in the mainstem or lower tributaries of the river (Myers et al. 1998). Therefore, losing one run timing could cause an underuse of available spawning habitat and reduce population distribution and spatial structure because fish within that watershed would be unable to fully utilize available habitats.

In summary, the loss of some historic populations (particularly early-timed fish) of Puget Sound Chinook salmon has negatively impacted the spatial structure of the ESU.

Diversity

Chinook salmon population diversity can range in scale from genetic differences within and among populations to complex life-history traits. Diversity of the Puget Sound Chinook ESU is influenced by past and contemporary hatchery programs, and habitat functions. The loss of early-run populations is a leading factor affecting ESU diversity (Myers et al 1998). As stated above, eight of the nine extinct populations were composed of early-returning fish. Run-timing is a life-history trait considered an adaptation to variable environmental conditions. The early-run populations were an evolutionary legacy of the ESU, and the loss of these populations reduces the ESU's overall diversity.

Since the 1950s, hatcheries have released nearly two billion fish into Puget Sound tributaries. Most of these fish came from fall-run (late returning) adults from the Green River stock or stocks derived from Green River stock resulting in some PS Chinook salmon populations containing substantial hatchery-origin spawner numbers (first generation hatchery fish). By releasing so many hatchery-origin spawners, the use of a single stock could reduce the naturally spawning populations' genetic diversity and fitness. In 1991, a stock transfer policy was developed by WDFW, and implemented to foster local brood stocks by significantly reducing egg and juvenile transfers between watersheds. This policy mandates hatchery programs to use local broodstocks in rivers with extant indigenous stocks. The North Fork Stillaguamish, South Fork Nooksack, Dungeness, and Elwha hatchery programs are conservation programs designed to sustain the genetic legacy of the population and augment total spawning adults. These programs likely support the overall maintenance of diversity within the ESU.

Degraded habitat conditions within all of the watersheds that host PS Chinook salmon populations likely limit the full expression of their natural run-timing and juvenile use of various habitats throughout the year. For instance, altered temperature regimes, loss of unique rearing habitat types, and degraded spawning conditions all adversely affect the ability of populations to use habitat and fully optimize habitat exploitation. Over generations, the diversity of the population can be reduced.

Puget Sound Chinook salmon are impacted by degraded habitat conditions that range from spawning grounds, lost and isolated rearing habitats, and nearshore development along the action area.

Limiting Factors

Some of the gains in PS Chinook salmon natural-origin spawner abundance since the 1990s have been lost during the most recent 5-year period (2005-2009). In fact, 2009 abundance numbers were near the historic lows of the 1990s. In addition, the overall abundance is still only a fraction of historical levels, and no populations are meeting their minimum viability abundance. Several risk factors identified in the 2005 status review (Good et al. 2005) are still present, including high fractions of hatchery fish in many populations and widespread habitat loss and degradation. Additionally, there has been no recent improvement in the species' spatial structure or diversity. None of the extirpated populations has been re-established. However, the process is just starting; many habitat and hatchery actions identified in the Puget Sound Chinook salmon recovery plan are expected to take years or decades to be implemented and produce significant improvements.

In summary, the viability of the PS Chinook salmon ESU is negatively influence by reduced abundance and productivity from historic times. Spatial structure and diversity of the ESU has been compromised by the loss of some historic populations and life-histories.

2.2.1.3 Status of Puget Sound Steelhead

On August 9, 1996, NMFS determined that the PS steelhead DPS did not warrant listing under the ESA. In response to a petition received on September 13, 2004, NMFS updated the species' status review. On May 11, 2007, NMFS listed PS steelhead—both natural- and some artificially-propagated fish—as a threatened species (72 Fed. Reg. 26722). NMFS concluded that the PS steelhead DPS was likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Two artificial propagation programs were listed as part of the DPS—Green River natural and Hamma Hamma winter-run steelhead hatchery stocks. NMFS promulgated 4(d) protective regulations for PS steelhead on September 25, 2008 (73 Fed. Reg. 55451). The section 4(d) protections (and limits on them) apply to natural and hatchery PS steelhead with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed.

Steelhead are found in most of the larger accessible tributaries to Puget Sound, Hood Canal, and the eastern Strait of Juan de Fuca. Surveys of Puget Sound (not including the Hood Canal) in 1929 and 1930 identified steelhead in every major basin except the Deschutes River (Hard et al. 2007). The DPS includes all naturally-spawned anadromous winter-run and summer-run *O. mykiss* populations in streams in the river basins of Puget Sound, Hood Canal, and the Strait of Juan de Fuca, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive). Hatchery steelhead are also distributed throughout the range of this DPS and, as noted above, two of these stocks are included in the ESA listing. Juvenile PS steelhead are rarely observed in Puget Sound, and are thought to emigrate as juveniles quickly to Pacific Ocean habitats (Hard et al. 2007). Adult steelhead habitat use in Puget Sound is also relatively unknown. Adult summer-run or winter-run steelhead may migrate through Puget Sound virtually throughout the year, though winter-run steelhead are known to migrate back to natal spawning grounds along portions of the nearshore in late fall through winter months (Olander 1991).

Of all the Pacific salmonids, *O. mykiss* probably exhibits the greatest life history diversity. Resident *O. mykiss*, commonly called rainbow trout, complete their life cycle entirely in fresh water; whereas steelhead, the anadromous form of *O. mykiss*, reside in fresh water for their first 1 to 3 years before migrating to the ocean. Smoltification and seaward migration occur principally from April to mid-May (WDF et al. 1993). Though not well understood, smolts are believed to migrate quickly offshore. Steelhead then remain in the ocean for 1 to 3 years before

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returning to fresh water to spawn. In contrast with other Pacific salmonid species, steelhead are iteroparous (capable of repeat spawning). Among all West Coast steelhead populations, eight percent of spawning adults have spawned previously, with coastal populations having a higher repeat spawning incidence than inland populations (Busby et al. 1996).

Steelhead life-history type expression comes through the degree of sexual development when adults enter fresh water. Stream-maturing steelhead, also called summer-run steelhead, enter fresh water at an early maturation stage, usually from May to October. These summer-run steelhead migrate to headwater areas, hold for several months, and spawn in the spring. Ocean-maturing steelhead, also called winter-run steelhead, enter fresh water from December to April at an advanced maturation stage and spawn from March through June (Hard et al. 2007). While some temporal overlap in spawn timing between these forms exist, in basins where both winter- and summer-run steelhead are present, summer-run steelhead spawn farther upstream, often above a partially impassable barrier. In many cases, summer migration timing may have evolved to access areas above falls or cascades during low summer flows that are impassable during high winter flow months.

Abundance

Historical PS steelhead abundance is largely based on catch records. Catch records from 1889 to 1920 indicate that catch peaked at 163,796 steelhead in 1895. Using harvest rates of 30 to 50 percent, the estimated peak run size for Puget Sound would range from 327,592 to 545,987 fish. In the 1980s, Light (1987) estimated the steelhead run size at approximately 100,000 winter-run and 20,000 summer-run steelhead. However, as many as 70 percent of the run were first-generation hatchery fish (Hard et al. 2007). By the mid 1990s, Busby et al. (1996) estimated a total run of 45,000 (winter- and summer-run combined). For the most recent 5-year period of escapement estimates (2005 to 2009) the present run size of PS steelhead is likely less than 20,000 (Ford et al. 2010). Steelhead are most abundant in the northern Puget Sound, with the Skagit and Snohomish rivers supporting the two largest winter-run steelhead populations. Hood Canal and Strait of Juan de Fuca populations are generally small, with their populations averaging fewer than 400 natural-origin spawners annually.

Juvenile outmigrant abundance estimates differ between natural and hatchery fish. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the ESU should produce roughly 2.1 million natural outmigrants annually. The combined production goal of WDFW for listed PS steelhead hatchery stocks is 42,000 adipose fin-clipped juveniles and 10,000 intact adipose juveniles.

Productivity

Productivity trends of PS steelhead were positive for 4 of 15 populations (Samish, East Hood Canal, West Hood Canal, and Port Angeles populations) while short-term trends (1995-2009) were positive for only 3 of 22 populations (Skokomish, East Hood Canal, and West Hood Canal populations) (Ford et al. 2010). Short-term trends were worse than long-term trends in all but four populations – Skagit, Nisqually, Skokomish, and West Hood Canal populations.

Growth rate measures the annual rate of change in pre-harvest recruits per spawner numbers. Long-term growth rates (1985 to 2009) were negative for all but one of the 16 populations (West Hood Canal). Growth rates were declining at greater than 5 percent for seven populations (White, Stillaguamish, Nisqually, Puyallup, Elwha, Dungeness, and Lake Washington).

Spatial Structure

Characterizing spatial structure includes species distribution and habitat range. There are winter-run populations of PS steelhead within each of the basins of the DPS (i.e., Hood Canal, South Sound). However, spatial structure has been compromised because an estimated 26 percent of the summer-run habitat and 21 percent of the winter-run habitat (pre-settlement) has been lost because of fish passage impediments and habitat degradation.

Although Puget Sound DPS steelhead populations include both summer- and winter-run life-history types, winter-run populations predominate. The WDFW has identified 38 winter-run and 15 summer-run steelhead stocks in this DPS. Summer-run stock statuses are mostly unknown; however, most appear to be small, averaging less than 200 spawners annually (Hard et al. 2007). Summer-run stocks are primarily concentrated in the northern Puget Sound and Hood Canal; the Dungeness River is the only extant summer-run steelhead stock in the rest of the DPS.

Diversity

As described above, the DPS is composed of both summer- and winter-run steelhead. Summer-run steelhead populations, historically occurring throughout the Puget Sound but now concentrated in the northern region, are generally small and characterized as isolated populations adapted to streams with distinct attributes. The one summer-run stock with abundance data (the Tolt River stock) exhibits a negative trend in natural-origin run size. Most other populations are very small, with annual escapements below 50 fish.

Artificial propagation is a major factor affecting the genetic diversity of both summer- and winter-run steelhead in the Puget Sound DPS. Although offsite releases and releases of steelhead fry and parr have largely ceased in the DPS, annual hatchery steelhead smolt releases derived from non-local populations (Skamania summer-run steelhead) or domesticated populations originally found within the DPS (Chambers Creek winter-run steelhead) persist in most systems. This sustained hatchery management practice has increased the likelihood of interbreeding and ecological interaction between wild and hatchery fish—in spite of the apparent differences in average spawning time and its associated adverse fitness consequences for both summer- and winter-run steelhead.

Limiting Factors

Throughout the DPS, natural steelhead production has shown, at best, a weak response to reduced harvest since the mid-1990s. Natural productivity declines are most pervasive in the southern Puget Sound but occur throughout much of the DPS. These trends primarily reflect patterns in winter-run steelhead—populations for which data are most plentiful. Patterns for most summer-run populations are unknown. The causes for the continued declines are somewhat

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unknown; but prominent causes include hatchery production, harvest management, and dam effects on habitat quality and quantity.

In summary, the viability of the PS steelhead DPS has been negatively influenced by severely reduced abundance and concurrent reduced productivity. Spatial structure has been reduced from fish migration blockages and habitat degradation. Diversity has been compromised by large scale hatchery releases.

2.2.1.4 Status of Hood Canal Summer-run Chum Salmon

On June 28, 2005, NMFS affirmed the previous listing of HCS chum salmon—both natural and some artificially-propagated fish—as a threatened species (70 Fed. Reg. 37160). The species comprises all naturally spawned populations of summer-run chum salmon in Hood Canal and its tributaries as well as populations in Olympic Peninsula rivers between Hood Canal and Dungeness Bay, Washington. Under the final listing in 2005, the section 4(d) protections (and limits on them) apply to natural and hatchery HCS chum salmon with an intact adipose fin, but not to listed hatchery fish that have had their adipose fin removed. NMFS listed nine artificial propagation programs as part of the ESU, and seven of the nine programs have met their goals and are no longer active. There are an estimated 275,000 juvenile hatchery releases annually (Tim Tynan, pers. comm., NMFS, June 10, 2011).

Chum salmon in this ESU are summer-run fish. Juveniles, typically as fry, emerge from the gravel and out-migrate almost immediately to seawater. For their first few weeks, they reside in the top 0.8 to 1.1 inches (2 to 3 cm) of estuarine surface waters while staying extremely close to the shoreline. Sub-adults and adults forage in coastal and offshore waters of the North Pacific Ocean before returning to spawn in their natal streams. The HCS chum salmon spawn from mid-September to mid-October (whereas fall-run chum salmon in the same geographic area spawn from November to December or January). Spawning typically occurs in the mainstems and lower river basins. Adults typically mature between the ages of 3 and 5 years old. The HCS chum salmon range from the Dungeness River clockwise around the Olympic Peninsula into and including Hood Canal. The HCS chum salmon inhabit the Olympic Peninsula east of the Dungeness River including Discovery and Sequim Bays.

Juvenile HCS chum salmon use the nearshore of Puget Sound during their emigration to the Pacific Ocean during the spring and early summer months. Adult HCS chum salmon migrate back through the Puget Sound and Straits region during late spring and summer months. Adults feed on small invertebrates and occasionally will eat forage fishes such as herring and smelt.

Abundance

Historical HCS chum salmon abundance is mostly unknown. In 1968, spawning escapement records indicate that 45,000 adult HCS chum salmon returned to tributaries (WDF et al. 1993). During the early 1970s, adult chum salmon spawners dropped to about 20,000 annually (Ford et al. 2010). By the 1980s, HCS chum salmon abundance began to decline ever more precipitously with several spawning aggregations extirpated during this period.

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The current average run size of 19,351 adult spawners (15,709 natural-origin and 3,642 hatchery-origin spawners) is largely the result of aggressive reintroduction and supplementation programs throughout the ESU (Ford et al. 2010).

Escapement data, the percentage of females in the population, and fecundity can estimate juvenile HCS chum salmon abundance. ESU fecundity estimates average 2,500 eggs per female, and the proportion of female spawners is approximately 45 percent of escapement in most populations (WDFW/PNPTT 2000). By applying fecundity estimates to the expected escapement of females (both natural-origin and hatchery-origin spawners), the ESU is estimated to produce approximately 21.8 million eggs annually. For HCS chum salmon, freshwater mortality rates are high with no more than 13 percent of the eggs expected to survive to the juvenile migrant stage (Quinn 2005). With an estimated survival rate of 13 percent, the ESU should produce roughly 2.8 million natural outmigrants annually. Annual hatchery juvenile outmigrants are estimated to be 275,000 annually (all unmarked).

Productivity

Long term productivity trends of HCS chum salmon have been negative (-1.1 percent) for the Hood Canal population and positive (1.3 percent) for the Strait of Juan de Fuca population (Ford et al 2010). Short-term trends (1995 to 2009) were positive for both populations (Ford et al 2010).

Growth rate measures the annual rate of change in pre-harvest recruits per spawner numbers. Growth rates are estimated for two alternative assumptions: (1) that hatchery fish success (HFS) is zero on the spawning grounds (HFS=0) and (2) that their spawning success is equivalent to natural origin fish (HFS=1). Long-term growth rates were negative for the Hood Canal population and positive for the Strait of Juan de Fuca population under the HFS=0 scenario. If HFS is assumed to equal natural-origin fish success, then the long-term trends are negative for both populations. Short-term growth rates were positive for both populations when HFS=0. When HFS is assumed to equal natural-origin fish success, then Hood Canal population growth rate is negative while the Strait of Juan de Fuca growth rate stays positive. These recent abundance increases are most likely a result of harvest reductions and the supplementation and reintroduction programs throughout the ESU.

Spatial Structure

The HCS chum salmon ESU has two populations, each containing multiple stocks or spawning aggregations. In the Strait of Juan de Fuca population, state and tribal biologists assessing the species' status in the early 1990s identified small but persistent natural spawning aggregations in three streams (Salmon, Snow, and Jimmycomelately Creeks). In the Dungeness River, spawning of unknown aggregations occurred.

In the Hood Canal population, spawning aggregations persisted in most of the major rivers draining from the Olympic Mountains into the western edge of the Canal, including Big and Little Quilcene Rivers, Dosewallips River, Duckabush River, Hamma Hamma River, and Lilliwaup Creek. On the eastern side of Hood Canal, persistent spawning was restricted to the

Union River. Historical information and habitat characteristics of other streams indicate that summer-run chum salmon distribution was once more region-wide, especially in the eastern shore streams draining into Hood Canal. Based on river size and historical tribal fishing records, a major spawning aggregation once occurred in the Skokomish River before the construction of Cushman Dam in the 1920s.

Diversity

Spatial structure changes are the greatest concern for the ESU's diversity with HCS chum salmon aggregations being more isolated than they were historically (NMFS 2005b). In the past, most HCS chum salmon aggregations were 12.4 to 24.9 miles (20 to 40 km) apart with none greater than 49.7 miles (80 km). Most extant summer-run chum salmon aggregations still occur within 12.4 to 24.9 miles (20 to 40 km) of each other, but some extinctions have led to a significant increase in spawning aggregations isolated by 49.7 miles (80 km) or more. Geographically, the extinctions occurred primarily in the northeastern Olympic Peninsula and northwestern Kitsap Peninsula (at the center of the ESU's geographic range), including all spawning aggregations within the Admiralty Inlet catchment, as well as the Skokomish and Tahuya Rivers. As geographic distances increase between spawning aggregations, they exchange fewer migrants. Such isolations impede the natural exchange of genetic information between spawning aggregations and populations.

The supplementation and reintroduction program designs address, among other issues, spatial structure and genetic isolation concerns. Recent abundance estimates indicate that natural-origin spawner numbers are increasing and that the programs are resulting in natural-origin spawner reintroductions in five of the seven extinct spawning aggregations: Big Beef, Dewatto, Tahuya, and Chimacum Creeks, and the Skokomish River.

Limiting Factors

While there is cause for optimism about this ESU's prospects, there is also cause for continued concern. Optimism comes from the recent improvements in the spatial structure, diversity, and short-term productivity trends. Supplementation and reintroduction programs have increased natural-origin spawner numbers and distribution in both populations. The Hood Canal population also has shown improvements since the early 1990s with abundance and productivity gains. However, abundance is still far below historical levels and, in many areas, well below the PSTRT's abundance targets. Average Hood Canal population abundance needs to double just to reach the lower end of the planning range for abundance, and the Strait of Juan de Fuca population is well under its target range.

In summary, the viability of the HCS Chum salmon ESU has been positively influenced by improving abundance and concurrent productivity in recent times. However, spatial structure has been compromised by the loss of a few populations because of migration blockages and habitat degradation and increased distance between populations in Hood Canal. Such isolations impede the natural exchange of genetic information between spawning aggregations and populations and impact species diversity.

2.2.1.5 Status of Southern Eulachon

On March 18, 2010, NMFS listed the Southern DPS of eulachon as a threatened species (75 Fed. Reg. 13012). This DPS encompasses all populations within the states of Washington, Oregon, and California and extends from the Skeena River in British Columbia south to the Mad River in Northern California (inclusive).

Eulachon are endemic to the northeastern Pacific Ocean, ranging from northern California to southwest and south-central Alaska and into the southeastern Bering Sea. Puget Sound lies between two of the larger eulachon spawning rivers (the Columbia and Fraser Rivers) but lacks a regular eulachon run of its own (Gustafson et al. 2010). Within the conterminous U.S., most eulachon production originates in the Columbia River Basin with the major and most consistent spawning runs returning to the Columbia River mainstem and Cowlitz River. Adult eulachon have occurred at several Washington and Oregon coastal locations, and they were previously common in Oregon's Umpqua River and the Klamath River in northern California. Runs occasionally occur in many other rivers and streams, although these tend to be erratic, appearing in some years but not others, and appearing only rarely in some river systems (Hay and McCarter 2000; Gustafson et al. 2010). The Elwha is the only river within the United States portion of Puget Sound and the Strait of Juan de Fuca that supports a consistent run of eulachon.

Eulachon generally spawn in rivers fed by either glaciers or snowpack and that experience spring freshets. Since these freshets rapidly move eulachon eggs and larvae to estuaries, it is believed that eulachon imprint and home to an estuary into which several rivers drain rather than individual spawning rivers (Hay and McCarter 2000). From December to May, eulachon typically enter the Columbia River system with peak entry and spawning during February and March (Gustafson et al. 2010). They spawn in the lower Columbia River mainstem and several tributaries of the Columbia River, including the Grays, Elochoman, Kalama, Lewis, and Sandy Rivers. Eulachon are semelparous, meaning they spawn once and then die after spawning.

Eulachon broadcast their eggs, averaging 0.04 inch (1 mm) in size, over and attached to substrates ranging from sand to pea-sized gravel. Stream currents carry the newly-hatched young, transparent and 0.16 to 0.28 inch (4 to 7 mm) in length, to the sea. After yolk sac depletion, eulachon feed upon pelagic plankton. After 3 to 5 years at sea, eulachon return as adults to spawn.

Adult eulachon weigh an average of 1.76 ounces (50 g) each and are 5.9 to 7.9 inches (15 to 20 cm) long with a maximum recorded length of 11.8 inches (30 cm). They are an important link in the food chain between zooplankton and larger organisms. Small salmon, lingcod, and other fish feed on small larvae near river mouths. As eulachon mature, wide varieties of predators consume them (Gustafson et al. 2010).

Once juvenile eulachon enter the ocean they become widely distributed in coastal waters where they are typically found near the ocean bottom in waters 65.6 to 492.1 feet (20 to 150 m) deep. Eulachon adults feed on zooplankton, chiefly eating crustaceans such as copepods and euphausiids (Hart 1973; Scott and Crossman 1973; Hay 2002; Yang et al. 2006), unidentified malacostracans, and cumaceans (Smith and Saalfeld 1955). Little specific information is known

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about eulachon habitat use in Puget Sound, though it appears that they occupy habitats near the bottom more than the pelagic environment because most eulachon caught in past WDFW research operations have been in bottom trawls.

Abundance and Productivity

Several aspects of eulachon biology indicate that large adult eulachon aggregations are necessary to maintain normal reproductive output. Eulachon are a short-lived, high-fecundity, high-mortality forage fish; such species typically have extremely large population sizes. Fecundity estimates range from 7,000 to 60,000 eggs per female, and egg-to-larva survival may be less than one percent (Gustafson et al. 2010). After three to five weeks of incubation, stream currents carry the larvae rapidly downstream to estuarine habitats. Larvae then rear in the pelagic zone and experience high mortality rates during their transition to the juvenile phase.

There are no direct estimates of productivity for any eulachon populations within the southern DPS. However, the ability of the Columbia River eulachon stock to respond rapidly to the good ocean conditions of the late 1999 to early 2002 period illustrates the species' resiliency (Gustafson et al. 2010). This resiliency buffers the species against future environmental perturbations. The productivity potential or intrinsic rate of increase of eulachon as indicated by life-history characteristics such as low age-at-maturity, small body size, and planktonic larvae, likely confer some resilience to extinction risk as they retain the ability to rapidly respond to favorable ocean conditions (Gustafson et al. 2010).

There are few direct estimates of eulachon abundance. In most areas of the southern DPS, escapement counts or estimates of spawning-stock biomass are unavailable. When available, catch statistics from commercial or recreational eulachon fisheries have been used by researchers as proxies of relative abundance. However, inferring population status or even trends from yearly changes in catch statistics requires assumptions that are seldom met, including consistent fishing effort and efficiency, a consistent relationship between the harvested portion and the total abundance of the stock, and that the catch represents a random sample of the entire population. In the United States there are few fishery-independent sources of abundance data available and few monitoring programs for eulachon. However, the combination of catch records and anecdotal information indicate that eulachon were present in large annual runs in the past and that significant declines in abundance have occurred over the last 20 to 30 years (Gustafson et al. 2010). Eulachon numbers are at, or near, historically low levels throughout the range of the southern DPS.

The Columbia River and its tributaries support the largest known eulachon run. Although direct estimates of adult spawning stock abundance are unavailable, commercial fishery landing records begin in 1888 and continue as a nearly uninterrupted data set to 2010 (Gustafson et al 2010.). Historic commercial catch levels were typically more than 500 metric tons[11], and occasionally exceeded 1,000 metric tons, from about 1915 to 1992. In 1993, the catch level began to decline; it averaged less than 5metric tons from 2005 through 2008 (Gustafson et al. 2010). Some of this pattern is due to fishery restrictions, which were put in place in response to

[11] The U.S. ton is equivalent to 2,000 pounds and the metric ton is equivalent to 2,204 pounds.

the sharp decline in abundance. Persistently low eulachon returns and landings in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan (WDFW and ODFW 2001). All recreational and commercial fisheries for eulachon were closed in Washington and Oregon in 2011.

Similar declines in abundance have occurred in the Fraser and other coastal British Columbia rivers (Hay and McCarter 2000; Moody 2008). Over 10 years, or 3 generations (1999-2009), the overall Fraser River eulachon population biomass declined by nearly 97 percent (Gustafson et al. 2010). The biomass was estimated to be 418 metric tons in 1999 and by 2009 it had dropped to just 14 metric tons. Abundance information is lacking for many coastal British Columbia subpopulations, but in general, Gustafson et al. (2010) found that eulachon were present in larger annual runs in the past.

In Northern California, no long-term eulachon monitoring programs exist. In the Klamath River, large eulachon spawning aggregations once regularly occurred, but eulachon abundance has declined substantially (Fry 1979; Moyle et al. 1995; Larson and Belchik 1998; Moyle 2002). Recent reports from Yurok tribal fisheries biologists mentioned only a few eulachon captured incidentally in other fisheries.

For the Puget Sound, eulachon abundance is not well known. The Fraser River population is the closest large spawning run of eulachon to Puget Sound. Under the Species at Risk Act, Canada designated this population as endangered in May 2011 because of a 98 percent decline in spawning stock biomass over the previous 10 years. Currently, this population is estimated at just under 300,000 adult spawners annually[12]. This estimate does not include the larger Columbia River spawning run or any other spawning runs and is therefore likely to be several times smaller than the actual eulachon abundance for the full DPS.

Some eulachon are incidentally caught within West Coast ocean shrimp fisheries (75 Fed. Reg. 13012, March 18, 2010), and bycatch reduction research is underway. The Oregon Department of Fish and Wildlife and WDFW sought and were awarded funds in 2010 by NMFS to support a bi-state, multi-part project to research eulachon. One research project included placing observers on shrimp trawl vessels fishing coastal waters of Washington (not including Puget Sound) and Oregon. The shrimp trawl observer project is intended to assess and reduce the impacts of shrimp trawl operations on eulachon by initiating an observer program to estimate the bycatch rates in Washington's ocean shrimp trawl fishery and by developing and testing modifications to ocean shrimp trawl gear or operations.

In summary, there are no direct estimates of productivity for any eulachon populations within the southern DPS. The productivity potential or intrinsic rate of increase of eulachon (Musick et al. 2000), as indicated by life-history characteristics such as low age-at-maturity, small body size, and planktonic larvae, likely confer some resilience to extinction risk as they retain the ability to rapidly respond to favorable ocean conditions (Gustafson et al. 2010). There are few direct estimates of eulachon abundance, though we do have estimates for the Fraser River population.

[12] http://www.pac.dfo-mpo.gc.ca/science/species-especes/pelagic-pelagique/herring-hareng/herspawn/pages/river1-eng.htm

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Spatial Structure and Diversity

There are no distinct differences among eulachon throughout the range of the southern DPS. However, the BRT did separate the DPS into four subpopulations in order to rank the threats they face. These are the Klamath River (including the Mad River and Redwood Creek), the Columbia River (including all of its tributaries), the Fraser River, and the British Columbia coastal rivers (north of the Fraser River up to, and including, the Skeena River). Eulachon population structure has not been analyzed below the DPS level.

As noted above, eulachon inhabit rivers in British Columbia, Washington, Oregon, and northern California. Though the DPS extends beyond the conterminous United States, this consultation will not consider any areas outside the United States.

Eulachon face a number of habitat-related threats. Climate change impacts on ocean habitat are the most serious threat to eulachon persistence (Gustafson et al. 2010). Other threats to the species include bycatch in shrimp trawl fisheries, climate change impacts on freshwater habitat, and habitat alteration and degradation from various activities. Additionally, hydroelectric dams block access to historical eulachon spawning grounds and affect spawning substrate quality through flow management, altered coarse sediment delivery, and siltation. During the eulachon spawning run, dredging activities may entrain and kill fish or otherwise decrease spawning success. Another threat is chemical contamination of eulachon habitat that results in high levels of chemical pollutants in eulachon tissues (EPA 2002). Although high contaminant loads in eulachon have not demonstrated increased mortality or reduced reproductive success, such effects in other fish species exist (Kime 1995). These factors (and others) have negatively affected the DPS's habitat to the extent that it was necessary to list them under the ESA.

Within the range of the southern DPS, Beacham et al. (2005) found genetic affinities among the populations in the Fraser, Columbia, and Cowlitz Rivers and also among the Kemano, Klinaklini, and Bella Coola Rivers along the central British Columbia coast. In particular, there was evidence of a genetic discontinuity north of the Fraser River, with Fraser and Columbia/Cowlitz samples diverging three to six times more from samples further to the north than they did from each other. Similar to the study of McLean et al. (1999), Beacham et al. (2005) found that genetic differentiation among populations was correlated with geographic distances. The authors also suggested that the pattern of eulachon differentiation was similar to that typically found in studies of marine fish, but less than that observed in most salmon species.

The eulachon BRT was concerned about risks to eulachon diversity because of its semelparity (spawn once and die) and data suggesting that Columbia and Fraser River spawning stocks may be limited to a single age class. These characteristics likely increase their vulnerability to environmental catastrophes and perturbations and provide less of a buffer against year-class failure than species such as herring that spawn repeatedly and have variable ages at maturity (Gustafson et al. 2010).

In summary, the spatial structure and diversity of eulachon is impacted by a number of habitat-related threats, including climate change, dams, dredging activities, and chemical contamination.

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Limiting Factors

The productivity potential or intrinsic rate of increase of eulachon as indicated by life-history characteristics such as low age-at-maturity, small body size, and planktonic larvae, likely confer some resilience to extinction risk as they retain the ability to rapidly respond to favorable ocean conditions. However, eulachon are threatened by bycatch in coastal shrimp fisheries, climate change, and other habitat threats that include freshwater habitat degradation, blocked access from dams, and spawning habitat alterations and chemical contamination.

In summary, the viability of the southern eulachon DPS has been negatively influenced by reduced abundance and concurrent reduced productivity in recent times, despite the lack of precise abundance data across many of the spawning aggregations. Spatial structure and diversity have been compromised by migration blockages and habitat degradation across the range of the DPS.

2.2.1.6 Status of Southern DPS of North American Green Sturgeon

On April 7, 2006, NMFS listed the southern DPS of North American green sturgeon (hereafter referred to as "green sturgeon") as a threatened species (71 Fed. Reg. 17757). The southern DPS ESA section 7 Consultation Number 2010/02572 consists of coastal and Central Valley populations south of the Eel River, with the only known spawning population in the Sacramento River. Information on their oceanic distribution and behavior indicates that green sturgeon make generally northern migrations—even occurring in numbers off Vancouver Island (NMFS 2005b). A mixed stock assessment assigned about 70 to 90 percent of the green sturgeon present in the Columbia River estuary and Willapa Bay to the southern DPS. The stock composition in Grays Harbor is about 40 percent southern DPS (Israel et al. 2009).

Green sturgeon—like all sturgeon—is a long-lived, slow-growing species. Adult green sturgeon typically migrate into fresh water beginning in late February and spawn from March to July. Green sturgeon females produce 60,000 to 140,000 eggs. Green sturgeon larvae are different from all other sturgeon because they lack a distinct swim-up or post-hatching stage and are distinguished from white sturgeon by their larger size, light pigmentation, and size and shape of the yolk sac. First feeding occurs 10 days after they hatch, and metamorphosis to juveniles is complete at 45 days. The larvae grow fast, reaching a length of 2.6 inches (66 mm) and a weight of 0.28 ounce (1.8 g) in three weeks of exogenous feeding. Larvae hatched in the laboratory are photonegative and exhibit hiding behaviors after the onset of exogenous feeding. The larvae and juveniles are nocturnal. Juveniles appear to spend 1 to 3 years in fresh water before they enter the ocean (NMFS 2005b).

Green sturgeon disperse widely in the ocean between their freshwater life stages. Tagged fish from the Sacramento River have been captured primarily to the north in coastal and estuarine waters. While there is some bias associated with this information (which was retrieved primarily from commercial fishing), a northern migration is also supported by the large concentrations of green sturgeon entering the Columbia River estuary, Willapa Bay, and Grays Harbor. These fish

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tend to be immature; however, some mature fish and at least one ripe fish have been found in the lower Columbia River (Adams et al. 2002).

The southern DPS's status and biological requirements are described in two status reviews (Adams et al. 2002; NMFS 2005b). The southern DPS was listed as threatened because NMFS found that they are not presently in danger of extinction, but are likely to become so. For the purposes of our later analysis, the southern DPS of green sturgeon requires adequate spatial structure, habitat, abundance, productivity, and diversity to ensure their survival and recovery in the wild.

Abundance and Productivity

Abundance and productivity for green sturgeon are not well known. Although no known populations of green sturgeon are known to spawn in Washington State (Adams et al. 2007), populations of both green sturgeon DPSs reside in the state. Because direct counts of green sturgeon are not available, known harvest is one way of indicating abundance trends. In Washington State, green sturgeon harvest is almost entirely made up of bycatch from white sturgeon commercial and sport fisheries and coastal groundfish trawl fisheries. Harvest data from 1985 to 2003 shows a decline of green sturgeon captures from an average of 6,356 individuals (1985 to 1988) to 780 individuals (1999 to 2003) (Adams et al. 2007).

From 1954 to 2001, the California Department of Fish and Game (CDFG) conducted a white sturgeon monitoring project in San Pablo Bay (CDFG 2002). Tagging experiments for white sturgeon in San Pablo Bay captured a total of 498 green sturgeon and tagged 233 of them. A green sturgeon population estimate was derived by multiplying the ratio of legal-size green sturgeon to legal-size white sturgeon caught in the tagging program by the legal-size white sturgeon population estimate (legal-size sturgeon are $\geq$ 40 inches (102 cm)). Green sturgeon population estimates ranged from 175 (1993) to 8,421 (2001); trend analysis of green sturgeon abundance and productivity indicates that the population is neither decreasing nor increasing (NMFS 2005b).

From 2002 to 2006, Israel and May (2010) collected 229 green sturgeon fry in the Sacramento River. By examining codominant microsatellite DNA markers, individuals were grouped into kin groups. Using yearly data and a conservative error rate, a range of 5.3 to 11.3 kin groups were calculated (using Eggert's equation). Further, Israel and May (2010) estimated each kin group at 10 to 28 spawners. Van Eeneennaam et al. (2006) observed a skewed sex ratio of 1.0 females:1.4 males in the Klamath River. This would calculate to an estimated population of 127 to 759 southern DPS green sturgeon adults.

Using high definition sonar imaging, green sturgeon spawning grounds were surveyed each of the past two years in the Sacramento River. Each year, approximately 200 adult green sturgeon were detected. A study using acoustic tags found that green sturgeon return on average every 4 years to spawn. Using this data, NMFS currently estimates a current population of 800 southern DPS green sturgeon adults (D. Woodbury, pers. comm., NMFS, January 3, 2012).

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In summary, though our knowledge about current abundance and productivity for green sturgeon is not extremely precise, there is strong evidence that a decline has occurred for both because of past harvest and bycatch.

Spatial Structure and Diversity

The only known spawning population of green sturgeon in the southern DPS is found in the Sacramento River. Adult green sturgeon have also been captured in the San Joaquin River delta (Adams et al. 2002).

Spatial structure has been altered by dams and habitat degradation. Recent habitat evaluations conducted in the upper Sacramento, Feather, and San Joaquin Rivers suggest that large amounts of potential green sturgeon spawning habitat were made inaccessible or were altered by dams (NMFS 2005b). An American Fisheries Society assessment concluded that the green sturgeon's range has declined by 88 percent (Musick et al. 2000). Logging practices, land use practices, railroad construction, and building and operating dams have all destroyed green sturgeon habitat (Adams et al. 2002). There has been a substantial loss of spawning habitat behind Keswick and Shasta dams—both impassable barriers to green sturgeon. Water temperatures in the current spawning areas are lower than they were historically because of water releases from Shasta Dam. Before dam construction, green sturgeon would have had to migrate farther up the mainstem than they do now in order to encounter water temperatures cool enough to trigger spawning. Additional habitat behind Shasta Dam—in the Pit, McCord, and Little Sacramento River systems—would have supported separate populations or at least a single, larger Sacramento River population less vulnerable to catastrophes than one confined to a single mainstem location (70 Fed. Reg. 17386, April 6, 2005).

Diversity in sturgeon populations can range in scale from genetic differences within and among populations to complex life-history traits. One of the leading factors affecting the diversity of the southern DPS of North American green sturgeon is the loss of habitat because of impassable barriers such as dams. As described above, several tributaries to the Sacramento River have been blocked and have therefore almost certainly reduced the DPS's diversity. Although this DPS migrates over long distances, its spawning locations are small and have been greatly affected by human activities.

In summary, spatial structure has been impacted by dams and habitat degradation across their range.

Limiting Factors

The southern DPS of North American green sturgeon remains vulnerable because of having only one small spawning population, potential growth-limiting and lethal temperatures, harvest concerns, loss of spawning habitat, and entrainment by water projects. There will have to be substantial changes in this species' status before it can recover.

In summary, the viability of the green sturgeon DPS has been negatively influenced by reduced abundance and concurrent reduced productivity in recent times. Spatial structure and diversity has been compromised by a severe loss of habitat access because of migration blockages and habitat degradation that mostly occur in fresh water.

2.2.2 Status of Critical Habitat

We review the status of designated critical habitat affected by the proposed action by examining the condition and trends of essential physical and biological features throughout the designated area. These features are essential to the conservation of the 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).

Puget Sound/Georgia Basin Yelloweye Rockfish, Canary Rockfish, and Bocaccio

Critical habitat for PS/GB yelloweye rockfish, canary rockfish, and bocaccio has not been designated by NMFS. However, for information on habitat conditions pertaining to this species, see the species' status section (Section 2.2.1) and the environmental baseline section (Section 2.3).

Puget Sound Chinook Salmon

NMFS designated critical habitat for PS Chinook salmon on September 2, 2005(70 Fed. Reg. 52630). There are approximately 1,683 miles of stream habitats and 2,182 miles (3,512 km) of nearshore marine habitats designated as critical habitat for PS Chinook salmon. All nearshore critical habitat is within the action area of this consultation.

As part of the designation process, NMFS convened Critical Habitat Analytical Review Teams (CHART) to evaluate the current habitat status and identify habitat health threats. The Puget Sound CHART's assessment of habitat quality and identification of habitat threats is available on our website at http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/2005-Biological-Teams-Report.cfm. In determining the areas eligible for critical habitat designation, the PS CHART identified the essential primary constituent elements (PCEs) for species conservation. PS Chinook salmon PCEs are those sites and habitat components which support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. The 2,182 miles (3,512 km) of designated nearshore marine habitats contain rearing and migration PCEs. The nearshore marine areas also received a rating of high conservation value, though approximately one-third of it has been altered by shoreline development. The nearshore marine areas support growth and maturation for juvenile Chinook salmon. The essential physical and biological features of the nearshore include habitat free of obstruction, water quality and quantity, natural cover, and forage opportunities.

The PS CHART identified human activities that affect PCE quantity and quality. The major categories are (1) forestry, (2) grazing, (3) agriculture, (4) road building/maintenance, (5) channel modifications/diking, (6) urbanization, (7) sand and gravel mining, (8) dams, (9) irrigation impoundments and withdrawals, (10) river, estuary, and ocean traffic, and (11) wetland loss/removal. In addition to these, salmonid prey species harvest (e.g., herring, anchovy, and sardines) was found by the CHART to affect nearshore marine PCEs. All of these activities

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affect PCEs by altering one or more of the following: stream hydrology, flow and water-level modifications, fish passage, geomorphology and sediment transport, temperature, dissolved oxygen, vegetation, soils, nutrients and chemicals, physical habitat structure, and stream/estuarine/marine biota and forage.

In summary, critical habitat for PS Chinook salmon is impacted by past and contemporary land use activities. The severity of this degradation depends upon the watershed. The nearshore of Puget Sound is the only critical habitat designated within the action area, and has been degraded by shoreline development.

Puget Sound Steelhead

Critical habitat for PS steelhead has not been designated by NMFS. However, for information on habitat conditions pertaining to this species, see "Habitat Use in the Action Area" in the species' status section (Section 2.2.1) and the environmental baseline section (Section 2.3).

Hood Canal Summer-run Chum Salmon

NMFS designated critical habitat for HCS chum salmon on September 2, 2005(70 Fed. Reg. 52630). There are approximately 79 miles (127 km) of stream habitats and 377 miles (607 km) of nearshore marine habitats designated as critical habitat for HCS chum salmon. All nearshore critical habitat is within the action area of this consultation.

As part of the designation process, NMFS convened Critical Habitat Analytical Review Teams (CHART) to evaluate the current habitat status and identify habitat health threats. The Puget Sound CHART's assessment of habitat quality and identification of habitat threats is available on our website at http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/2005-Biological-Teams-Report.cfm. In determining the areas eligible for critical habitat designation, the PS CHART identified the PCEs essential for species conservation. PCEs for HCS chum salmon are those sites and habitat components that support one or more life stages including freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and nearshore marine areas. The 377 miles (607 km) of designated nearshore marine habitats contain rearing and migration PCEs. The nearshore marine areas support growth and maturation for juvenile HCS chum salmon. The essential physical and biological features of the nearshore include habitat free of obstruction, water quality and quantity, natural cover, and forage opportunities.

The PS CHART identified human activities that affect PCE quantity and quality. The major categories are: (1) forestry, (2) agriculture, (3) road building/maintenance, (4) channel modifications/diking, (5) urbanization, (6) sand and gravel mining, (7) dams, (8) river, estuary, and ocean traffic, and (9) beaver removal. In addition to these, the harvest of salmonid prey species (e.g., herring, anchovy, and sardines) was found to affect nearshore marine PCEs. All of these activities affect PCEs by altering one or more of the following: stream hydrology, flow and water-level modifications, fish passage, geomorphology and sediment transport, temperature, dissolved oxygen, vegetation, soils, nutrients and chemicals, physical habitat structure, and stream/estuarine/marine biota and forage.

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Over the past 150 years, development has occurred in nearly all estuaries within Hood Canal and the eastern Strait of Juan de Fuca. Degradation is severe in more than half of these estuaries with an additional 25 percent moderately degraded. Dikes, roads or causeways, remnant dikes or ditches, and fill are the primary causes of estuarine habitat degradation. In estuarine and nearshore areas, bulkheads, revetments, and impaired riparian corridors have reduced the amount of rearing habitat. Altered river and tidal dynamics have likely reduced estuarine food web productivity and, thus, the carrying capacity for chum salmon and other salmonids.

Southern Eulachon

On October 20, 2011, NMFS designated critical habitat for the southern DPS of eulachon (76 Fed. Reg. 65324). Based upon the best available scientific information, physical and biological features critical to eulachon conservation were summarized into three categories. The first category is freshwater spawning and incubation sites with the necessary substrate and water flow, quality, and temperature conditions to support spawning and incubation. The second category is freshwater and estuarine migration corridors free of obstruction and with the necessary water flow, quality, and temperature conditions to support larval and adult mobility, and with abundant prey items to support larval feeding after yolk sac depletion. The third category is nearshore and offshore marine foraging habitat with the necessary water quality and available prey to support juvenile and adult survival. For the 42 creeks and rivers with documented eulachon presence in the contiguous U.S., 16 locations were determined to meet at least one of these criteria. For the Puget Sound region, the nearest site is the Elwha River and its associated estuary. No critical habitat for eulachon occurs in the action area for this consultation.

Southern Green Sturgeon

NMFS designated critical habitat for sturgeon on October 9, 2009 (74 Fed. Reg. 52300); it includes approximately 320 miles (515 km) of freshwater river habitat, 897 square miles (2,323 square km) of estuarine habitat, 11,421 square miles (29,580 square km) of marine habitat, 487 miles (784 km) of habitat in the Sacramento-San Joaquin Delta, and 135 square miles of habitat within the Yolo and Sutter bypasses (Sacramento River, CA). Green sturgeon critical habitat occurs in the San Juan and Strait of Juan de Fuca portions of the action area for this consultation.

As part of the designation process, NMFS convened a CHART to identify habitat features essential to the conservation of the species and provide a biological assessment of these features within the range of the species. The CHART recognized that the different systems occupied by green sturgeon at specific stages of their life cycle serve distinct purposes and thus may contain different PCEs. Based on the best available scientific information, the CHART identified PCEs for freshwater riverine systems, estuarine areas, and coastal marine waters. The specific PCEs essential for the conservation of the Southern DPS in coastal marine areas are: (1) migration corridors, (2) water quality, and (3) food resources.

Based on discussions with the CHART and consideration of the economic analysis, several activities were identified that may threaten the PCEs to the extent that special management considerations or protection may be required. Major categories of habitat-related activities are: (1) dams, (2) water diversions, (3) dredging and disposal of dredged material (including

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activities associated with wetland loss and removal), (4) in-water construction or alterations (including channel modifications/diking, sand and gravel mining, gravel augmentation, road building and maintenance, forestry, grazing, agriculture, urbanization, and other activities), (5) National Pollution Discharge Elimination System permit activities and activities resulting in nonpoint source pollution, (6) power plants, (7) commercial shipping (including concerns related to exotic/invasive species introductions or spread), (8) aquaculture, (9) desalination plants, (10) proposed alternative energy hydrokinetic projects (e.g., tidal energy and wave energy projects), (11) liquefied natural gas projects, (12) bottom trawling, and (13) habitat restoration activities for other species. All of these activities may have an effect on one or more PCEs by altering one or more of the following: stream hydrology, water level and flow, water temperature, dissolved oxygen levels, erosion and sediment input/transport, physical habitat structure, vegetation, soils, nutrients and chemicals, fish passage, and stream/estuarine/marine benthic biota and prey resources.

2.3 Environmental Baseline

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

The environmental baseline for this opinion is the result of the impacts that many activities (summarized below and in the species' status sections) have had on the various listed species' survival and recovery. Because the action area under consideration covers much of the various listed species' ranges (refer to Section 1.4), many of the effects of these past activities on the species themselves (effects on abundance, productivity, etc.) are discussed in the rangewide status of the species sections that precede this section (refer to Section 2.2) and summarized here. With respect to the species' habitat, the environmental baseline is the combination of these effects on the PCEs that are essential to the conservation of the species (where those are applicable). Below we provide general information on the action area and describe baseline conditions and threats for different habitat types (nearshore and deepwater). In addition, the environmental baseline section addresses impacts of past research and harvest activities in the action area as they are the most relevant to analyzing the effects of the proposed action.

2.3.1 Puget Sound and Georgia Basin Action Area

The Puget Sound and Georgia Basin is the southern arm of an inland sea located on the Pacific Coast of North America and directly connected to the Pacific Ocean. Most of the water exchange in Puget Sound proper is through Admiralty Inlet near Port Townsend, and the configuration of sills and deep basins results in the partial recirculation of water masses and the retention of contaminants, sediment, and biota (Rice 2007). Tidal action, freshwater inflow, and ocean currents interact to circulate and exchange salty marine water at depth from the Strait of Juan de Fuca, and less dense fresh water from the surrounding watersheds at the surface produce a net seaward flow of water at the surface (Rice 2007).

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Listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, green sturgeon, and eulachon are linked to numerous other fish species in the Puget Sound through the food web. Groundfish (often referred to as demersal fish, or bottom fish), make up the majority of the estimated 211 species of fish within Puget Sound (Donnelly and Burr 1995) and constitute the largest number of species in the action area. Groundfish collectively occupy habitats ranging from intertidal zones to the deepest waters of the region. The WDFW has estimated that the biomass of benthic bottom fishes in Puget Sound is 220 million pounds (WDFW 2011a). Herring, surf smelt (*Hypomesus prefiosus*), Pacific sand lance (*Ammodytes hexapterus*), and eulachon are referred to as forage fish. Forage fish are an important food source for many fish species, including ESA-listed rockfish and PS Chinook salmon. Forage fish are generally highly migratory, and occupy a variety of depths throughout the action area (Donnelly and Burr 1995). Aside from eulachon, forage fish lay their eggs in the marine environment on aquatic vegetation that includes eel grass (herring), in bottom mud/sand habitats (sand lance), or in the upper intertidal zone (surf smelt). Herring are a key food source for many marine fish, and their spawning biomass in Puget Sound fluctuates widely, but has averaged approximately 12,000 to 15,000 tons in recent times (Stick 2011). General impacts to these species from human activities, fishing, and management of their habitats are described below, as applicable.

Washington State has a variety of marine protected areas managed by 11 Federal, state, and local agencies (Van Cleve et al. 2009), though some of these areas are outside of the range of the rockfish DPSs. The WDFW has established 25 marine reserves within the DPSs, and 16 host rockfish (Palsson et al. 2009), though most of these reserves are within waters shallower than those typically used by adult yelloweye rockfish, canary rockfish, or bocaccio. The WDFW reserves total 2,120.7 acres of intertidal and subtidal habitat. The total percentage of the Puget Sound region within reserve status is unknown, though Van Cleve et al. (2009) estimate that one percent of the subtidal habitats of Puget Sound are designated as a reserve. Compared to fished areas, studies have found higher fish densities, sizes, or reproductive activity in the assessed WDFW marine reserves (Eisenhardt 2001, 2002; Palsson 1998; Palsson and Pacunski 1995). These reserves were established over several decades with unique and somewhat unrelated ecological goals, and encompass relatively small areas (average of 23 acres).

Below, we describe impacts to habitats within the nearshore and deeper than the nearshore separately because they are ecologically distinct, face different threats, and are affected by the proposed action differently.

Nearshore

The nearshore of the Puget Sound includes intertidal waters extending outward to the termination of the photic zone (upper layer of a water body delineated by the depth at which enough sunlight can penetrate to allow photosynthesis), which is approximately 90 feet (30 m) deep. Nearshore habitats are naturally dynamic; wave energy and sediment inputs from local streams, rivers, and beach bluff erosion cause fluctuating habitat conditions such as temperatures, light levels, and suspended sediment levels (Downing 1983). Eelgrass and kelp grow nearly exclusively within the nearshore (Mumford 2007). Kelp cover is highly variable and has shown long-term declines in some basins, while kelp beds have increased in areas where artificial substrate provides additional kelp habitat (Palsson et al. 2009). Threats to kelp and eelgrass include toxins such as

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petroleum products, which lower photosynthesis and respiration, and harvest (Mumford 2007). Indirect stressors to kelp include low dissolved oxygen, eutrophication, and changes in trophic structure resulting from harvest of organisms that feed upon kelp (Mumford 2007). Development has occurred along approximately 30 percent of the Puget Sound shoreline (Broadhurst 1998) and has increased in recent years (Cornwall and Mayo 2008). Development along the shoreline has been linked to reduced invertebrate abundance and species taxa diversity (Dugan et al. 2003), and reduced forage fish egg viability (Rice 2006). These are examples of food web changes that may alter forage fish prey composition or abundance for rockfish, salmonids, and other fish.

Deepwater Habitats

Most of the benthic deepwater (i.e., deeper than 90 feet) habitats of Puget Sound proper consist of unconsolidated sediments such as sand, mud, and cobbles. The vast majority of the rocky-bottom areas of the Puget Sound occur within the San Juan Basin, with the remaining portions spread among the rest of Puget Sound proper (Palsson et al. 2009). Depths in the Puget Sound extend to over 920 feet (280 meters). Mean depths in each of the major basins of the DPSs include 113 feet (34.7 meters) in the San Juan/Strait of Georgia Basin, 206 feet (63 meters) in the Whidbey Basin, 323 feet (98.5 meters) in the Main Basin, 147 feet (45.1 meters) in the South Sound, and 176.5 feet (53.8 meters) in Hood Canal (Burns 1985).

Deepwater benthic habitats within Puget Sound have been influenced by a number of factors. The degradation of some rocky habitat, loss of eelgrass and kelp, introduction of non-native species that modify habitat, and degradation of water quality are threats to marine habitat in Puget Sound (Drake et al. 2010; Palsson et al. 2009). Some benthic habitats have been degraded by derelict fishing gear that include lost fishing nets and shrimp and crab pots (Good et al. 2010). Derelict fishing nets can continue "ghost" fishing and are 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 eaten by rockfish (Good et al. 2010). Observers and researchers have documented thousands of nets within Puget Sound and most are in the San Juan Basin and the Main Basin. The Northwest Straits Initiative has operated a program to remove derelict gear throughout the Puget Sound 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 (Good et al. 2010). The removal of nearly 4,000 nets and over 2,000 derelict pots has restored approximately 500 acres of benthic habitat (Northwest Straits Initiative 2011), though many derelict nets and crab and shrimp pots remain in the marine environment. Approximately 123 nets have been documented in waters deeper than 100 feet, though some of these may be other debris such as derelict crab pots (NRC 2010a). The Northwest Straits Initiative has documented over 200 rockfish within recovered derelict gear, including one canary rockfish (within a net) (NRC 2010b). Because habitats deeper than 100 feet (30.5 m) are most readily used by adult yelloweye rockfish, canary rockfish, and bocaccio, there is an unknown but potentially significant impact from deepwater derelict gear on rockfish habitats within Puget Sound.

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Over the last century, human activities have introduced a variety of toxins into the Georgia Basin at levels that may affect adult and juvenile rockfish habitat and/or the prey that support them. Toxic pollutants in the Puget Sound include oil and grease, polychlorinated biphenyls (PCBs), phthalates, PBDEs, and heavy metals that include zinc, copper, and lead. Several urban embayments in Puget Sound have high levels of heavy metals and organic compounds (Palsson et al. 2009). About 32 percent of the sediments in the Puget Sound region are considered to be moderately or highly contaminated (Puget Sound Action Team 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Puget Sound Partnership 2010).

In addition to chemical contamination, water quality in the Puget Sound region is compromised by sewage, animal waste, and nutrient inputs. These nutrient inputs can cause lowered levels of dissolved oxygen; Hood Canal has seen persistent and increasing areas of low dissolved oxygen since the mid 1990s. Typically, rockfish move out of areas with dissolved oxygen less than 2 mg/L, though when low dissolved oxygen waters were quickly upwelled to the surface in 2003, about 26 percent of the rockfish population was killed, though no ESA-listed rockfish were observed (Palsson et al. 2009). In addition to Hood Canal, periods of low dissolved oxygen are becoming more widespread in waters south of Tacoma Narrows (Palsson et al. 2009).

Degraded habitats within Puget Sound have varying effects on the ability of ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, eulachon, and green sturgeon to recover. These affects are highly dependent upon the species and life-stage, and additional research is necessary to fully understand potential effects on the viability parameters for these species. Despite the uncertainties, there is sufficient evidence to indicate that productivity of these species may be negatively impacted from habitat degradation that includes shoreline development, poor water quality (including low dissolved oxygen and contaminants), and derelict fishing gear.

2.3.2 Research Effects in the Environmental Baseline

Although not identified as a factor for decline or a threat preventing recovery, scientific research and monitoring activities have the potential to affect the species' survival and recovery by killing listed fish. For the year 2012 and beyond, NMFS has issued several research section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species (Table 5). In a separate process, NMFS also has completed the review and expects to re-authorize the state scientific salmon research programs under ESA section 4(d). The table below displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A). For salmonids, eulachon, and green sturgeon, these takes occur in freshwater, estuarine, and saltwater habitats of the Puget Sound region.

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Table 5. Annual take allotments for research on listed species in 2012-2016 (NMFS Consultation Number 2011/06218).

Species	Life Stage	Production/Origin[a]	Total Take	Lethal Take[b]
PS Chinook Salmon	Adult	Hatchery	2295	92
		Natural	659	55
	Juvenile	Hatchery	148,481	11,825
		Natural	427,911	12,414
HCS Chum Salmon	Adult	Hatchery	0	0
		Natural	569	6
	Juvenile	Hatchery	615	9
		Natural	356,827	2,612
PS Steelhead	Adult	Hatchery	43	4
		Natural	1,186	25
	Juvenile	Hatchery	12,526	222
		Natural	47,142	997
S Eulachon	Adult	Natural	1,462	1,073
PS/GB Bocaccio	Adult	Natural	32	13
PS/GB Canary Rockfish	Adult	Natural	68	48
PS/GB Yelloweye Rockfish	Adult	Natural	64	48
S Green Sturgeon	Adult	Natural	17	0

[a] The hatchery-origin fish represent a combination of ESA-protected fish with an intact adipose fin, and those fish with no take prohibitions (with a clipped adipose).
[b] Lethal take is a sub-set of the total take for each species, as applicable.

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels. There are two reasons for this. First, most researchers do not handle the full number of outmigrants (or adults) they are allowed. (Our research tracking system reveals that researchers on average end up taking about 37 percent of the number of fish they estimate needing.) Second, the estimates of mortality for each proposed study are purposefully inflated (the amount depends upon the species) to account for potential accidental deaths, and it is therefore very likely that fewer fish, especially juveniles, than the researchers are allotted (in some cases many fewer) would be killed during any given research project.

2.3.3 Harvest and Bycatch Effects in the Environmental Baseline

Puget Sound Chinook Salmon and Hood Canal Summer-run Chum Salmon

In other consultations, NMFS has evaluated the joint resource management plans (RMPs) for salmon fisheries in the Puget Sound (PS Chinook salmon, HCS chum salmon). The Chinook salmon RMP specified the management of commercial, recreational, subsistence, and tribal salmon fisheries as potentially affecting listed PS Chinook salmon from May 1, 2011 through

April 30, 2014. The HCS chum salmon RMP similarly specified the fisheries as affecting this species.

The above RMPs together encompass all of the action area for the proposed action. Harvest objectives specified in each RMP account for fisheries-related mortality of each species. The RMPs also include implementation, monitoring, and evaluation procedures designed to ensure fisheries are consistent with these objectives. The PS Chinook salmon RMP places limits on the cumulative directed and incidental fishery-related mortality to each PS Chinook salmon population or management unit. The PS Chinook RMP limits to the cumulative fishery-related mortality are expressed as: (1) an exploitation rate ceiling, (2) an upper management threshold, (3) a low abundance threshold, and (4) a critical exploitation rate ceiling. Each RMP also incorporates a comprehensive monitoring and evaluation plan to maintain and improve population assessment methodologies. This enables the assessment of fishing-related impacts on hatchery and naturally spawning Chinook salmon populations; the abundance of hatchery and naturally spawning fish for each of the identified management units; the effectiveness of the fishing regimes and general approach; and regulatory compliance.

The RMPs do not explicitly state annual fishing regimes (e.g., where and when fisheries occur or how fish will be allocated) because abundance of each population is different each year. Rather, each plan provides the management framework to establish annual fishing regimes to protect threatened PS Chinook salmon and HCS chum salmon—a framework that is responsive to the unique circumstances faced each year [consultation number F/NWR/2010/06051].

ESA-listed Rockfish

The salmon fisheries authorized by the PS Chinook salmon RMP incidentally catch ESA-listed rockfish. In our consultation on that RMP [consultation number F/NWR/2010/06051] we estimated that 93 yelloweye rockfish, 312 canary rockfish, and 26 bocaccio would be caught annually by anglers targeting salmon (NMFS 2011). We determined that ESA-listed rockfish habitat would be damaged from lost (or "derelict") commercial fishing nets targeting salmon. Based on recent net loss rates, we estimated that a range of 2.6 acres to 6.7 acres of benthic habitat are degraded by derelict fishing nets per year, but were unable to estimate the number of ESA-listed rockfish killed by these lost nets.

Puget Sound Steelhead

Table 6 summarizes how many summer- and winter-run steelhead are likely to be killed in the Puget Sound salmon and steelhead commercial and recreational fisheries (NMFS 2011).

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Table 6. Average annual catch (harvest rates as a proportion of total run size and/or numbers of fish) of listed summer and winter steelhead for Puget Sound treaty and non-treaty fisheries.

Fishery or Activity	Treaty Indian	Non-Treaty	Harvest rate %	Number of Fish caught
Treaty marine salmon	126[13]		-	126
Non-treaty marine commercial salmon		1	-	1
Non-treaty marine recreational salmon		198	-	198
Total steelhead bycatch in marine areas	126	199	-	325

In its listing determination for PS steelhead, NMFS determined that the current harvest management strategy that has eliminated direct harvest of wild steelhead in Puget Sound has largely addressed the threat of decline to the listed DPS posed by harvest (72 Fed. Reg. 26722, May 11, 2007).

Southern Green Sturgeon and Southern Eulachon

No harvest or bycatch of green sturgeon or eulachon have been authorized by NMFS under section 7(a)(2) or section 10(a)(1)(B) of the ESA.

2.4 Effects of the Proposed Actions on the Species and Their Designated Critical Habitat

"Effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but are reasonably certain to occur. As detailed in Section 2.1, we assess the effects of the action on several scales, including effects to individual fish (i.e., injury) and then to the ESA-listing unit (DPS or ESU). We assess the effects to the DPS or ESU based on how research actions and fisheries would alter the species' viability parameters (abundance, productivity, spatial structure, and diversity) that in turn inform its likelihood of survival and recovery. In biological terms, a "viable" population is one that has a high probability of persisting into the future (Waples 1997). Thus, the term viability has an inherent link to the concepts of survival and continued existence because if a population is highly likely to persist into the future, that means it has a high likelihood of surviving (Waples 1997). Recovery is also underlying the concept of viability because it enables a species to withstand or exploit changing habitat conditions and catastrophic events, among other factors (McElhaney et al. 2000). For example, populations that have recovered (or are on a recovery trajectory) are better able to withstand events such as oil spills or other large scale and potentially negative events. Similarly, recovered species are able to exploit positive habitat changes such as beneficial ocean conditions or large-scale/multiple habitat restoration actions. Because the WDFW has enumerated the number of fish affected by the proposed action, we are

[13] Catch estimate includes a combination of hatchery-origin and natural-origin fish.

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able to conduct the most precise analysis of the viability parameters on abundance for each species.

2.4.1 Effects on the Species

Research Effects

Capturing and handling fish in research trawls or on hook-and-line causes them injury, physiological stress, or can kill them. When caught in trawl nets, fish can be injured and killed through force trauma or suffocation. In a few cases, individual fish can recover rapidly. Several factors associated with the proposed activities could injure or kill fish: (1) rapid decreases in pressure occur when fish are brought from extreme depths—this can cause barotraumas; (2) differences in water temperatures between the sea and wherever the fish are held can cause shock; (3) dissolved oxygen levels that are different from natural habitats to those in holding tanks; (4) the amount of time that fish are held out of the water can cause stress; (5) fish transferred to holding tanks can experience trauma if care is insufficient during the transfer process; and (6) any physical trauma that may lead to predation after fish are released. For rockfish, the primary factor relating to injury and death is barotrauma. Fish have two different types of swim bladders: physostome (open swim bladder) and physoclist (closed swim bladder). Physostome fish (such as salmonids) have a swim bladder connected to the esophagus via the pneumatic duct that allows them to gulp air to fill their swim bladder or quickly release the air when necessary. Physoclist fish (such as rockfish) lack the duct connection to the esophagus and are dependent upon passive gas exchange through their blood in their swim bladders. This allows them to become buoyant at much deeper depths than physostome fish, but they are unable to offload gases quickly during a rapid ascent. When rockfish are brought from depths of deeper than 60 feet (18.3 m) the rapid decompression causes over-inflation and/or rupture of the swim bladder (termed barotrauma), which can result in multiple injuries (Jarvis and Lowe 2008; Palsson et al. 2009; Parker et al. 2006). These injuries cause various levels of disorientation among rockfish species, which result in fish remaining at the surface after they are released (Hannah and Matteson 2007). Rockfish at the surface are susceptible to predation by birds, sharks, or marine mammals, damage from solar radiation, and gas embolisms (Palsson et al. 2009). Because of the physiological differences described above, the other listed fishes considered in this opinion are not susceptible to barotraumas.

To limit effects from research activities, capture and handling is conducted by trained professionals using established protocols. No researcher would receive a permit unless their activities incorporate NMFS' uniform, pre-established set of mitigation measures that minimize the effects of capturing and handling fish. These measures are described in Section 1.3 of this opinion and are incorporated (where relevant) into every permit as part of the conditions to which a researcher must adhere.

In summary, general research effects include injury and harm from the sampling gear and removal from the natural environment. The severity of these effects depends upon the particular species, handling techniques, and type of sample gear. The effects of WDFW sampling gear would be relatively small (discussed in *Habitat Effects from Research and Fisheries* below).

Species-specific Effects of the Research Permits

This section assesses the effects of each research permit (15848, 16091, 15890, 16021) on listed fish, and the Integration and Synthesis Section 2.6 assesses the entire take associated with the proposed action and the environmental baseline combined. Abundance information allows us to assess an action's effect in terms of the species' overall numbers. In previous sections, we estimated the annual abundance of adult and juvenile listed fish and summarized take levels for approved research activities from 2012 through 2016 (as applicable). Table 7 displays the estimated annual abundance of the listed fish. Estimating abundance for each species is challenging, particularly for listed rockfish, and we use best available data as benchmarks to compare the effect of take from the proposed action.

Table 7. Estimated annual abundance of ESA-listed fish in Puget Sound.

Species	Life Stage	Origin	Abundance
PS/GB Bocaccio	-	Natural	4,606
PS/GB Canary Rockfish	-	Natural	20,548
PS/GB Yelloweye Rockfish	-	Natural	47,407
PS Chinook Salmon	Adult	Listed Hatchery[b]	12,206
		Natural	25,928
	Juvenile	Listed Hatchery	23,970,000
		Natural	3,050,000
HCS Chum Salmon	Adult	Natural and Listed Hatchery	18,834
	Juvenile	Listed Hatchery Intact Adipose	275,000
		Natural	2,750,000
PS Steelhead	Adult	Listed Hatchery[a]	1,870
		Natural	12,996
	Juvenile	Listed Hatchery	52,000
		Natural	1,700,000
S Eulachon	-	Natural	296,200[a]
S Green Sturgeon	-	Natural	800

[a] Eulachon abundance is for the Fraser River population.

[b] Listed Hatchery-origin salmon adults are a combined estimate of Listed Hatchery Adipose Clip and Listed Hatchery Intact Adipose adults.

[c] Personal communication, David Woodbury (NMFS), July 27, 2011.

Because multiple populations of listed fish mix in the action area, we could not reliably assign take to specific populations or group of populations. Thus, we assess the effect of the action in terms of its impact on the relevant species' total abundance. For eulachon, we use the estimated Fraser River population

As noted previously, issuing permit 15848, permit 16091, and permit 15890 would authorize WDFW to continue research trawls throughout the action area. Research trawls take bottom fish and other fish, and because of the nature of the sampling, many sampled fish die. Of the fish captured, at least 50 percent may die, so effects of the proposed action are best seen in the context of the fish that are likely to be killed. Those fish not killed are expected to recover from capture quickly, and not experience sub-lethal effects (such as susceptibility to future disease). To determine the effects the research may have, we compared the numbers of fish that may be killed to the total abundance numbers estimated for these species.

Also noted previously, issuing permit 16021 would authorize the WDFW to use hook-and-line gear targeting non-listed rockfish and bottom fish. Hook-and-line gear may unintentionally capture ESA-listed rockfish and PS Chinook salmon. Rockfish could suffer from barotraumas, and the hooks would injure each species of fish. These injuries would include tissue damage, loss of blood, and infection. Some of these injuries would lead to mortality of released fish (from injury and infection, and/or increased susceptibility to predation). The total mortality estimates are derived from the applicant, and include deaths resulting from injuries, and occur later in time after fish are released. Salmon do not suffer barotraumas; thus, for PS Chinook salmon, most fish would survive after their release.

In addition to negative impacts on species from killing fish as part of research, there are also benefits to the species because research supports and informs conservation and recovery. We are, however, unable to quantify the conservation benefit from research on listed fish. Nonetheless, each research permit would enable additional understanding of listed fish abundance, productivity, spatial structure, and diversity characteristics within the action area. In addition, each research permit would enable an enhanced understanding of the status of the Puget Sound ecosystem and habitats used by listed fish and their prey sources.

Puget Sound/Georgia Basin Yelloweye Rockfish, Canary Rockfish, and Bocaccio

The estimated amounts of mortality likely caused by the various research permits are reported in Table 8. NMFS anticipates that most caught ESA-listed rockfish will be mortalities because they would be caught in research trawls or hook-and-line gear. Note that some fish, particularly those caught by hook-and-line gear, could survive.

Thus, no permit would kill more than 0.04 percent of bocaccio, 0.05 percent of canary rockfish, or 0.0001 percent of yelloweye rockfish. Moreover, that take (and its potential impacts) would be distributed over each of the major basins of each DPS; thus, no individual basin's population would be likely to experience a disproportionate amount of these losses. Therefore, there would be a very small impact on each species' abundance, a likely similarly very small impact on their productivity, and no measurable effect on their spatial structure or diversity.

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Table 8. Annual mortalities (M) of ESA-listed rockfish in Puget Sound from listed research permits.

Species	Permit 15848		Permit 16091		Permit 15890		Permit 16021	
	M	% of DPS	M	% of DPS	M	% of DPS	M	% of DPS
Bocaccio	2	0.04	2	0.04	2	0.04	2	0.04
Canary Rockfish	10	0.05	10	0.05	2	<0.0001	2	<0.0001
Yelloweye Rockfish	4	<0.0001	2	<0.0001	2	<0.0001	2	<0.0001

Puget Sound Chinook Salmon

The amounts of mortality estimated by NMFS likely caused by the various research permits are summarized in Table 9.

Table 9. Annual mortalities (M) of Puget Sound Chinook salmon from activities associated with research permits 15848, 16091, 15890, and 16021.

		Permit 15848		Permit 16091		Permit 15890		Permit 16021	
		M	% of ESU	M	% of ESU	M	% of ESU	M	% of ESU
Adult	Listed Hatchery	2	<0.0001	1	<0.0001	1	<0.0001	1	<0.0001
	Natural	1	<0.0001	1	<0.0001	1	<0.0001	1	<0.0001
Juvenile	Listed Hatchery	7	<0.0001	10	<0.0001	5	<0.0001	1	<0.0001
	Natural	2	<0.0001	5	<0.0001	3	<0.0001	1	<0.0001

The total requested annual take for each research type and Puget Sound Chinook salmon are in Appendix A.

Each permit would result in activities that could kill at most 0.0001 percent of PS Chinook salmon's natural and hatchery juvenile and adult life stages. Take would occur over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar very small impact on their productivity, and no measureable effect on their spatial structure or diversity.

Hood Canal Summer-run Chum Salmon

The amounts of mortality estimated by NMFS and WDFW likely caused by the various research permits are reported in Table 10.

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Table 10. Annual mortalities (M) of Hood Canal Summer-run Chum Salmon in Puget Sound from activities associated with research permits 15848, 16091, 15890, and 16021.

		Permit 15848		Permit 16091		Permit 15890		Permit 16021	
		M	% of ESU	M	% of ESU	M	% of ESU	M	% of ESU
Adult	Natural	1	<0.0001	1	<0.0001	1	<0.0001	0	0
Juvenile	Natural	1	<0.0001	1	<0.0001	1	<0.0001	0	0

The total requested annual take for each research type and Hood Canal Summer-run chum salmon are in Appendix A.

Each permit would result in activities that could kill at most 0.0001 percent of HCS chum salmon's natural juvenile and adult life stages. Take would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar very small impact on their productivity, and no measureable effect on their spatial structure or diversity.

Puget Sound Steelhead

The amounts of mortality estimated by NMFS likely caused by the various research permits are reported in Table 11.

Table 11. Annual mortalities (M) of Puget Sound steelhead in Puget Sound from activities associated with research permits 15848, 16091, 15890, and 16021.

		Permit 15848		Permit 16091		Permit 15890		Permit 16021	
		M	% of DPS	M	% of DPS	M	% of DPS	M	% of DPS
Adult	Listed Hatchery[a]	1	<0.0001	1	<0.0001	0	0	0	0
	Natural	1	0.0005	1	0.0005	0	0	0	0
Juvenile	Listed Hatchery[a]	1	<0.0001	1	<0.0001	1	<0.0001	0	0
	Natural	1	<0.0001	1	<0.0001	1	<0.0001	0	0

[a] Includes only adipose-clipped fish. The total requested annual take for each research type and Puget Sound steelhead are in Appendix A.

Each permit would result in activities that could kill at most 0.0005 percent of PS steelhead natural and hatchery juvenile and adult life stages. Take would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar very small impact on their productivity, and no measureable effect on their spatial structure or diversity.

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Southern Eulachon

The amounts of mortality estimated by NMFS likely to be caused by the various research permits are reported in Table 12. All caught eulachon are anticipated to be mortalities because of suffocation and force trauma caused by the trawl net.

Table 12. Annual mortalities (M) of Southern eulachon in Puget Sound from activities associated with research permits 15848, 16091, 15890, and 16021.

	Permit 15848		Permit 16091		Permit 15890		Permit 16021	
	M	% of DPS[a]	M	% of DPS[a]	M	% of DPS[a]	M	% of DPS[a]
Adult (Natural)	400	0.14	160	0.05	60	0.02	0	0

[a] We use the estimated population of the Fraser River for the proportion of the eulachon DPS within the action area.

Each permit would result in activities that could kill at most 0.14 percent of eulachon of the Fraser River population. Eulachon from other populations of the DPS are likely present in the action area as well, so the impact to the Fraser River population would be less than estimated. Nonetheless, these activities would have a very small impact on the species' abundance, a likely similar very small impact on their productivity, and no measureable effect on their spatial structure or diversity.

Southern Green Sturgeon

Two green sturgeon may be captured by researchers, but we expect that all would survive and recover with no long-term effects. There would be no impact on the species' abundance, productivity, and spatial structure or diversity because none of the activities associated with these permits would actually kill any green sturgeon. This is because the encounter rate of research gear and green sturgeon are likely to be low (bottom trawls) or non-existent (mid-water trawl gear, hook-and-line gear in saltwater areas).

In summary, each permit would result in activities that could kill a small fraction of ESA-listed fish populations in the action area. Take would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar very small impact on their productivity, and no measureable effect on their spatial structure or diversity.

WDFW Fisheries Management

Under the terms of the ITP, WDFW would manage recreational bottom fishing and the commercial shrimp trawl fishery, which are discussed further below; and closures of the set net, set line, and bottom trawl fisheries would continue. They have been closed since 2010, so the benefit of the closure is already in effect. The set net, set line, and bottom trawl fisheries historically caught rockfish as bycatch or targeted rockfish, but they would not continue to have such effects because they would not be re-opened. By contrast, there is little evidence of past bycatch of PS Chinook salmon, PS steelhead, HCS chum salmon, green sturgeon, or eulachon in these closed fisheries; thus, their continued closure is unlikely to have a large positive impact.

In the past several decades, the set net, set line, and bottom trawl fisheries caught relatively large numbers of yelloweye rockfish, canary rockfish, and bocaccio in Puget Sound, even though some of these fisheries targeted other species (Williams et al. 2010):

> {In the early 1980s} The non-target bycatch of rockfish also expanded from growing set-line and set-net fisheries that targeted Pacific cod and spiny dogfish. These gears appeared to be selective for particular rockfish species in some regions, with approximately 70% (by weight) of the rockfish bycatch in commercial set-nets during 1984 represented by bocaccio in the Central and South Sound regions and 20% by yelloweye rockfish in the San Juan Island region. Set lines were similarly effective for catching bocaccio in Hood Canal (30% of rockfish catch by weight) and South Sound (50%), and for yelloweye in the Strait of Juan de Fuca (50%) and Hood Canal (30%).

We do not know how many yelloweye rockfish, canary rockfish, or bocaccio would be protected by the continued closure of these fisheries, but their closures for the duration of the ITP would nonetheless be an important protective measure because these fisheries caught some of these species as bycatch. In addition, the closure of the bottom trawl and scallop trawl fishery would protect benthic habitats used by listed fish, particularly rockfish.

Recreational Bottom Fishing

Recreational anglers targeting bottom fish such as lingcod and cabezon (and to a lesser extent flatfish) use lures and bait that sometimes unintentionally catch yelloweye rockfish, canary rockfish, bocaccio, and PS Chinook salmon. Although recreational fishers are required by state law to return all rockfish species to the water, the mortality rate of released rockfish is relatively high (described in Section 2.4.1). Based on previous bycatch estimates and continued mitigation measures, NMFS and WDFW projected bycatch for ESA-listed rockfish for the duration of the five year ITP (Figure 6). An estimated 142 yelloweye rockfish, 128 canary rockfish, and 38 bocaccio would be caught annually (as bycatch) by recreational fishermen targeting bottom fish in the Puget Sound. NMFS and WDFW estimate that 42 PS Chinook salmon, and no eulachon or sturgeon, would be incidentally caught in the recreational fishery. Under the terms of the ITP, WDFW would continue several important protective measures to reduce the bycatch of yelloweye rockfish, canary rockfish, and bocaccio in the recreational bottom fish fishery. Anglers could not target or retain rockfish of any species, and fishing would be prohibited in waters deeper than 120 feet (36.6 m) where sub-adult and adult ESA-listed rockfish are most likely to reside. While these measures are unlikely to reduce the actual number of unintentionally hooked PS Chinook salmon, the WDFW would continue protective measures to reduce the injuries and deaths of unintentional hooking; they would prohibit barbed hooks and limit fishing gear to two individual hooks (no treble hooks). Both measures would reduce injuries among PS Chinook salmon and ESA-listed rockfish by reducing soft-tissue damage and the time needed to release fish from the hook. With the continuation of these measures, WDFW estimates that bycatch in the recreational bottom fish fishery would decrease by approximately

40 percent for yelloweye rockfish and 33 percent for canary rockfish (Figure 6). Because of their relative scarcity in recent fishery catch statistics, we do not have similar estimates for bocaccio. However, sub-adult and adult bocaccio primarily occupy waters deeper than 120 feet, and thus would have enhanced protection from bycatch as well.

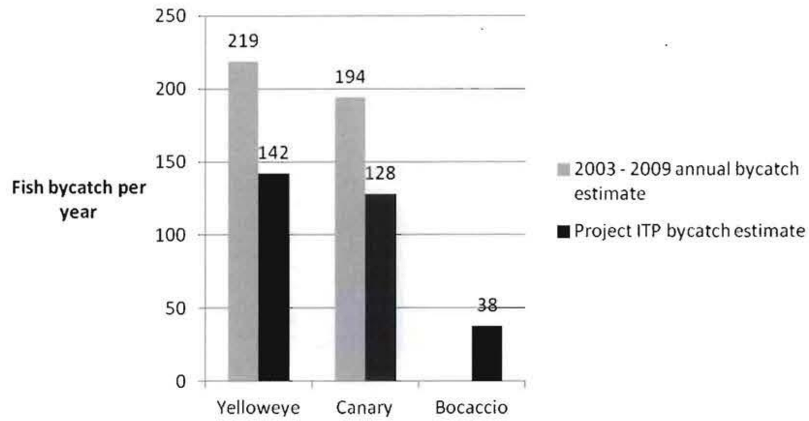

Figure 6. Bycatch estimates for yelloweye rockfish and canary rockfish by recreational bottom fish anglers from 2003 to 2009 compared to estimated annual bycatch for the duration of the ITP (WDFW 2011b).

Commercial Shrimp Trawl

We anticipate the annual bycatch of ESA-listed rockfish in the shrimp trawl fishery to be relatively small (10 yelloweye rockfish, 10 canary rockfish, 5 bocaccio) because the fishery primarily occurs in habitats that lack the complex bottom structure preferred by rockfish. Shrimp trawls may capture some PS Chinook salmon (50 anticipated each year) because they occasionally forage near the bottom. The shrimp bottom trawl fishery catches some eulachon (3,240 anticipated each year) because eulachon in Puget Sound appear to prefer habitats near the bottom. ESA-listed fish would likely be injured or killed in the shrimp trawl fishery by the same things that injure or kill them in the research trawls: barotraumas (rockfish), force trauma, and suffocation (rockfish, PS Chinook salmon, and eulachon).

Little is known about green sturgeon habitat use in the Puget Sound, though they likely spend most of their time in coastal marine and estuarine water, and rely on areas of Puget Sound for migration to and from over-summering and over-wintering habitat areas, and to and from spawning areas. In over 1,700 tows over two decades, WDFW research trawls have caught (and released alive) one green sturgeon in Puget Sound; this data provides an indication of the potential catch rate for green sturgeon in the shrimp trawl fishery. Thus, WDFW anticipates the bycatch of green sturgeon in the shrimp trawl fishery to be quite low, with an estimated one fish per year. Green sturgeon are generally more able to withstand the rigors of being caught in a

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trawl net than other fish, and thus any caught fish could be released alive. However, to enable a conservative analysis, we presume that one fish would be killed annually in the shrimp trawl fishery. WDFW would manage the fishery to track bycatch with on-board observers. Observer data would enable adaptive management measures to reduce the catch of listed fish in the future, as necessary.

Table 13 provides our assessment of the percentage of lethal and non-lethal takes for ESA-listed rockfish, eulachon, PS Chinook salmon, and green sturgeon from the recreational bottom fish fishery and the shrimp trawl fishery.

To determine the effects the two covered fisheries may have, we compared the numbers of fish that may be killed to the total abundance numbers estimated for these species (Table 13). Rockfish bycatch would probably be most prevalent in the North Puget Sound where they are most abundant, though fish from other basins of Puget Sound would also be unintentionally caught. Thus, the fisheries, even taken together, would have only a small impact on each species' abundance and a proportionally similar small impact on ESA-listed rockfish productivity, spatial structure, or diversity. Even in the worst case scenario where annual bycatch reaches the adaptive management trigger, there would still be only relatively small impacts on abundance and productivity, spatial structure, and diversity.

Table 13. Annual takes of ESA-listed fish within the recreational bottom fish fishery and the shrimp trawl fishery in Puget Sound for the proposed action.

Species	Projected Annual Take for Rec. Bottom Fish and Shrimp Trawl[a]	Percent of DPS/ESU	Years 1, 2, and 3 Adaptive Management Trigger[d]	Percent of DPS/ESU
Bocaccio	43 (5 from shrimp trawl)	0.9	50	1.1
Canary rockfish	138 (10 from shrimp trawl)	0.7	166	0.8
Yelloweye rockfish	152 (10 from shrimp trawl)	0.3	180	0.4
Eulachon	3,240 (all from shrimp trawl)	1.1	3,889	1.3[b]
Chinook salmon	92 (50 from shrimp trawl	<0.0001[c]	Na	na
Green sturgeon	1 (from shrimp trawl)	0.13	Na	na

[a]This includes lethal and non-lethal takes. It combines Table 1 (research takes) and Table 2 (fisheries takes).
[b]This number is the percent of the Fraser River population of eulachon.
[c] Compared to the natural component of juvenile PS Chinook salmon listed in Table 7.
[d] See Table 3. No other listed fish would be caught in these two fisheries.

A maximum of 3,889 eulachon could end up as bycatch in the shrimp trawl fishery, with this number as the adaptive management trigger. This represents a very small portion of only the Fraser River population and would therefore have only a very small effect on that population's abundance, a proportionally similar small impact on their productivity, and no measureable effect on their spatial structure or diversity. Effects to the overall eulachon DPS abundance would be even smaller. Annual bycatch that reaches the adaptive management trigger would still result in relatively small impacts to abundance and productivity, spatial structure, and diversity.

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Bycatch of PS Chinook salmon in the recreational bottom fish fishery would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound, while all Chinook salmon bycatch in the shrimp trawl fishery would occur in the North Sound. No particular population would be disproportionately killed by fisheries bycatch because Chinook salmon populations mix within the Puget Sound. Each fishery would have an extremely small impact on PS Chinook salmon abundance, a similarly small impact on their productivity, and no measureable effect on their spatial structure or diversity because the numbers of bycatch are very small compared to total population numbers and take is spread out geographically.

The annual bycatch and death of one green sturgeon in the shrimp trawl fishery would have a very small effect on abundance, a similarly small impact on their productivity, and no measureable effect on their spatial structure or diversity.

The adaptive management triggers (Table 13) have been set specifically for ESA-listed rockfish and eulachon because of the uncertainty regarding bycatch rates in the recreational bottom fish fishery and the shrimp trawl fisheries. As described in Section 1.3.2, the bycatch rate estimates of ESA-listed rockfish have varied widely in the past, and additional uncertainty about future bycatch rates comes from the new depth regulations. Bycatch of eulachon in the shrimp trawl fishery would be sporadic as well. Though limited, the past observer data for this fishery showed most tows caught no eulachon, but one tow had 144 fish (WDFW FCP 2012). As such, the adaptive management triggers in years one, two, or three of the ITP would enable possible modifications of each fishery to reduce bycatch. In addition, WDFW would continue to conduct research of Puget Sound marine biota and ESA-listed rockfish, which would focus on producing estimates of abundance, demographics, and spatial distribution throughout the ranges of the DPSs. In addition, any new (or better understood) environmental/habitat threats or improvements can be assessed in the context of stock survival and recovery.

Within their annual reports, WDFW would provide a report that: 1) provides estimates of bycatch for each species within the marine catch areas from covered commercial and recreational fisheries; 2) provide incidental bycatch numbers of each species from research efforts; 3) provide any new research results for each species; and 4) assess the potential need for modifications of fisheries regulations or reporting methodology or other management measures to protect these species. These provisions would enable WDFW to modify fisheries management actions to enhance protections for covered species as warranted.

In summary, the two covered fisheries would have small effects on ESA-listed rockfish, eulachon, green sturgeon, and PS Chinook salmon productivity, spatial structure, or diversity because the numbers of bycatch are very small compared to total population numbers and take is spread out geographically.

Habitat Effects from Research and Fisheries

Bottom trawls can affect benthic habitats. Under permits 15848 and 16091, WDFW would conduct research bottom trawls annually in each of the major basins of Puget Sound. Under the ITP, WDFW would authorize the commercial shrimp trawl fishery. The habitat effects of these trawls include altering the seafloor and catching some fish that would otherwise be potential prey for listed fish. In addition, if a trawl net were lost, it could modify and degrade localized benthic habitats by inducing sedimentation or scour of benthic substrates.

Bottom trawls would suspend bottom sediments and redistribute bottom structure such as cobble, larger rocks, and sunken logs. However, these trawls would generally occur in areas that lack complex bottom structure in the first place; thus, the possibility of damaging rockfish habitat is small. The shrimp trawls use beam trawl gear (no rockhopper gear would be allowed) and would not alter areas of rocky bottoms most likely to be primary habitat for ESA-listed rockfish. Most suspended sediments would settle back to benthic habitats quickly and finer materials would be carried further away by currents.

The probability of losing a trawl net is small. WDFW lost one net over the course of 1,700 tows previously undertaken in the research program. Moreover, only two out of 902 recovered derelict fishing nets were from commercial trawl fisheries (Good et al. 2010). Thus, it is unlikely that a net would be lost during either the research or the commercial shrimp fishery.

Trawls would catch and kill some fish (e.g., herring, eulachon) that would otherwise be potential prey for ESA-listed rockfish, PS Chinook salmon, HCS chum salmon, PS steelhead, and green sturgeon. The amount of bycatch is small. Pacific herring have been documented to occur as bycatch in the commercial shrimp trawl fishery at a rate of approximately 107 fish annually, and WDFW research trawls would catch approximately 800 fish annually (Pacunski 2011). The catch of nearly 1,000 herring would remove only a small fraction of the 12,000 to 15,000 tons of annual spawning biomass of Pacific herring, and therefore not impact species viability. In addition, nearly all caught fish would be released back into Puget Sound, and even those that are killed would remain in the food web.

Hook-and-line gear used by research anglers under permit 16021 and the recreational bottom fish fishery would have the potential to alter benthic habitats by snagging structure and losing gear. Recreational bottom fish anglers use jigs, weights, and hooks that could alter benthic habitats by snagging structure and some gear could be lost. However, there have been no observations of adverse effects to the seafloor from lost recreational fishing gear in WDFW habitat surveys (Pacunski 2011), and those that could occur within the recreational bottom fish fishery would be on very small spatial scales. As such, habitat effects would not likely impact listed species addressed in this opinion.

In summary, effects of the fisheries and permits on habitat would be minimal because the trawls would be mainly in areas without covered species, and would catch only minimal amounts of prey species. Additionally, they are limited spatially and temporally across the action area.

2.4.2 Effects on Critical Habitat

The critical habitat (CH) analysis begins with a summary of the effects of the activities on CH PCEs, followed by an evaluation of how changes in PCEs affect conservation value at localized and species-wide scales. The commercial shrimp trawl fishery would occur outside of salmon critical habitat in waters deeper than 120 feet (36.6 m). As such, it would not affect passage conditions, water quality, or natural cover of these designated areas.

Eulachon, Rockfish, and PS Steelhead

Critical habitat for eulachon would not be affected by the proposed action because all critical habitat for eulachon occurs in freshwater habitats outside the action area. Critical habitat has not been designated for PS steelhead or ESA-listed rockfish.

Puget Sound Chinook Salmon and Hood Canal Summer-run Chum Salmon Critical Habitat

Passage Conditions Free of Obstructions to Allow for Migration, Resting, and Foraging

Some WDFW research trawls would occur in the nearshore and affect passage for a period of 5 to 20 minutes in isolated sections of Puget Sound. Fish passage may be hindered for very short periods of time in very limited areas (a few minutes at a time over a few hundred square meters), but such blockages are so small in terms of area affected and time of affect compared to the overall area used for passage that it would not measurably affect salmonid migration, or resting or foraging conditions.

Water Quality Sufficient to Support Growth and Development

Research trawls would mobilize and suspend sediments, and in turn, temporarily reduce the transmission of light through the water column. Sedimentation would occur in areas of the nearshore with naturally dynamic suspended sediment and light levels (Downing 1983) and thus would not alter habitat conditions at scales that would degrade conditions sufficient for growth and development. After trawls conclude, water quality would recover quickly as sediment settles out of the water column. Thus, water quality effects would be too small to cause adverse effects on CH.

Prey Species of Sufficient Quantity, Quality, and Availability to Support Individual Growth, Reproduction, and Development, as well as Overall Population Growth

Some WDFW research trawls take place in the nearshore, but the commercial shrimp trawl fishery would not. However, the catch of some forage fishes that occur outside of the nearshore could nonetheless result in reduced prey resources in the nearshore. Pacific herring have been documented to occur as bycatch in the commercial shrimp trawl fishery at a rate of approximately 107 fish annually (NMFS 2011); WDFW research trawls would catch approximately 800 fish annually (Pacunski 2011). The catch of nearly 1,000 fish would remove only a fraction of the 12,000 to 15,000 tons of annual spawning biomass of Pacific herring and would therefore not impact species viability or reduce prey resources for PS Chinook salmon or HCS chum salmon. Similarly, the catch of over 3,000 eulachon annually would be approximately 1.3 percent of the total estimated eulachon that most readily use Puget Sound (the Fraser River population). Aside from eulachon and herring, prey for PS Chinook salmon and HCS chum salmon include anchovy, surf smelt, sand lance, and other numerous fish and invertebrates. None of these prey sources would be caught in the trawl research. The removal of some herring and eulachon would not meaningfully reduce prey resources for these salmon species, and not affect prey resources to the point of reducing individual growth, reproduction, and development as well as overall population growth.

Natural Cover

The WDFW research trawls could temporarily remove or damage natural cover such as macroalgae and eelgrass in small sections of the nearshore environment. Because these trawls would occur for a short period (5 to 20 minutes) at a time, and cover relatively small areas of habitat, affected areas would likely recover quickly after the disturbance event, and natural cover would not be meaningfully reduced.

Relevance of Action Area Effects on Primary Constituent Elements to Salmonid Designated Critical Habitat

When designating salmonid critical habitat, NMFS assembled teams to assess and rate the conservation value of freshwater, estuarine, and marine areas within the geography of the rangewide designation of CH for PS Chinook salmon and HCS chum salmon. The nearshore marine area includes the zone from extreme high water out to a depth of 98 feet (30 m) and adjacent to watersheds occupied by these ESUs. This area generally encompasses photic zone habitats supporting plant cover (e.g., eelgrass and kelp) important for rearing, migrating, and maturing Chinook salmon, chum salmon, and their prey. The teams concluded that habitat areas in all 19 nearshore zones of Puget Sound (including areas adjacent to islands), Hood Canal, and the Strait of Juan de Fuca (to the mouth of the Elwha River) warranted a high rating for conservation value to the ESUs. These habitat areas occur along approximately 2,376 miles (3,824 km) of shoreline within the range of these ESUs.

As summarized above, the proposed WDFW research bottom trawls and shrimp trawl fishery would have limited short-term effects on the CH marine nearshore PCE in the action area. The adverse effects to the PCEs would be minor and persist only for up to 20 minutes per tow.

The PCEs would thus recover their function quickly enough so that the proposed action would neither diminish the conservation value of CH at the specific trawl locations, nor influence the conservation role of CH in the action area. Furthermore, the effects in the action area would not combine synergistically with any past or ongoing actions to influence the conservation role of those watersheds. Therefore, the action area changes would not adversely affect the conservation value of CH.

Southern Green Sturgeon Critical Habitat

Southern green sturgeon critical habitat is located in the San Juan Basin and Strait of Juan de Fuca. All of the shrimp trawls would occur in designated critical habitat for green sturgeon, and a moderate subset of the WDFW research bottom trawls would as well. The specific PCEs essential for the conservation of the Southern DPS in coastal marine areas are: (1) migration corridors, (2) water quality, and (3) food resources. These trawls would alter portions of green sturgeon critical habitat by affecting sediment quality and available food resources (NMFS 2009). Trawling would result in a small decrease of benthic invertebrates and small fish that green sturgeon eat. However, bottom trawling may also have positive effects on food resources by digging up and making prey resources more available for green sturgeon (NMFS 2009). The shrimp trawls use beam trawl gear (no rockhopper gear would be allowed) and thus would not alter areas of more complex habitats. Trawl gear would be used in sandy, muddy/cobble habitats and would alter portions of the sea floor of the North Sound by suspending sediment and changing habitat complexity, smoothing sedimentary bedforms, and changing bottom roughness in localized areas. Trawls in less structurally complex habitats, such as areas fished by the commercial shrimp trawlers, are less affected than areas of more complex habitat (Roberts 2008). The effect of suspended sediment would be small and temporary as sediment would re-settle to local habitats.

For the shrimp trawl fishery, temporary sediment suspension would not alter light levels (and thus, would not interrupt photosynthesis or affect species such as eelgrass or kelp) because this suspended sediment is limited to waters deeper than 120 feet (36.6 m), which are deeper than the photic zone. Some WDFW research trawls would occur in the photic zone (such as the nearshore of Puget Sound); thus, temporary sediment suspension could reduce light levels on a short-term basis. Temporarily reduced light levels would be unlikely to alter benthic habitats because habitat conditions and sediment levels in the nearshore are naturally dynamic.

The recreational bottom fish fishery in all waters of Puget Sound shallower than 120 feet (36.6 m) would likely result in approximately 100,000 angler trips annually. In addition, some WDFW research activities would use recreational fishing methods. Jigs, weights, and hooks used by anglers have the potential to alter benthic habitats by snagging structure, and some gear could be lost. However, there have been no observations of adverse effects to the seafloor from lost recreational fishing gear in WDFW habitat surveys (Pacunski 2011), and those that could occur within the recreational bottom fish fishery would be on very small spatial scales.

In summary, the proposed research activities and fisheries would not degrade the overall condition of green sturgeon critical habitat in the Puget Sound because they are unlikely to have more than transitory effects (at very small geographic scales) on habitat structure and function.

2.5 Cumulative Effects

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

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects somewhat uncertain. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve ESA-listed species within the action area, see any of the recent status reviews, Federal Register notices of listings, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A) research permits, the Puget Sound Salmon Recovery Plan (NMFS 2006), the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000), and the Southern Resident killer whale recovery plan (NMFS 2008).

Non-Federal actions such as the discharge of non-point sources of nutrients and contaminants, and development of lands around the Puget Sound are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze because of this opinion's geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in the baseline, the adverse cumulative effects are likely to increase. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we consider the effects of the action (Section 2.4, see Tables 8 and 13) in the context of the environmental baseline (Section 2.3, see Table 5) the status of the species and critical habitat, and the cumulative effects (Section 2.5) to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) result in appreciable reductions in the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution (jeopardy); or (2) reduce the value of designated or proposed critical habitat for the conservation of the species (adverse modification or destruction). These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2). In addition, this assessment is made in the context of how limiting factors that are detailed in recovery plans and/or best available information for each species interplay with the effects of the proposed action, which include direct take and any habitat changes that occur as a result of the proposed action. This assessment represents a comprehensive analysis of the effects of the proposed action on species viability (which encompasses survival and recovery). Viability is discussed earlier in Section 2.4, where we explain that viability is the concept of the species' ability to persist long term. While this may initially sound as though it only relates to survival, NMFS considers the ability to persist long term to include the ability to recover. Recovery means that the species will increase in numbers and geographic range, among other factors, to a point where it would no longer need to be listed. For species included in this consultation, to not appreciably reduce the likelihood of recovery means that the fishing and research activities will not cause any meaningful decrease in abundance and other viability parameters.

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Degraded habitats within Puget Sound have varying effects on ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, eulachon, and green sturgeon (listed fishes). These effects are highly dependent upon the species and life-stage, and additional research is necessary to fully understand potential effects on the viability parameters for these species. Despite the uncertainties, there is sufficient evidence to indicate that each species is at risk with regard to each of the four VSP criteria, and their habitats in the action area are impacted by nearshore development, derelict fishing gear, contaminants within the food-web, and regions of poor water quality, among other stressors. Benefits to habitats within the action area have come through the removal of thousands of derelict fishing nets, though nets deeper than 100 feet remain a threat.

Of each of the listed fishes considered in this opinion, only ESA-listed rockfish reside within the action area for their full life-cycle. Each of the other listed fishes spawn within fresh water (outside of the action area) and/or migrate to oceanic habitats outside the action area. As such, the rangewide status of these fishes is influenced by habitat conditions beyond the action area that are not affected by the proposed action. Nonetheless, many of these habitats outside the action area are degraded, which has contributed to reduced abundance and productivity, spatial structure, and diversity for each species.

2.6.1 Puget Sound/Georgia Basin Yelloweye Rockfish, Canary Rockfish, and Bocaccio

As detailed in the Environmental Baseline (Section 2.3), yelloweye rockfish, canary rockfish, and bocaccio are caught by anglers targeting salmon, and taken through research activities. The proposed action includes additional takes of ESA-listed rockfish from WDFW research and fisheries. To assess if take requested by WDFW for research and fisheries described in the proposed action (Section 1.3) threatens the viability of each species, we review the population-level impact from the proposed action fisheries and research (Table 14), in combination with other sources of bycatch in the environmental baseline. The combined takes are presented in Table 15. We then compare the total take numbers from all sources to the overall population of the rockfish DPS of each species to inform our assessment of viability of each species.

As described above in the Status of the Species (Section 2.4), one challenge to this analysis is the lack of reliable estimates of the abundance of any of the ESA-listed rockfish DPSs. The best available abundance data for any basin for each species comes from the 2008 WDFW ROV surveys in the San Juan Basin. In addition, WDFW documented canary rockfish within the San Juan Islands and Strait of Georgia regions during bottom trawl and drop camera surveys (see Table 4). For purposes of this analysis (and as noted in Section 2.2.1.1), we made the conservative assumption that the estimated abundance in the surveyed San Juan Island and Strait of Georgia regions represented the total abundance of the DPSs. We made this assumption because, as explained in Section 2.2.1.1 (Status of Species), there are no reliable abundance estimates of yelloweye rockfish, canary rockfish, or bocaccio within Puget Sound proper. The WDFW may have over- or underestimated the abundance of each species when it expanded the data from previous surveys to produce the abundance estimates. This risk is inherent in each study design and methodology and a common challenge to fisheries management and species conservation. To address the possibility that each survey method resulted in over-estimates of abundance, our analysis includes two population scenarios—one based on the WDFW estimates and one that is approximately 20 percent smaller. WDFW did not report the confidence intervals for its ROV estimates (see status sections). We incorporated the 20 percent reductions in our analysis to test the sensitivities of the abundance estimate for each species (whether the 20 percent made a difference regarding the effects of the proposed action). We note that there may be equal probability that the WDFW population numbers are underestimates of abundance for each species. Thus, to account for the uncertainty of the total numbers of the listed rockfish populations, we underestimated the total abundance of each DPS, resulting in a conservative evaluation of cumulative fishery bycatch mortality effects for each species.

To assess the effect of all expected mortalities from previously approved actions and the proposed action on population viability, we adopted the methodology used by the Pacific Fishery Management Council (Council) for rockfish species (Ralston 1998, 2002). The decline of West Coast groundfish stocks prompted the Council to reassess harvest management (Ralston 1998, 2002). The Council held a workshop in 2000 to review procedures for incorporating uncertainty, risk, and the precautionary approach in establishing harvest rate policies for groundfish. The workshop participants assessed best available science regarding "risk-neutral" and "precautionary" harvest rates (Scientific and Statistical Committee 2000). The workshop identified risk-neutral harvest rates of 0.75 of natural mortality, and precautionary harvest rates of 0.5 to 0.7 (50 to 70 percent) of natural mortality for rockfish species. These rates are supported by published and unpublished literature (Scientific and Statistical Committee 2000; Walters and Parma 1996), and guide rockfish conservation efforts in British Columbia, Canada (Fisheries and Oceans Canada 2010; Yamanaka and Lacko 2001). Fishery mortality of 0.5 (or less) of natural mortality was deemed most precautionary for rockfish species, particularly in data-limited settings, and was considered a rate that would not hinder population viability (Scientific and Statistical Committee 2000; Walters and Parma 1996). Given the similar life history of yelloweye rockfish, canary rockfish, and bocaccio to coastal rockfish managed by the Council, we concluded that this method represented the best available scientific information for assessing the effects of fisheries-related mortality on the viability of the ESA-listed rockfish.

To assess the population-level effects to yelloweye rockfish, canary rockfish, and bocaccio from activities associated with research permits and recreational bottom fish fishery and shrimp trawl fishery within the proposed action we calculated the mortalities associated with each permit based on the Council's method (Table 14).

Table 14. Total annual requested take and lethal take for the research (Table 8) and fisheries permits (Table 13 and Table 2) combined, and percentages of the ESA-listed rockfish abundance for permits covered in this Biological Opinion.

Species	Total Take	Abundance Scenario	Percent of Abundance	Lethal Take	Percent of DPS Killed
Bocaccio	51	3,500	1.5	25	0.7
		4,606	1.1		0.5
Canary rockfish	162	16,000	1.0	81	0.5
		20,548	0.8		0.4
Yelloweye rockfish	162	37,000	0.4	75	0.2
		47,407	0.3		0.16

Lethal take is the most relevant assessment for effects to species viability because it allows a direct analysis of the proposed action's effects on species abundance that relates to viability. For yelloweye rockfish, canary rockfish, and bocaccio, total takes and lethal takes from the proposed research, recreational bottom fish fishery, and the commercial shrimp trawl fisheries in the DPS would be well below the precautionary level explained below for each of the abundance scenarios.

The annual natural mortality rate for bocaccio is approximately 8 percent (as detailed in Section 2.2.1.1) (Palsson et al. 2009); thus, following the methodology of Ralston (1998, 2002) the precautionary level of fishing and research mortality would be 4 percent (Ralston's precautionary harvest rates were of 0.5 to 0.7 (50 to 70 percent) of natural mortality for rockfish species)). Total take and lethal takes from the proposed research, recreational bottom fish fishery, and the commercial shrimp trawl fisheries in the DPS would be well below the precautionary level for each of the abundance scenarios. Annual natural mortality rates for canary rockfish ranges from 6 to 9 percent (as detailed in Section 2.2.1) (Methot and Stewart 2005; Stewart 2007); thus, the precautionary level of fishing and research mortality would be 3 to 4.5 percent. Total take and lethal takes from the proposed research, recreational bottom fish fishery, and the commercial shrimp trawl fisheries in the DPS would be well below the precautionary level for each of the abundance scenarios. Annual natural mortality rates for yelloweye rockfish range from 2 to 4.6 percent (as detailed in Section 2.2.1) (Wallace 2007; Yamanaka and Kronlund 1997); thus, the precautionary range of fishing and research mortality would be 1 to 2.3 percent. Total take and lethal takes from the proposed research, recreational bottom fish fishery, and the commercial shrimp trawl fisheries in the DPS would be well below the precautionary level for each of the abundance scenarios.

To assess the DPS-level effects to yelloweye rockfish, canary rockfish, and bocaccio from activities associated with research permits within the proposed action, the research permits within the environmental baseline, fishery take associated with the proposed action, and fishery take within the environmental baseline, we calculated the mortalities for all takes combined (Table 15).

Table 15. Total expected annual take of the ESA-listed rockfish for research and fisheries already approved for 2012 to 2016 plus permits covered in this Biological Opinion, percentages of the ESA-listed rockfish abundance, and comparison with precautionary thresholds (0.5 of natural mortality).

Species	Total Take[a]	Abundance Scenario	Percent of Abundance	Lethal Take	Percent of DPS Killed	Precautionary Threshold Percent
Bocaccio	109	3,500	3.1	64	1.8	4
		4,606	2.3		1.4	
Canary Rockfish	542	16,000	3.4	441	2.8	3-4.5
		20,548	2.6		2.1	
Yelloweye Rockfish	319	37,000	0.9	216	0.6	1-2.3
		47,407	0.7		0.5	

[a] Total take numbers are derived from already permitted research (see Table 5 in the Environmental Baseline section),already permitted fisheries (PS Chinook FMP take), and the proposed action (Table 14).

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Thus, for yelloweye rockfish, canary rockfish, and bocaccio, the total take, including lethal takes, from the proposed research, recreational bottom fish fishery, and the commercial shrimp trawl fisheries in the DPSs, in addition to previously assessed scientific research and fishery bycatch (detailed in Section 2.3), would be below the precautionary level for all species in both the abundance scenarios. This means that the effects of take from the research and fishing activities in the proposed action would not reduce the likelihood of survival and recovery of the listed rockfish because total fisheries mortalities are below levels that would induce risks to each species' abundance and productivity, spatial structure, and diversity. In addition, the proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of listed rockfish, would cause a small effect on the diversity, productivity, or spatial structure of each DPS. Though bocaccio is listed as endangered, and yelloweye rockfish and canary rockfish are listed as threatened under the ESA, the mortalities associated with the proposed action would not hinder species viability and the recovery potential of each DPS.

Given the threatened status of yelloweye rockfish and canary rockfish and the endangered status of bocaccio in the Puget Sound/Georgia Basin DPS, we will continue to evaluate (such as during recovery planning, and future fisheries assessments under sections 10 or 7(a)(2) of the ESA) whether it is appropriate for us to rely on precautionary mortality levels established using the methods described by Walters and Parma (1996) and the Scientific and Statistical Committee (2000). The adaptive management program, described in the FCP and above, would ensure that precautionary management would occur throughout the 5-year term of the ITP.

Salmonids

The majority of the PS Chinook salmon, HCS chum salmon, and PS steelhead that would be captured, handled, and otherwise taken during the course of the proposed research projects would survive with no long-term effects. Most of the captured fish would survive the research actions, and represent such small percentages of the populations that it is likely that only very small adverse effects would result from these non-lethal actions at either the population or the species level. Therefore, adverse effects are expressed in terms of the individual fish that may be killed during the permitted research and fisheries activities.

Nonetheless, and for a number of reasons, the displayed percentages of take in the following Tables are in reality almost certainly much smaller than stated, but are appropriate in order to address uncertainties in a manner that conserves the species. First, we deliberately developed the juvenile abundance estimates to generate a conservative picture of abundance. Second, we purposefully inflated estimates of lethal take for most of the proposed studies to account for potential accidental deaths, and it is therefore very likely that fewer juveniles would be killed by the research than stated. Third, many of the fish that may be affected would be in the smolt stage, but others definitely would not be. These latter fish would simply be described as "juveniles," which means they may actually be yearlings. Smolts are a life stage prior to "yearlings," thus each lifestage being caught during the same sampling event would occur on two different salmonid year-classes (or generations). Therefore, the already small percentages were derived by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class. Thus, the actual numbers of juvenile salmonids the research would be likely to kill are undoubtedly smaller than the stated figures. We compare the proposed takes associated with the proposed action with those in the environmental baseline, including previously approved research (Table 5) in order to determine the total amount of take for the species.

Puget Sound Chinook Salmon

To assess the effects to PS Chinook salmon from activities associated with research permits, the recreational bottom fish fishery, and the shrimp trawl fishery within the proposed action we calculated the mortalities associated with each (Table 16).

Table 16. Total requested annual take for the research and fisheries permits and percentages of Puget Sound Chinook salmon abundance for permits covered in this Biological Opinion.

		Abundance	Total Take	Percent of Abundance per Life Stage	Lethal Take	Percent of ESU Killed
Adult	Listed Hatchery[a]	12,206	102	0.8	67	0.05
	Natural	25,928	8	0.03	4	0.02
Juvenile	Listed Hatchery	23,970,000	60	<0.001	23	<0.001
	Natural	3,050,000	30	<0.001	11	<0.001

[a] Includes those fish incidentally caught in the recreational bottom fish fishery and shrimp trawl fishery. The WDFW did not report the life stage of Chinook salmon that would be subject to bycatch in the shrimp trawl fishery and recreational bottom fish fishery. We attribute these fish to the adult life stage for the purposes of this analysis because the adults are the life stage that would most likely be in the proximity of the fishing gear.

The combined research and fisheries activities would kill, at most, 0.02 percent of any PS Chinook salmon component or life stage. These impacts would occur over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measureable effect on their spatial structure or diversity.

As detailed in the Environmental Baseline (Section 2.3), PS Chinook salmon would be taken in previously permitted scientific research projects in the Puget Sound. To assess the effects to PS Chinook salmon from activities associated with research permits within the proposed action, the research permits already approved within the environmental baseline, and fishery take associated with the proposed action, we calculated the mortalities for all such actions in the Puget Sound together (Table 17).

The total combined take of PS Chinook salmon's natural and listed hatchery juvenile and adult life stages is small relative to their total numbers. Take of fish would occur over more than 900 square miles (2,331 sq. km) of the Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small

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impact on the species' abundance, a likely similar impact on their productivity, and no measureable effect on their spatial structure or diversity.

Table 17. Total expected annual take of Puget Sound Chinook salmon for research and fisheries already approved for 2012 to 2016 plus permits covered in this Biological Opinion.

Species	Life Stage	Production/Origin[a]	Total Take	Percent of abundance	Lethal Take[b]	Percent of Abundance
PS Chinook Salmon	Adult	Hatchery[a]	2335	19.1	159	1.3
		Natural	667	2.6	59	0.2
	Juvenile	Hatchery[a]	148,541	0.6	11,848	.05
		Natural	427,411	14	12,425	0.4

[a] Includes only adipose-clipped fish.

As detailed in the Environmental Baseline (Section 2.3), recreational and commercial fisheries in Puget Sound catch PS Chinook salmon. NMFS concluded that implementation of the 2010 PS Chinook Harvest RMP and previously approved scientific research projects would not appreciably reduce the likelihood of survival and recovery of the PS Chinook Salmon ESU in the wild [consultation number F/NWR/2010/06051]. The mortalities from the recreational bottom fish fishery and the commercial shrimp trawl fishery, along with the four scientific research permits, in addition to previously authorized takes, would kill less than 0.4 percent of the natural and listed juvenile and adult life stages of PS Chinook salmon, and not more than 1.3 percent of the hatchery adults. The proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of PS Chinook salmon, would cause no discernible effect on the diversity, productivity, or spatial structure of the ESU. Though the PS Chinook salmon ESU is listed as threatened under the ESA, the mortalities associated with the proposed action would not hinder species viability and the recovery potential of the ESU.

Hood Canal Summer-run Chum Salmon

To assess the effects to HCS chum salmon from activities associated with research permits, the recreational bottom fish fishery, and the shrimp trawl fishery within the proposed action we calculated the mortalities associated with each permit (Table 18).

The proposed actions would kill no more than 0.02 percent of the natural HCS chum salmon's adult or juvenile life stages. That take would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measureable effect on their spatial structure or diversity.

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Table 18. Total requested annual take for the research and fisheries permits and percentages of Hood Canal summer-run chum salmon abundance for permits covered in this Biological Opinion.

		Abundance	Total Take	Percent of Abundance	Lethal Take	Percent of ESU Killed
Adult	Natural	18,834	3	<0.02	3	<0.02
Juvenile	Natural	2,750,000	8	<0.0001	3	<0.0001

As detailed in the Environmental Baseline (Section 2.3), HCS chum salmon would be taken in previously permitted scientific research projects in the Puget Sound. To assess the effects to HCS chum salmon from activities associated with research permits within the proposed action, and the research permits already approved within the environmental baseline, we calculated the mortalities for all such actions in Puget Sound together with the proposed actions (Table 19).

Table 19. Total requested annual take for the research and fisheries permits and percentages of Hood Canal summer-run chum salmon for 2012 to 2016 plus permits covered in this Biological Opinion.

Species	Life Stage	Production/Origin[a]	Total Take	Percent of abundance	Lethal Take	Percent of Abundance
HCS Chum Salmon	Adult	Hatchery	0	0	0	0
		Natural	572	3.0	9	<0.0001
	Juvenile	Hatchery	615	0.2	9	<0.0001
		Natural	356,835	13.0	2,615	<0.0001

[a] Includes only adipose-clipped fish.

The total combined take of HCS chum salmon's juvenile and adult life stages is small. Take of fish would occur over more than several hundred miles of the Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measureable effect on their spatial structure or diversity.

The mortalities from the scientific research permits, in addition to previously authorized takes, would kill less than 0.001 percent of the natural and listed juvenile and adult life stages of HCS chum salmon. The proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of HCS chum salmon, would cause a small effect on the diversity, productivity, or spatial structure of the ESU. Though the HCS chum salmon ESU is listed as threatened under the ESA, the mortalities associated with the proposed action would not hinder species viability and the recovery potential of the ESU.

Puget Sound Steelhead

To assess if take requested by the WDFW for research described in the proposed action (Section 1.3.1) threatens the viability of PS steelhead, we reviewed the DPS-level impact from the fisheries and research combined (Table 20).

All the permits taken together would kill no more than 0.1 percent of any PS steelhead component or life stage. Take of fish would be distributed over the more than 900 square miles (2,331 sq. km) of Puget Sound; thus, no population is likely to experience a disproportionate amount of these losses. Therefore, these activities would have a very small impact on the species' abundance, a likely similar impact on their productivity, and no measureable effect on their spatial structure or diversity.

Table 20. Total requested annual take for the research and fisheries permits and percentages of Puget Sound steelhead abundance for permits covered in this Biological Opinion.

		Abundance	Total Take	Percent of Abundance	Lethal Take	Percent of DPS Killed
Adult	Listed Hatchery[a]	1,870	4	0.2	2	0.1
	Natural	12,996	4	0.002	2	<0.002
Juvenile	Listed Hatchery[a]	52,000	8	0.02	3	<0.001
	Natural	1,700,000	8	<0.001	3	<0.001

[a] Includes adipose-clipped juveniles.

As detailed in the Environmental Baseline (Section 2.3), PS steelhead are caught by anglers targeting salmon. To assess if take requested by the WDFW for research and fisheries described in the proposed action (Section 1.3) threatens the viability of PS steelhead, in combination with other sources of take in the environmental baseline, we reviewed the DPS-level impact from all fisheries and research combined (Table 21).

As detailed in the Environmental Baseline (Section 2.3), a few PS steelhead are caught in fisheries in Puget Sound. NMFS concluded that implementation of the 2010 PS Chinook Harvest RMP and previously approved scientific research projects would not appreciably reduce the likelihood of survival and recovery of the PS steelhead DPS in the wild. The mortalities from the recreational bottom fish fishery and the commercial shrimp trawl fishery, along with the

Table 21. Total requested annual take for the research and fisheries permits and percentages of Puget Sound steelhead for 2012 to 2016 plus permits covered in this Biological Opinion.

Species	Life Stage	Production/Origina	Total Take	Percent of abundance	Lethal Take[b]	Percent of Abundance
PS Steelhead	Adult	Hatchery	47	2.5	42	2.2
		Natural	1,515	11.7	27	0.2
	Juvenile	Hatchery	12,604	24	228	0.04
		Natural	47,150	2.8	1,000	0.06

[a] Includes adipose-clipped and non-adipose-clipped juveniles.

[b]Includes 325 adult steelhead of hatchery- or natural-origin caught within the marine waters of the Puget Sound Chinook salmon RMP.

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four scientific research permits, in addition to previously authorized takes, would kill less than 2.2 percent of the natural and listed juvenile and adult life stages of PS steelhead. The proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of PS steelhead, would cause no discernible effect on the diversity, productivity, or spatial structure of the PS steelhead DPS. Though the PS steelhead DPS is listed as threatened under the ESA, the mortalities associated with the proposed action would not hinder species viability and the recovery potential of the DPS.

Southern Eulachon

To assess if take requested by the WDFW for research and fisheries described in the proposed action (Section 1.3) threatens the viability of eulachon, in combination with other sources of take in the environmental baseline, we reviewed the ESU-level impact from the fisheries and research combined. Table 22 combines the research (Table 1) and fishery takes (Table 2) for the proposed action.

Table 22. Total requested annual take for the research and fisheries permits and percentages of eulachon population abundance for permits covered in this Biological Opinion.

	Abundance	Total Take	Percent of Abundance	Lethal Take	Percent of Fraser River Population Killed
Adult and Juveniles	296,000	3,860	0.6	3,860	1.3

All the takes from the proposed action taken together would kill approximately 1.3 percent of eulachon that are estimated to occupy the action area. This assessment presumes that all eulachon taken would be from the Fraser River population, though it is probable that eulachon from other rivers of the DPSs also occupy the action area. As such, takes of eulachon would likely occur among several populations and would result in a very small impact on the species' abundance and productivity, and no measureable effect on their spatial structure or diversity.

As detailed in the Environmental Baseline (Section 2.3), eulachon are also taken by other research projects in the action area. To assess if take requested by WDFW for research and fisheries described in the proposed action (Section 1.3) threaten the viability of eulachon, in combination with other sources of take in the environmental baseline, we reviewed the ESU-level impact from the fisheries and research combined (Table 23).

Table 23. Total requested take for the research and fisheries permits and percentages of Southern eulachon for 2012 to 2016 plus permits covered in this Biological Opinion.

	Total Take	Percent of Abundance	Lethal Take	Percent of DPS Killed
Adult and Juveniles	5,322	1.8	4,933	1.7

As described in the status of the species section, marine mortality is likely very high for eulachon. Thus, the death of up to 4,933 individuals of different age classes in the action area would translate to a far smaller number of spawning adults. Although it is not possible to quantify exactly how small (because of the mix of age classes that are likely to be encountered),

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based on our knowledge of survival of fishes with similar life histories, it could potentially be substantial. For example, the annual mortality rate of adult Pacific herring has been estimated at 50 percent (Hourston and Haegele 1980) and the annual mortality rate of 4 to 5 year-old capelin has been estimated as high as 93 percent (Dommansnes and Røttingen 1985). At a minimum, if we assume that all eulachon caught in the proposed action would have spawned in the following year (a conservative estimate given that multiple age classes will likely be caught) and we assume an annual mortality rate of 50 percent, then the 4,530 eulachon killed by the proposed action would represent approximately 2,265 adult spawners.

Although eulachon abundance has declined greatly in the last 10 years, the total estimated Fraser River population in the action area remains high enough that the removal of approximately 4,933 individuals in the action area would only have a minor effect on total abundance. This is primarily because the fish would be killed during juvenile and sub-adult life stages in which natural rates of mortality (mostly through predation) are very high and therefore translates into a much smaller number of spawning adults. The fish that would be killed by the proposed action represent less than 1.7 percent of the estimated total abundance of eulachon in the action area. This analysis is based on a very conservative worst-case scenario that considers more than the expected number of fish killed as well as lower population numbers than is likely. It is likely that the total number of eulachon captured in the previously permitted research, and the research and shrimp trawl fishery that is part of the proposed action, would be smaller than considered here. The adaptive management trigger (maximum amount of fish that could be caught) for catch of eulachon also provides NMFS confidence that total take of eulachon would be capped and management measures to reduce take could be implemented, if necessary

The proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of eulachon, would cause no discernible effect on the diversity, productivity, or spatial structure of the southern DPS of eulachon. Further, the losses would to some extent be offset by the fact that the research (and shrimp trawl fishery bycatch) would generate information that would be used to improve our knowledge of their spatial structure and distribution. Although these actions are not designed specifically to study or catch eulachon, they would generate information about where eulachon are found in the action area at more precise levels than currently available. Very little is currently known about the marine distribution of eulachon and the data generated by the proposed research and shrimp trawl fishery would help to fill this information gap, and adaptive management could lead to further conservation measure to benefit eulachon in the Puget Sound.

Southern Green Sturgeon

To assess if take requested by WDFW for research activities and the shrimp trawl fishery described in the proposed action (Section 1.3) threatens the viability of green sturgeon, we review the DPS-level impact from the combined take (Table 24).

Table 24. Total annual requested take for the research and fisheries permits and percentages of southern green sturgeon abundance for permits covered in this Biological Opinion.

	Total Take	Percent of Abundance	Lethal Take	Percent of DPS Killed
Adult	3	0.4	1	0.2

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As detailed in the Environmental Baseline (Section 2.3), a few green sturgeon are also taken by other research projects. To assess if take requested by WDFW for research and the shrimp trawl fishery threatens the viability of green sturgeon, in combination with other sources of take in the environmental baseline we reviewed the DPS-level impact from the combined take (Table 25).

Table 25. Total annual requested take for the research and fisheries permits and percentages of Puget southern green sturgeon abundance for 2012 to 2016 plus permits covered in this Biological Opinion.

	Total Take	Percent of Abundance	Lethal Take	Percent of DPS Killed
Adult	20	2.5	1	0.13

The take authorized in all permits combined would result in activities that may kill at most 0.13 percent of green sturgeon. The proposed actions, when combined with the take within the environmental baseline, and considered in light of the status of green sturgeon, would cause a small effect on the diversity, productivity, or spatial structure of the southern DPS. Though the southern green sturgeon DPS is listed as threatened under the ESA, the mortalities associated with the proposed action would not hinder species viability and the recovery potential of the DPS.

Summary of the Integration and Synthesis

Our assessment accounted for the status of the environmental baseline, the particular species' rangewide status, the effects of the fishing and research activities, and impacts to their viability. In biological terms, a "viable" population is one that has a high probability of persisting into the future (Waples 1997). Thus, the term viability has an inherent link to the concepts of survival and continued existence because if a population is highly likely to persist into the future, that means it has a high likelihood of surviving (Waples 1997). In summary, degraded habitats within the action area have varying effects on the ability of ESA-listed rockfish, PS Chinook salmon, PS steelhead, HCS chum salmon, eulachon, and green sturgeon to recover, though these effects are highly dependent upon the species and life stage.

We used a conservative method of estimating total non-lethal and lethal take for each listed fish; numbers we used in our analysis are almost certainly much higher than actual takes that would occur for the duration of these permits. For research projects, WDFW's estimates of non-lethal and lethal take are higher than the levels of actual take that have occurred in similar studies in recent years (to account for potential accidental takes that are higher than recent history). Research takes within the environmental baseline are similarly conservative. For the vast majority of scientific research permits, history has shown that researchers generally take far fewer than the allotted number of fish every year. For listed salmon, many of the fish that may be affected would be in the smolt stage, but others definitely would not be. These latter would simply be described as "juveniles," which means they may actually be yearlings, parr, or even fry—life stages represented by multiple spawning years and many more individuals than reach the smolt stage, perhaps as much as an order of magnitude more. Therefore, the already small percentages of total abundance affected by the proposed action were derived by (a) conservatively estimating the actual number of juveniles, (b) overestimating the number of fish likely to be killed, and (c) treating each dead juvenile fish as part of the same year class.

For the covered fisheries, WDFW's estimates of listed rockfish takes in the recreational bottom fish fishery and shrimp trawl fishery are similarly conservative. Actual takes of listed rockfish, PS Chinook salmon, and eulachon would very likely be lower than estimated within their FCP, but nonetheless similarly enables a conservative estimate of effects and accounts for potential accidents (such as catching a large amount of eulachon within one trawl event).

As a result, with conservative take estimates, NMFS determined that the detrimental effects from the research activities and fisheries on each species' abundance would be minimal. For each listed species assessed in this opinion, the number of individual fish killed from the proposed action would be very small relative to their total numbers. Because these effects are so small, the actions would have minor effects, in some cases barely measureable effects, on the species' abundance and even smaller impacts on productivity. The habitat effects of the proposed actions would have small impacts on benthic habitats from shrimp trawls and research bottom trawls. These effects would be spread out over a large geographic area and occur over small spatial and temporal scales and have no meaningful impacts on habitat conditions. Moreover, because that slight impact is in most cases distributed throughout all the listing units, it would be so attenuated as to have no appreciable effect on spatial structure or diversity. In addition, the mortalities from the scientific research permits, covered fisheries, in addition to previously authorized takes, would kill a small fraction of the covered species across a large geographic area. As such, these mortalities and habitat effects would not affect the likelihood of both survival and recovery of the species.

2.6.3 Critical Habitat

Habitats in the action area are previously described in Environmental Baseline (Section 2.3), Effects on Species (Section 2.4.1-Habitat Effects from Research and Fisheries subsection), and Critical Habitat (Section 2.4.2).

Critical habitat of PS Chinook salmon, HCS chum salmon, and green sturgeon are designated in portions of the action area. Eulachon critical habitat is not designated in the action area. The overall effects to the designated critical habitats in the action area from the proposed action include short-term alterations of benthic habitats from research trawls and shrimp trawls, and the death of some prey sources of listed fish (e.g., herring, bottom fish). These effects are added to the condition of the environmental baseline. The environmental baseline of the nearshore of Puget Sound has been degraded by shoreline development, and conditions of the nearshore are naturally dynamic because of changing tides and sediment levels (Downing 1983). Puget Sound has been negatively impacted by the input of toxins, invasive species, and derelict fishing gear. In addition to activities degrading habitats, there are also beneficial activities intended to improve the quality of habitats. In recent years, nearly 500 acres of benthic habitats have been improved by the removal of derelict gear.

As discussed in Section 2.4.2, NMFS determined that the effects of the action on critical habitat of each listed species would be small and transitory, compared to the size of the area in critical habitat. When considered in the context of the environmental baseline that is somewhat degraded, the loss of a small amount of prey and degraded benthic habitats from trawling would not alter the PCEs essential for the conservation of the southern green sturgeon DPS in coastal marine areas, including: (1) migration corridors, (2) water quality, and (3) food resources. Similarly, the effects of the action of would not alter the PCEs essential for the conservation of PS Chinook salmon and HCS chum salmon beyond short-term and transitory effects. These PCEs include: passage conditions free of obstructions to allow for migration, resting, and foraging; water quality sufficient to support growth and development; and prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth and natural cover.

Because the effects of the proposed action would be small and transitory, it would not alter the PCEs of PS Chinook salmon and HCS chum salmon to such an extent that it would cause adverse modification or destruction of designated critical habitat within the action area.

2.7 Conclusions

2.7.1 Puget Sound/Georgia Basin Rockfish

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound/Georgia Basin DPSs of yelloweye rockfish, canary rockfish, and bocaccio. No critical habitat has been designated or proposed for these species; therefore, none will be affected.

2.7.2 Puget Sound Chinook Salmon

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the PS Chinook salmon ESU or destroy or adversely modify its designated critical habitat.

2.7.3 Hood Canal Summer-run Chum Salmon

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the listed HCS chum salmon ESU, or destroy or adversely modify its designated critical habitat.

2.7.4 Puget Sound Steelhead

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the listed Puget Sound steelhead DPS. No critical habitat has been designated or proposed for this species; therefore, none will be affected.

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2.7.5 Southern Green Sturgeon

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the listed Southern green sturgeon DPS, or destroy or adversely modify its designated critical habitat.

2.7.6 Southern Eulachon

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the proposed actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Southern DPSs of eulachon, or destroy or adversely modify its designated critical habitat.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without 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 to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[14] 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 an incidental take statement.

This incidental take statement specifies the impact of any incidental taking of endangered or threatened species, as well as the specific levels of incidental take allowed. It also provides reasonable and prudent measures that are necessary or appropriate to minimize impacts, and sets forth terms and conditions in order to implement the reasonable and prudent measures. Species caught as a result of activities under scientific research permits are not considered incidental take, and are not included in Section 2.8.1.

[14] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as an intentional or negligent act or omission which creates 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 (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the U.S. Fish and Wildlife interpretation of the term.

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2.8.1 Amount or Extent of Incidental Take

Puget Sound/Georgia Basin Rockfish

Not more than 760 yelloweye rockfish, 690 canary rockfish, and 215 bocaccio may be incidentally taken over the 5 year term of the ITP. This equates to an average of 152 yelloweye rockfish, 138 canary rockfish, and 43 bocaccio incidentally taken annually during the fisheries activities that are part of the proposed action and assessed within the biological opinion. Of these, up to 65 yelloweye rockfish, 57 canary rockfish, and 17 bocaccio would be incidentally killed annually.

Puget Sound Chinook Salmon

NMFS anticipates that up to 92 PS Chinook salmon would be incidentally taken annually during the fisheries assessed within the biological opinion. Of these, up to 50 would be killed.

Southern Eulachon

NMFS anticipates that not more than 16,200 eulachon would be taken over the 5-year term of the ITP. This equates to an average of 3,860 eulachon incidentally taken and killed annually during the fisheries and research activities assessed within the biological opinion.

Southern Green Sturgeon

NMFS anticipates that up to one green sturgeon would be incidentally taken and killed annually in the shrimp trawl fishery.

2.8.2 Effect of the Take

In Section 2.7of the biological opinion, NMFS determined that the level of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat

2.8.3 Reasonable and Prudent Measures, and Terms and Conditions

"Reasonable and prudent measures" (RPMs) are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02). The applicant will minimize the extent of incidental take by implementing the following Terms and Conditions. All conservation measures described in the final FCP (WDFW 2012), together with the actions contained in its associated section 10(a)(1)(B) permit issued with respect to the FCP, are hereby incorporated by reference as reasonable and prudent measures and terms and conditions (summarized below). Such terms and conditions are non-discretionary and must be undertaken for the exemptions under section 10(a)(1)(B) and section 7(o)(2) of the ESA to apply. If the permittee fails to adhere to these terms and conditions, the protective coverage of the section 10(a)(1)(B) permit and section 7(o)(2) may lapse. The amount or extent of incidental take anticipated under the proposed FCP, associated reporting requirements, and provisions for disposition of dead or injured fish are as described in the FCP and its accompanying section 10(a)(1)(B) permit.

The RPMs in this ITS are the same as the conservation measures in the FCP because they are the best available measures to minimize incidental take to the maximum extent practicable. Therefore, there are no additional measures that could further minimize incidental take.

Summary of Conservation Measures from the FCP that are included as RPMs:

1. Continue the permanent closure by permanent regulation of the set net, set line, bottom fish trawl, bottom fish pot, and scallop trawl fisheries;
2. Continue to prohibit fishing for rockfish in Marine Catch Areas 5 through 13;
3. Continue to prohibit retention of rockfish caught in any fishery in Marine Catch Areas 5 through 13;
4. Continue to prohibit bottom fishing in waters deeper than 120 feet throughout the DPSs;
5. Require permit holders in the shrimp trawl fishery to have on-board observers on 10 percent of all trips who would identify and track bycatch; and
6. Continue to allow only beam trawls in the shrimp trawl fishery (no rockhopper gear).
7. Adaptive Management to respond to take levels and new information, as necessary.

Terms and Conditions

In order to track the amount of incidental take, and determine if the amount or extent is exceeded, monitoring is necessary. Therefore the following terms and conditions are necessary to determine if incidental take is exceeded.

1. Monitoring: As described in the FCP on pages 33 to 39 for the recreational bottom fish fishery, and pages 10 to 16 for the commercial shrimp trawl fishery.

2.9 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. This opinion has been prepared in response to WDFW applications under section 10 of the ESA. As such, the following are discretionary conservation recommendations for the WDFW and their fishery management program in Puget Sound:

- The WDFW should enhance their education and outreach efforts regarding: 1) accurate rockfish species identification by recreational fishermen, 2) angler knowledge of bottom fishing regulations, and 3) angler knowledge of rockfish life history.

- The WDFW should partner with tribes, agencies, and stakeholder groups to begin the process of identifying high-value areas as candidate rockfish conservation areas in the Puget Sound.

Please notify NMFS if the WDFW carries out any of these recommendations so that we will be kept informed of actions that minimize or avoid adverse effects, and those that benefit species or their habitats.

2.10 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action on listed species or designated critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.11 "Not Likely to Adversely Affect" Determination

NMFS' concurrence with a determination that an action "is not likely to adversely affect" listed species or critical habitat is based on our finding that the effects are expected to be discountable, insignificant, or completely beneficial (USFWS and NMFS 1998). Insignificant effects relate to the size of the impact and should never reach the scale where take occurs; discountable effects are those that are extremely unlikely to occur; and beneficial effects are contemporaneous positive effects without any adverse effects to the species or critical habitat.

Southern Resident Killer Whales Determination

The Southern Resident (SR) killer whale DPS composed of J, K, and L pods was listed as endangered under the ESA on November 18, 2005 (70 Fed. Reg. 69903). The final rule listing SR killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. The final recovery plan includes more information on these potential threats to SR killer whales (NMFS 2008a).

NMFS published the final rule designating critical habitat for SR killer whales on November 29, 2006 (71 Fed. Reg. 69054). Critical habitat includes approximately 2,560 square miles (6,630 square km) of inland waters including Puget Sound, but does not include areas with water less than 20 feet (6 m) deep relative to extreme high water. The primary constituent elements (PCEs) of SR killer whale critical habitat are: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

SR killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and then move south into Puget Sound in early autumn. Pods make frequent trips to the outer coast during this season. In the winter and early spring, SR killer whales move into the coastal waters along the outer coast from the southeast Alaska south to central California (NMFS 2008). SR killer whales consume a variety of fish and one species of squid, but salmon, and Chinook salmon in particular, are their primary prey (NMFS 2008). Ongoing and past diet studies of SR killer whales conducted sampling during spring, summer, and fall months in inland waters of Washington State and British Columbia (i.e., Ford and Ellis 2006; Hanson et al. 2010). Genetic analysis of these samples indicate that when SR killer whales are in inland waters from May to September, they consume Chinook salmon stocks that originate from regions including the Fraser River (including Upper Fraser, Mid Fraser, Lower Fraser, North Thompson, South Thompson, and Lower Thompson), Puget Sound (North and South Puget Sound), the Central British Columbia Coast, West and East Vancouver Island, and Central Valley California (Hanson et al. 2010). Other research and analysis provides additional information on the age of prey consumed (Hanson, unpublished data, as summarized in Ward et al. unpublished report), confirming that SR killer whales predominantly consume larger (i.e., older) Chinook salmon.

The proposed actions may affect SR killer whales indirectly by reducing availability of their primary prey, Chinook salmon. As described in the effects analysis for salmonids (Section 2.4.1), up to 71 adult PS Chinook salmon (34 juveniles), four adult PS steelhead (six juveniles), and three adult HCS chum salmon (three juveniles) may be killed annually during proposed research activities and as bycatch for the two covered fisheries. The proposed action is not expected to have appreciable effects on productivity, diversity, or distribution for listed salmonids, so the take of salmonids would not affect the quantity of prey available to the whales in the long term. Additionally, these take estimates are likely an overestimate of the actual number of salmon that would be taken during research activities, and thus the actual reduction in prey available to the whales is likely smaller than stated above.

Given the total quantity of prey available to SR killer whales throughout their range, this reduction in prey is extremely small, and although measurable, we do not anticipate that the reduction will be statistically different than zero (based on NMFS' previous analysis of the effects of salmon harvest on SR killer whales; e.g., NMFS 2008b). Because the reduction is so small, there is also a very low probability that any of the juvenile salmon killed by the research activities would have later (in 3 to 5 years' time) been intercepted by the killer whales across inland waters of their range in the absence of the research activities. Therefore, NMFS determined that the amount of take of salmonids associated with the proposed actions would result in an insignificant reduction in adult prey for SR killer whales.

The death of some PS Chinook salmon, PS steelhead, and HCS chum salmon could affect the prey PCE of designated critical habitat. As described above, however, considering the estimate of up to 74 adult salmon (and 4 adult steelhead) that could be taken by the proposed action, and the total amount of prey available in the critical habitat (in the thousands), the reduction would be insignificant and would not affect the conservation value of the critical habitat. Therefore, the proposed action would have an insignificant effect on the water quality or passage PCEs for SR killer whales.

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Therefore, NMFS finds that potential adverse effects of the proposed research on SR killer whales are insignificant, and determines that the proposed action may affect, but is not likely to adversely affect, SR killer whales and their critical habitat.

Humpback Whales and Steller Sea Lion Determination

Humpback whales (*Megaptera novaeangliae*) and Steller sea lions (*Eumetopias jubatus*) are also listed under the ESA under NMFS' jurisdiction, and these species may occur in Puget Sound. The Marine Mammal Protection Act of 1972 requires all commercial fisheries to be placed in one of three categories, based on the relative frequency of incidental serious injuries and mortalities of marine mammals in each fishery. All Puget Sound fisheries (with the exception of the Washington Puget Sound salmon drift gillnet fishery), were identified as meeting the Category III designation (remote likelihood or no known serious injuries or mortalities) (76 Fed. Reg. 73912; November 29, 2011). Humpback whales' use of inland Washington waters is occasional. Small numbers of Stellar sea lions occur in Puget Sound year around with the peak abundance during the winter. Stellar sea lion abundance in Puget Sound is lowest during late spring and summer when adults leave the inland waters for breeding sites in Oregon, British Columbia, and Alaska. No rookeries exist in Washington (NMFS 2008b). The infrequent presence of Steller sea lions, unpredictability of where they might occur, and the dispersed nature of the fisheries during this time of year make any interactions with the fisheries that are the subject of this opinion unlikely. No interactions with marine mammals have been reported in the recreational bottom fish or commercial shrimp trawl fishery. NMFS determined that the amount of take of salmonids associated with the proposed actions would result in an insignificant reduction in adult equivalent prey resources for Stellar sea lions. Therefore, the fisheries and research addressed in this opinion would have no effect on humpback whales, and their effects on Stellar sea lions are discountable.

2.12 Endangered Species Act Section 10(a)(2)(B) Statement of Findings for the Incidental Take Permit

Section 10(a)(2)(B) Issuance Considerations. In determining whether to issue an incidental take permit, the Assistant Administrator will consider the following:

(i) *The status of the affected species or stocks.* NMFS evaluated the status of all species covered in the ITP. The status of ESA-listed species is described in the status section (Section 2.2.1) of the opinion, above. The baseline conditions of the action area covered by the ITP were also considered by NMFS, and the evaluation can be found in the Environmental Baseline Section 2.3 of the opinion.

(ii) *The potential severity of direct, indirect, and cumulative impacts on the species or stocks and habitat as a result of the proposed activity.* The opinion includes NMFS' analysis of effects to species that are covered by the ITP, as well as an analysis of effects to the designated CH of species currently listed under the ESA. The effects analysis evaluated the direct and indirect effects of activities covered by the ITP (see Biological Opinion, Effects of the Proposed Actions Section 2.4). NMFS also evaluated the cumulative effects from other non-Federal activities that

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are reasonably likely to occur in the action area. We found that the effects of the action would not impact the survival and recovery of listed fish addressed in this opinion.

(iii) *The availability of effective monitoring techniques.* For the recreational fisheries in Puget Sound, WDFW has conducted dock-side monitoring of all fisheries for several decades, and will continue this monitoring regime throughout the 5-year term of the ITP. Monitoring is included in the conservation measures in the FCP. This dockside monitoring is essential for generating bycatch estimates of listed species. For the commercial shrimp trawl fishery, in 2011 WDFW initiated on-board observers for 10 percent of all fishing trips and would continue this coverage throughout the 5-year term of the ITP. These observers are deployed on a random basis and document all bycatch. On-board observations of many West Coast fisheries have been commonplace for many years, and enable a verification of catch totals and species identifications by trained fisheries biologists. The identification of species by on-bard observers is particularly important, as many rockfish species and forage fish species look similar.

Given these considerations, effective monitoring is securely funded for the 5-year term of the ITP. Monitoring of ITP implementation and the effectiveness of the ITP and FCP prescriptions is a critical feature. Monitoring reports will be completed and submitted annually to NMFS according to the schedule described in Section 1.3 of this opinion.

(iv) *The use of the best available technology for minimizing or mitigating impacts.* The prescriptions established in the ITP represent the most recent developments in science and technology in minimizing and mitigating impacts to aquatic habitats and species. The methods used to minimize and mitigate impacts are well-tested and effective (i.e. fishery closures, depth restrictions, on-board observers).

(v) *The views of the public, scientists, and other interested parties knowledgeable of the species or stocks or other matters related to the application.* NMFS announced the availability of the FCP for review through a Notice of Availability (NOA) in the Federal Register on March 30, 2012 (77 Fed. Reg. 19225). This NOA announced a 30-day public comment period, during which other agencies, tribes, and the public were invited to provide comments and suggestions regarding issues in the FCP. This public comment period was extended until May 11, 2012. NMFS sent letters to the Northwest Indian Fisheries Commission notifying them of the draft EA on March 30, 2012. During the review period announced in the NOA, no comment letters were received.

WDFW conducted a State Environmental Policy Act (SEPA) review on its Rockfish Conservation Plan (WDFW 2011a). The plan (WDFW 2011a) encompasses more management actions than are addressed in the FCP (Subsection 1.2, Description of the Proposed Action) because WDFW is not seeking take coverage for all of the activities in the Rockfish Conservation Plan. For instance, the Rockfish Conservation Plan discusses the future use of hatchery supplementation and artificial habitats as a proposed means to augment populations of rockfish and to improve their habitat, but these actions are not a component of the ITP.

The SEPA analyses are subject to public comments, and received many comments on a diversity of topics addressed in the plan. The WDFW responded to these comments and issued a final Rockfish Conservation Plan

Section 10(a)(2)(B) Issuance Findings. Having considered the above, NMFS must make certain findings under section 10(a)(2)(B) of the ESA, with regard to the adequacy of the FCP meeting the statutory and regulatory requirements for an ITP under section 10(a)(1)(B) of the ESA and 50 CFR section 222.307. To issue the permit, NMFS must find that:

(i) *The taking will be incidental.* NMFS concluded in its opinion that take in the form of harm or harassment is likely to occur incidentally to the recreational bottom fish fishery, and commercial shrimp trawl fishery because the two fisheries do not target listed fish. Harm is the significant modification of habitat that impairs the listed species' behavior patterns (breeding, feeding, and sheltering) in such a way as to cause injury or death. The recreational bottom fish fishery will not significantly harm habitat, but would result in incidental injury and death to some yelloweye rockfish, canary rockfish, and bocaccio as well as some PS Chinook salmon. Commercial shrimp trawl harvest activities would also result in injury and death to yelloweye rockfish, canary rockfish, and bocaccio as well as PS Chinook salmon, green sturgeon, and eulachon and would affect fish habitat, as described in the effects analysis above. Neither of these actions are intended to kill, injure, or harm ESA-listed fish. Thus, NMFS finds that any take that occurs is incidental to the activities authorized under the ITP.

(ii) *The applicant will, to the maximum extent practicable, monitor, minimize, and mitigate the impacts of such taking.* NMFS finds that WDFW would minimize and mitigate the impacts of take of the covered species to the maximum extent practicable for a period of five years. Under the provisions of the FCP, the impacts of take would be minimized, mitigated, and monitored in accordance with the requirements of the ITP through the following measures:

1. Continue the closure by permanent regulation of the set net, set line, bottom fish trawl, bottom fish pot, and scallop trawl fisheries;

1. Continue to prohibit fishing for rockfish in Marine Catch Areas 5 through 13;

2. Continue to prohibit retention of rockfish caught in any fishery in Marine Catch Areas 5 through 13;

3. Continue to prohibit bottom fishing in waters deeper than 120 feet throughout the DPSs;

4. Require permit holders in the shrimp trawl fishery to have on-board observers on 10 percent of all trips who would identify and track bycatch;

5. Continue to allow only beam trawls in the shrimp trawl fishery (no rockhopper gear);

6. WDFW would report to NMFS annually on the above activities and adapt future fisheries and research efforts as necessary;

7. WDFW would continue long-standing regulations to reduce hooking mortalities for released fish. They include a prohibition on barbed hooks and limit fishing gear to two individual hooks (no treble hooks); and

8. Ensuring funding to fully implement the FCP and the ITP (described below).

NMFS views the FCP, like most other conservation plans, as having integrated its minimization and mitigation measures with the activities for which the applicant seeks incidental take authorization.

The collective value of these measures will be to enhance the protections of covered species and reduce their incidental catch in the Puget Sound, as described in the accompanying opinion. These measures minimize and mitigate the effects of take to the maximum extent practicable because they closed several fisheries that had historically high catch rates (of ESA listed rockfish), and leave two fisheries where bycatch still occurs, yet at levels that are low enough to not jeopardize covered species.

In consideration of all the above facts, NMFS finds that: (a) the mitigation is commensurate with the impacts; (b) the FCP is consistent with the long-term survival and recovery of Covered Species (also see (iii) below); and (c) the HCP minimizes and mitigates the effects of take to the maximum extent practicable.

(iii) *The taking will not appreciably reduce the likelihood of the survival and recovery of the species in the wild.* NMFS, using the best available science (provided in the References section of the opinion), has evaluated the anticipated extent of take that will be incidental to the activities covered by the FCP throughout its term (summarized in Incidental Take Statement and opinion, above), and has concluded that the incidental takings likely to occur will not appreciably reduce the likelihood of survival and recovery for any listed species. This conclusion can be found in the conclusion section of the opinion. The 7(a)(2) "no jeopardy" standard is identical to the section 10(a)(2)(B) "no jeopardy" standard, so it is appropriate to rely on our analysis and conclusion in the opinion.

(iv) *The applicant has amended the conservation plan to include any measures (not originally proposed by the applicant) that the Assistant Administrator determines are necessary or appropriate.* NMFS identified no additional conservation measures. The FCP and ITP incorporate all elements determined by NMFS to be necessary for approval of the FCP and issuance of the permit.

(v) *There are adequate assurances that the conservation plan will be funded and implemented, including any measures required by the Assistant Administrator.* NMFS finds that the Permittee will ensure funding adequate to implement the FCP. We considered the following mechanisms that demonstrate WDFW has the ability and commitment to fully implement the FCP and the ITP:

WDFW is committed to funding the FCP conservation strategy because the measures built into the FCP have already been, and will continue to be, implemented by WDFW. Fisheries closures have been finalized, fishery regulations for the recreational bottom fish fishery have been in place since 2010, and in 2011, the commercial shrimp trawl fishery was required to have observer coverage on 10 percent of trips, which is paid for by the industry. The funding for monitoring has also been on-going for several decades and comes out of the state general fund among other sources.

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

The consultation requirement of section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effects include the direct or indirect physical, chemical, or biological alterations 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 EFH, and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by NMFS, and descriptions of EFH for Pacific coast salmon (PFMC 1999), groundfish FMP, and coastal pelagic FMP, contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

Essential Fish Habitat (EFH) has been designated for 44 species of groundfish in the Puget Sound, three species of salmonids, and five species of coastal pelagic fish (Appendix B, Species of Fishes with Designated EFH in the Action Area). In the Puget Sound action area, EFH includes the nearshore and all other marine environments. In the action area, eelgrass has been designated as a Habitat Area of Particular Concern.

3.2 Adverse Effects on Essential Fish Habitat

As the biological opinion above describes, the proposed research and shrimp trawls would have short-term adverse effects on Pacific salmon and groundfish EFH. Benthic habitat EFH would be altered by the shrimp trawl fishery and research bottom trawls to minor degrees in several ways. The shrimp trawls use beam trawl gear (no rockhopper gear would be allowed) and thus, would not alter areas of rocky bottoms. Research trawls similarly avoid rocky and complex benthic habitats to avoid losing gear. Trawl gear would be used in sandy, muddy/cobble habitats and would alter portions of the sea floor of Puget Sound (mostly concentrated in the North Sound) by suspending sediment and changing habitat complexity, smoothing sedimentary bedforms, and changing bottom roughness in localized areas. Trawls in these less structurally complex habitats, such as areas fished by the commercial shrimp trawlers, have less effect than they do in more complex habitat (Roberts 2008). The effect of suspended sediment would be small and temporary, as sediment would re-settle rapidly.

For the shrimp trawl fishery, temporary sediment suspension would not alter light levels (and thus, would not interrupt photosynthesis or affect species such as eelgrass or kelp) because this

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suspended sediment is limited to waters deeper than 120 feet (36.6 m), which are deeper than the photic zone.

Some WDFW research trawls would occur in the photic zone (such as the nearshore of Puget Sound); thus, temporary sediment suspension could reduce light levels on a short-term basis. Temporarily reduced light levels would be unlikely to alter benthic habitats because habitat conditions and sediment levels in the nearshore are naturally dynamic.

In summary, the adverse effects of the proposed action on EFH, including HAPCs, would be minimal because of the short duration of trawl activities, and the transitory effects of suspended sediments caused by them.

3.3 Essential Fish Habitat Conservation Recommendations

While small and short-term adverse effects to EFH would occur from trawls associated with the proposed action, conservation measures are built into the action that prevent longer term effects to EFH. They include conservation measures adopted by the WDFW: 1) limiting the shrimp trawl fishery to waters deeper than 120 feet (36.6 m), thus eliminating any potential damage to the photic zone and important habitat such as eelgrass and kelp, and 2) prohibiting the use of rockhopper trawl gear, which eliminates trawling in more complex and sensitive benthic habitats. In addition, WDFW closed the commercial bottom trawl fishery and the inactive scallop trawl fishery. NMFS is not providing any EFH conservation measures because the proposed action includes adequate measures to mitigate for the small, short-term adverse effects from shrimp trawls.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. Given that there are no conservation recommendations, there is no statutory response requirement.

3.5 Supplemental Consultation

The action agency must reinitiate EFH consultation 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 the EFH conservation recommendations [50 CFR 600.920(l)].

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The 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 consultation are the applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation. Individual copies were made available to the applicants. This consultation will be posted on the NMFS NW Region web site (http://www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards

This consultation and its supporting documents are clear, concise, complete, unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 *et seq.*, and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

Best Available Information

This consultation and its supporting documents use the best available information, as referenced in the literature cited section. The analyses in this biological opinion/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.

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Review Process

This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

5. REFERENCES

5.1 Federal Register Notices

Federal Register, Volume 70 No. 17386. April 6, 2005. Proposed Rule: Endangered and Threatened Wildlife and Plants: Proposed Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon.

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6. APPENDICES

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Appendix A

Estimated Numbers of ESA-listed Fish Species

to be Taken from Scientific Research

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			Biological Sampling		Bottom Trawl		Midwater Trawl		PSAMP		Total	
SPECIES	PROD. /ORIGIN	LIFE STAGE	Expected encounters	Mortality	Expected encounters	Mortality	Expected encounters	Mortality	Expected encounters	Mortality	Expected encounters	Mortality
Eulachon	Natural	Adult	0	0	300	300	40	40	60	60	400	400
		Juvenile	0	0	100	100	20	20	100	100	220	220
Bocaccio	Natural	Adult	1	1	1	1	1	1	1	1	4	4
		Juvenile	1	1	1	1	1	1	1	1	4	4
Canary rockfish	Natural	Adult	1	1	5	5	1	1	5	5	12	12
		Juvenile	1	1	5	5	1	1	5	5	12	12
Yelloweye rockfish	Natural	Adult	1	1	2	2	1	1	1	1	5	5
		Juvenile	1	1	2	2	1	1	1	1	5	5
Chinook salmon	Listed Hatchery Adipose Clip	Adult	2	1	4	2	2	1	2	1	10	5
		Juvenile	5	1	15	7	20	5	20	10	60	23
	Natural	Adult	2	1	2	1	2	1	2	1	8	4
		Juvenile	5	1	5	2	10	3	10	5	30	11
Chum salmon	Natural	Adult	0	0	1	1	1	1	1	1	3	3
		Juvenile	0	0	2	1	5	1	1	1	8	3
Steelhead	Listed Hatchery Adipose Clip	Adult	0	0	2	1	1	0	1	1	4	2
		Juvenile	0	0	2	1	5	1	1	1	8	3
	Natural	Adult	0	0	2	1	1	0	1	1	4	2
		Juvenile	0	0	2	1	5	1	1	1	8	3
Green sturgeon	Natural	Adult	0	0	1	0	0	0	1	0	2	0

Appendix B

Species of Fishes with Designated

EFH in the Action Area

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EFH Groundfish Species		
English sole *Parophrys vetulus*	Pacific ocean perch *S. alutus*	flathead sole *Hippoglossoides elassodon*
soupfin shark *Galeorhinus galeus*	redbanded rockfish *S. babcocki*	Pacific sanddab *Citharichthys sordidus*
spiny dogfish *Squalus acanthias*	rosethorn rockfish *S. helvomaculatus*	petrale sole *Eopsetta jordani*
big skate *Raja binoculata*	rougheye rockfish *S. aleutianus*	rex sole *Glyptocephalus zachirus*
California skate *R. inornata*	sharpchin rockfish *S. zacentrus*	rock sole *Lepidopsetta bilineata*
Longnose Skate *R. rhina*	shortbelly rockfish *S. jordani*	sand sole *Psettichthys melanostictus*
ratfish *Hydrolagus colliei*	shortraker rockfish *S. borealis*	starry flounder *Platichthys stellatus*
Pacific rattail *Coryphaenoides acrolepis*	silverygray rockfish *S. brevispinis*	chilipepper *S. goodei*
lingcod *Ophiodon elongatus*	splitnose rockfish *S. diploproa*	shortspine thornyhead *Sebastolobus alascanus*
Pacific cod *Gadus macrocephalus*	stripetail rockfish *S. saxicola*	arrowtooth flounder *Atheresthes stomias*
sablefish *Anoplopoma fimbria*	vermilion rockfish *S. miniatus*	darkblotched rockfish *S. crameri*
aurora rockfish *S. aurora*	widow rockfish *S. entomelas*	butter sole *Isopsetta isolepis*
black rockfish *S. melanops*	yellowtail rockfish *S. flavidus*	curlfin sole *Pleuronichthys decurrens*
blue rockfish *S. mystinus*	Dover sole *Microstomus pacificus*	greenspotted rockfish *S. chlorostictus*
bocaccio *S. paucispinis*		greenstriped rockfish *S. elongatus*
EFH Coastal Pelagic Species		
anchovy *Engraulis mordax*	Pacific sardine *Sardinops sagax*	Pacific mackerel *Scomber japonicus*
jack mackeral *Trachurus symmetricus*	market squid *Loligo opalescens*	
EFH Pacific Salmon Species		
Chinook salmon *Oncorhynchus tshawytscha*	coho salmon *O. kisutch*	Puget Sound pink salmon *O. gorbuscha*

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