Peer Review Report[1] for Proposed Critical Habitat Designation and Draft Biological Report for Yelloweye Rockfish, Canary Rockfish and Bocaccio of the Puget Sound/Georgia Basin.

Reviewer 1:

Overall I think the document provides an adequate review of ESA rockfish life history attributes, the physical and biological features essential to conservation, and specific areas for designation. The lack of biological and life-history information for canary, yelloweye and bocaccio in PS clearly restricts a more complete analysis of critical habitat needs of these species, thus obligating a conservative approach to designating critical habitat.
One issue not addressed is how new scientific information will be used in the future to modify or redefine CH. Specifically I see the amount of CH proposed for designation will be subsequently reduced as new maps and survey data become available. Is this something that can (or should) be added to this document?
P.5 line 3. Define "deep waters"
P. 9 line 5. "trawlable" is associated with "more complex habitat" and "untrawlable" is associated with "less trawlable habitat" when it should be the reverse.
P.16 line 24. Strike the word "rocky". Adult and subadult habitats have been previously described and not all are rocky.
P. 20. Change *Ciona savignyo* to *Ciona savignyi*
P. 21. Under the Trawl Fisheries and Research section: the last sentence in paragraph 2 should be rewritten (e.g., Trawls in less structurally complex habitats generally have less impact on the substrate than trawls conducted in more complex habitats.)

P.23. Mapping Areas of Complex Bathymetry section.

Maybe a semantic issue, but to me the word "habitat" suggests an understanding of both substrate and structure. Since substrate information is not utilized as an input for the BTM, I have to disagree with the statement that the BTM classifies "habitats" and would prefer to see "habitat" replaced by "terrain" or "features" since that is more specifically what the BTM is doing. The resultant terrain definitions can then be used (in conjunction with slope and rugosity outputs from BTM) to make inferences regarding potential habitats, which is different than saying that the BTM classifies habitat.

P.24. line 11. Define mega- and mesohabitats.

P. 25. Why was 0.5 miles picked as the cutoff for non-designation of Estuary Wetland and Mud Flats? Are shorter segments being proposed for designation?

P. 27 line 21. The sentence "Most of the basin's numerous…" implies that juvenile canary and bocaccio are settling and rearing in these areas, which may or may not be the case. As such, I would add "could potentially" before the word "support" for clarification.

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[1] This report was generated by Mr. Wayne Palsson of the Washington State Department of Fish and Wildlife (now working for NOAA's Alaska Fisheries Science Center), and Mr. Robert Pacunski of the Washington State Department of Fish and Wildlife. A third review was solicited but no comments were received.

P. 30. South Puget Sound section

The 4th sentence is oddly-worded. I would rewrite it as "The sill at the Tacoma Narrows restricts water exchange between South Puget Sound and the Main Basin…"

P. 31 line 27. Move this sentence to the Hood Canal section and correct spelling of *Ciona savignyi.*

Appendix C: This section should contain some justification for the selection of the 200 m buffer and the 600 m smoothing tolerance. (I understand why, of course, but I think it needs to be formally addressed in the document for the benefit of other readers).
Relative to my comments for page 23, in the first sentence of this section I would replace "benthic habitats" with "benthic features" and add "that may be" before the word "used".
Is there a biological or practical reason for using a rugosity value of 1.005 for designating "high rugosity" areas? Maybe provide a table or graph of rugosity vs. area values for each basin.

Reviewer 2:

The designation of critical habitat is built upon the logic model of describing the knowledge of habitat and life history requirements of the three ESA rockfish species, identifying where those habitats critical to life history occur in the DPS, and then identifying what are the major limiting threats to those habitats. This is a logical approach, but the major limitation is a lack of specific knowledge about habitat requirements, life histories, and habitat occurrence of the ESA rockfishes in the Puget Sound DPSs. It is logical to draw from knowledge of habitat and life history requirements throughout the range of these species, but the authors should emphasize even more than they have, that there is a lack of direct information regarding the juvenile habitat requirements for canary and bocaccio rockfishes in Puget Sound and that what is known from coastal populations, especially from California, may not apply to the unique geomorphology and oceanography of the Puget Sound DPSs.

In the big picture and lacking more precise bathymetry and habitat information, the BTM approach likely is a conservative, risk-averse approach to defining adult and juvenile habitat because it does include most historical and survey records and likely habitat. More fine-scale bathymetry or focused studies must be obtained or conducted in the future. Critical and constructive comments are found below.

One problem in the beginning was a lack of clarity on what constitutes a juvenile vs. sub-adult rockfish. The authors need to clearly make this distinction. I assumed that a juvenile was a post-metamorphosis fish that occupies a different habitat than the adults and that sub-adults are not yet mature but do occupy the adult habitat. The problem with this definition is that juvenile yelloweye can occupy adult habitats, so aside from their color patterns, how are they defined? Is size a criterion, color, or some other characteristic the discrimination? One related problem to the juvenile yelloweye designation, is that small fish <15 cm are often observed in depths from 20 to 30 m (60 to 90 feet) and with the stated approach, this habitat will not likely be included in the critical habitat designation.

Critical Habitat

The authors cite most of the appropriate studies to describe the biological ranges and habitat associations of the three species. These studies mostly resulted from observations by submersible-based observers in California and British Columbia (BC). However, the author missed a key study conducted by Wang (2005) who identified habitat associations for yelloweye and canary rockfishes off the NW Washington coast, an area close to the DPSs. In particular, she found that the observed yelloweye rockfish occurred on larger patches of scattered and piled boulders and with high anemone (or crinoid) densities. Canary rockfish density was associated with high crinoid abundance or low crinoid abundance in deep depths. Canary rockfish were also present on all habitat types and often above the bottom. While these associations were valid for the transects and patches where these species occurred, the factor and regression tree models were not good at predicting density or presence outside of the dataset, that is, there were many vacant habitats with the right characteristics.

The approach taken by most habitat researchers is to describe the habitat associations of occupied habitat. As Wang (2005) found, the factors such as seafloor type or slope, often do not predict where the animals will actually occur as the data is often plagued by many zero observations even in favorable habitats. Rooper and Martin (2009) recognized this problem in predicting the occurrence of shortspine thornyhead in the northeastern Pacific. They developed and applied a two-stage model to reduce the influence of zero observations. The approach consisted of applying two-stage non-linear models to first predict the presence/absence of the species and then the second model predicted the abundance at the stations where the first stage predicted presence. They used a suite of ecologically important variables in each to predict presence or abundance. Once they found the best suite of predictors from a subset of the data, they then tested the ability of the model to predict presence/absence and abundance on data from years or areas not included in the developmental model. They found relatively good fits and predictive power with their model.

A statistically-based predictive model would be the best case approach to scientifically define critical habitat for ESA rockfish in Puget Sound. The authors of the draft critical habitat designation did not have a data rich situation to develop a powerful predictive model. Instead, they identified rugosity as their predictive variable in waters >30 m and used a BTM to generate the critical habitat for adults of all three species and for juvenile yelloweye rockfish. They generated a juvenile canary and bocaccio model based upon the Washington Department of Natural Resource's (WDNR) ShoreZone maps were shorelines consisting of sand, cobble, or rock occurred. The generated a map of these habitats for Puget Sound proper were provided and but the map for northern Puget Sound that relies upon a geological classification by Gary Greene was not provided. The map of Puget Sound proper shows about a half of all marine waters designated as adult or juvenile critical habitat. Generally, the designated habitat rings Puget Sound and progressively moves offshore from juvenile canary and bocaccio habitat to adult habitat of all three species and juvenile yelloweye rockfish habitat.

There are several problems with this approach, the first of which is that it is not scientific, that is it has not been substantiated to predict the critical habitat for adults or juveniles of the ESA species. At the minimum, the authors should use the maps generated by WDFW from survey and historical sources (supplied by the authors but not referred to in the text) to evaluate the effectiveness of their BTM at encompassing known occurrences of the adults within the DPSs. The evaluation should include historical and survey records with sufficiently precise geographic coordinates that are overlain on the generated maps. My brief inspection finds that most but not all records fall within the proposed critical habitat designations with notable exceptions of yelloweye in inner Elliott Bay on the wreck of the Fullerton, bocaccio in Ports Gamble and Port Orchard, and canary rockfishes in Skagit Bay and Misery Point in Hood Canal.

Without stated criteria linking occurrences, habitat associations, or life history requirements for the three species to an amount or type of critical habitat that needs protectiong, I am not able to say whether the proposed critical habitat is valid. The accuracy for the BTM cannot be evaluated with regards to historical/survey records that were not included in the BTM. For example, the habitat associations described for canary rockfish show that this species is commonly found on a variety of habitats other than rock and not necessarily in association with the seafloor. Therefore, the rugosity-based approach will not capture that portion of the canary rockfish's habitat, but I cannot judge whether that is important or not to include or exclude these occurrences. Because the authors have limited the designation to depths greater than 30 m, then the BTM excludes the shallow water records for the adult ESA rockfishes that are frequent in Puget Sound, but again is this significant to the persistence and recovery of the species? Several other questions are why was a rugosity of 1.005 picked as the threshold? Was a sensitivity analysis conducted to justify this value? Could this threshold be increased to include less habitat but still include those historical/survey records? Also, because rugosity is being calculated at the 30 m scale, smaller patches of complexity may be ignored and more spurious habitats merely consisting of the muddy walls of the fjord may be overestimating the amount of critical habitat.

The authors might include current speed in the adult BTM to help reduce the areas that consist of silt-mud and not likely to be critical habitat. The authors cite Oregon and California-based studies that found canary rockfish and bocaccio can be associated with mud habitats that contained boulders and rocks. The BTM appears to include many mud habitats that likely do not contain rock or boulders due to the fjord-like nature of Puget Sound. Examples include Case and Carr Inlets, portions of Dyes Inlet, upper Port Susan, Discovery Bay, and Dabob Bay. The nature of the mud-boulder relationships may also be different from the coast and Puget Sound where the mud is more likely to be fine silt. There is a limitation by many visual studies by submersible or remotely-operated vehicles to distinguish classes of silt, mud, and fine sand. By including current speed into the model, habitats containing coarser sediments that would more likely serve as critical habitat would be selected and otherwise exclude muddy habitats that do not contain boulders and likely habitat. Another improvement to the BTM would be to use WDFW bottom trawl data or other information to model fish communities in terms of hard or soft-bottom types that could help predict where ESA rockfishes are more likely to occur.

Another criticism is that the BTM was imprecise at identifying juvenile habitat in shallow water <30 m that consisted of sand, cobble, and rock and that using Shorezone to predict subtidal substrates from intertidal ones may not be an appropriate tool. Shorelines consisting of sand,

cobble, or even rock can give way to muddy or silty environments not predicted by the shoreline character—This can be especially the case in the inner and eastern San Juan Islands and in south Puget Sound. The authors did test the juvenile BTM by comparing where kelp occurred as identified by the Shorezone results compared to the BTM results and found good correspondence. However, understory kelp can grow in artificial or other substrates in muddy habitats and therefore not reflect the sand, cobble, rock habitat targeted by the critical habitat criteria. Specifically, juvenile habitat was identified in the heads of non-estuarine embayments such as Case, Carr, and Dyes Inlets, Port Madison, Sinclair Inlet, Penn Cove, Discovery Bay, and Port Townsend Bay that likely don't fit the target criteria. A better test would have been to check the juvenile BTM against the historic NOAA bottom substrate database that has been shared across Puget Sound researchers and also present on several of the fine-scale nautical charts of Puget Sound. The BTM could be refined by using current speed predictions to help exclude otherwise muddy nearshore habitats.

The buffering of the BTM might be tweaked to account for habitat continuity or edge effects where there are isolated patches of non-critical habitat amongst critical habitat. Such irregularities occur at Possession Bar, Foulweather Bluff, and Admiralty Inlet. Isolated patches of non-critical habitat would be difficult to geolocate and manage from the adjacent critical habitats.

Special Management Considerations or Protection

I am puzzled how the list of 10 special management considerations came to be. Some are certainly those identified by Drake et al. (2010) and many seem to be associated with the physical habitat that would affect the designated Critical Habitat. Special management considerations can take in both biological and physical features and both are used in the threat assessment. Those selected are inconsistent or at least undocumented in their likelihood of affecting the ESA rockfishes and reflect a lack of a consistent approach to identifying and ranking threats.

In particular, "Kelp Harvest" and "Trawl Fisheries and Research and Fisheries that Take Prey" are singled out as special considerations. Kelp harvest is limited in Puget Sound and almost exclusively occurs in intertidal waters, where there is an unlikely threat to ESA juveniles. For research and trawl fisheries, the singling out of trawl research and fisheries is extremely obtuse. First WDFW trawls target unconsolidated sediments that are not likely the prime adult habitat of the ESA species—yes, occasionally yelloweye and canary rockfishes have been taken by the research trawl and yes, the trawl does take potential prey species. But, WDFW itself should not be singled out as the only organization that conducts research trawls or other research that takes ESA or prey species. The University of Washington, other academic institutions, consulting firms, non-profit groups, and NOAA conduct teaching or research trawls in Puget Sound. These entities and WDFW also employ other sampling devices that can disrupt critical habitat or take great numbers of prey species. These gears or activities include beach seines, dredges, beam trawls, mid-water trawls, tow nets, purse seines, plankton nets, gill nets, and longlines that can also take ESA species, affect habitat, or even target forage fish species. Taken in total, these research gears likely far exceed the annual catch by the WDFW research trawl. If research take

and activity are thought to be significant, then they all should be considered as special management considerations for protecting ESA rockfishes.

As far as fisheries, the shrimp trawl is identified as a potential threat because its contact with the seafloor. What are not included as a special management considerations are recreational and tribal fisheries for salmon, halibut, and salmon which have known encounters of ESA species and take high numbers of potential prey species. Other threats under Aquaculture should be investigated such as the hardening of intertidal and subtidal habitats by the addition of non-native oyster shells, gravel, and PVC tube for clam and oyster aquaculture.

Some of the activities listed by the authors were likely identified internally or by a *charrette* process with WDFW. A more balanced and transparent process would be to apply an expert process such as that used by Halpern et al. (2007) to evaluate potential threats to the ESA species in terms of scale, frequency, functional impact, resilience, recovery time, and certainty. The results of similar threat assessments conducted by NMFS/NWFC could be an advanced starting place for such a ranking and evaluation of threats. Also, the IEA for Puget Sound could be used to model the impacts to prey communities by research or fishery removals. More balance to special considerations these approaches would be result in more effective protections for the ESA rockfishes and provide greater support by the public. Threat analyses by experts should be stratified by area to inform the special considerations by regions.

Evaluation of the Conservation Value of the Special Areas

The authors did not choose to list or evaluate any special areas citing a lack of systematic sampling in Puget Sound. However, WDFW did conduct two ROV surveys in the San Juan Islands, a region known to have the great majority of rocky habitat throughout the DPS. WDFW forwarded the outcomes of the 2008 survey showing the northeastern portion of the San Juans to have the most frequent, even common, occurrence of yelloweye rockfish. This finding might be reconsidered as worthy of special protection. Although other areas of Puget Sound have not been systematically sampled in all habitats, the results of the WDFW bottom trawl survey does provide a basis to evaluate the occurrence of ESA species throughout the DPS and shows the relative rarity of the ESA species in most areas of Puget Sound proper. Combined historical records do show, however, that some habitats and areas of Hood Canal and Puget Sound proper might be special areas, especially around Tacoma Narrows. I suggest that these records and areas of concentrations be reviewed and considered for their conservation values.

Recommendations:

- Expand juvenile yelloweye rockfish habitat to include waters >20 m in depth.
- Use current as a predictor in both adult and juvenile BTM.
- Validate BTM with NOAA bottom type data and the historic and survey maps generated by WDFW.
- Use higher criteria of rugosity in the BTM to exclude embayment habitat.
- Use fish community characteristics from bottom trawls to identify rockfish habitat and apply to BTM

- Conduct or refine threat analysis for special management considerations.
- Develop focused studies to improve bathymetry to 2 m resolution and to investigate potential ESA rockfish habitat in Puget Sound proper.
- Re-evaluate special areas in the San Juan Islands and Tacoma Narrows.

Comments on General Biology Appendix

See comments inserted in the document and note there are several new publications on the genetics of some of the species.

- The discussion of bocaccio should be updated to include the findings of Bounaccorsi et al. (2012) and Sivasundar and Palumbi (2010)
- Include the findings of Wang (2005) in the discussion of the habitat associations of yelloweye and canary rockfishes.
- Revise the discussion of maturity for yelloweye rockfish as commented in the text. Use Hannah et al. (2009) and Kronlund and Yamanaka (2001).

Literature Not Otherwise Cited by Original Document

Bounaccorsi, V.P., C.A. Kimbrell, E.A. Lynn, and J.R. Hyde. 2012. Comparative population genetic analysis of bocaccio rockfish (*Sebastes paucispinis*) using anonymous and gene-associated simple sequence repeat loci. Journal of Heredity 201:391-399.

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Hannah, R.W., M.T.O.Blume, and J.E. Thompson. 2009. Length and maturity of female yelloweye rockfish (*Sebastes ruberrimus*) and cabezon (*Scorpaenichthys marmoratus*) from Oregon waters based upon histological evaluation of maturity. Oregon Dept. Fish and Wildlife Information Reports Number 2009-04.

Kronlund, A.R., and K.L. Yamanaka. 2001. Yelloweye rockfish (*Sebastes ruberrimus*) life history parameters assessed from areas with contrasting fishing histories. Spatial Processes and Management of Marine Populations. Alaska Sea Grant College Program AK-SG-01-02:257-277.

Rooper, C.N., and M.H. Martin. 2009. Predicting presence and abundance of demersal fishes: a model application to shortspine thornyhead *Sebastolobus alascanus*. Marine Ecology Progress Series 379:253-266.

Sivasundar, A., and S.R. Palumbi. 2010. Life history, ecology, and the biogeography of strong genetic breaks among 15 species of Pacific rockfish, Sebastes. Marine Biology 157:1433-1452.

Wang, S.S. 2005. Groundfish habitat associations from video survey with a submersible off the Washington State Coast. Master of Science Thesis. University of Washington, Seattle. 305 p.