Center for Independent Experts Independent Peer Review: Puget Sound Nearshore Conservation Calculator and Puget Sound Nearshore Habitat Values Model

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Submitted to:

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I. Executive Summary

The Puget Sound Nearshore Conservation Calculator and the Puget Sound Nearshore Habitat Values Model were designed to assess impacts and benefits of small shoreline development and mitigation projects. They work by weighting affected areas by numerical scores that represent expected effects on juvenile salmon.

I found the overall modeling approach appropriate and reasonable for its purpose. The Model combines key advantages of more conventional modeling approaches without their disadvantages. Mechanistic population models (especially, the individual-based models that I develop and use) have the advantage of explicitly representing the mechanisms through which habitat alteration affect fish survival, growth, and migration; but are not useful for assessing individual small developments that would each have impacts indistinguishable from population model stochasticity and uncertainty. Habitat selection models are useful for assessing habitat alteration without the uncertainties of predicting population responses, but are typically based on empirical "suitability" relations that would be very difficult to develop for all the kinds of development and habitat addressed by the Calculator. The Puget Sound model resembles habitat suitability models but uses mechanistic understanding and assumptions instead of empirical suitability relations. The basis in mechanisms, and the authors' extensive reviews of supporting literature, provide a credible basis for model assumptions and weighting scores.

The model's approach of dividing shoreline habitat into four zones, with impacts of the same activity differing among zones, a practical and credible method for dealing with spatial variation. Temporal variation—for example, in how juvenile salmon presence, size, and habitat use varies seasonally—is much more complex and not addressed as explicitly. However, the authors clearly considered the full range of fish sizes, from fry to smolts, in developing the model.

I identified only a few minor questions about model assumptions and methods. The primary remaining need I see is refining the model documentation and user materials, if NMFS determines it worthwhile to support expected users. Developing clear, comprehensive, and well-organized model documentation is a very large task that is often best done by people other than the model developers. The documentation and Excel files I reviewed are certainly usable, especially by experienced users, but could be improved in a number of ways.

II. Background

This report provides my review of the Puget Sound Nearshore Conservation Calculator and the Puget Sound Nearshore Habitat Values Model that the Calculator implements, performed for the NMFS Center for Independent Experts Program. The review process began with a meeting to address reviewer questions on September 21, 2023. I conducted my review entirely independently, without any consultation with other reviewers or NMFS staff.

The documents provided for review are listed in Appendix 1. I used the Performance Work Statement "CIE Desk Review of the Puget Sound Nearshore Conservation Calculator and the integral Puget Sound Nearshore Habitat Values Model" (PWS; Appendix 2) as the primary source of guidance on review format and contents.

To develop my review comments, I: (a) read the background documents listed in the PWS, especially the report on the previous model version (Ehinger et al. 2015); (b) reviewed the Scientific Rationale (Ehinger et al. 2023) and its appendices, and the User Guide, in detail; and (c) explored the Nearshore Calculator and Habitat Values Model Excel files.

Throughout this document I use the following terms to refer to project documents:

- "the Report" refers to the Scientific Rationale (Ehinger et al. 2023; Puget Sound Nearshore Habitat Conservation Calculator Final 7 23 23.pdf),
- "the User Guide" refers to Puget Sound Nearshore Habitat Calculator User Guide (Ehringer et al. 2023; calculator-user-guide-v1.5.pdf),
- "the Calculator" is the Nearshore Calculator Excel file (Nearshore Calculator 2023 V1.5b annotated 7 13 23.xlsm), and
- "the Model" is the habitat values model Excel file (Nearshore habitat values model July 13 2023.xlsx) and the modeling concepts it implements.

III. Reviewer's Role in the Review

I am an environmental engineer and ecologist by training, with over 40 years' experience in modeling effects of habitat modification (especially, river management) on aquatic life and especially on salmonid fish. In particular, for almost 25 years I have been the lead developer of a family of mechanistic individual-based salmonid models (https://ecomodel.humboldt.edu/) that are comparable in complexity to the Calculator and Model. Like the Puget Sound models, ours are intended for widespread use and therefore require software and documentation suitable for non-experts.

The Performance Work Statement lists six areas of expertise for reviewers. My strongest expertise is in three areas:

1. Salmon ecology. I have extensive experience modeling effects of freshwater habitat on trout and salmon. Developing our salmonid models has required in-depth familiarity with literature on specific mechanisms by which various habitat characteristics affect salmonid survival, feeding and growth, and spawning success.

3. Development of models to support environmental management decisions. Our salmonid models (and other management models I co-developed, e.g., for river management effects on frogs and riparian trees) are designed specifically for assessment of environmental impacts and mitigation alternatives. Largely as a result of that experience, I have co-authored three books on ecological modeling and especially individual-based modeling.

6. Quantifying effects of habitat changes on fish. Our salmonid models specifically represent how salmonid growth, survival, and reproduction are affected by habitat features such as water depth and velocity, hiding and feeding cover, food availability, and predator types. Further, they represent how fish behaviors that trade off risk vs. growth (e.g., in selecting safer vs. more productive locations and times for feeding) link growth and survival. I am also familiar with the many field and laboratory experiments by my colleague Bret C. Harvey (Pacific Southwest Research Station, US Forest Service) to quantify habitat effects and to test and parameterize our model assumptions.

I do not have direct experience with Habitat Equivalency Analysis, but its fundamental assumptions—using habitat area weighted by ecological value as an assessment metric—are similar to those of the conventional instream flow assessment models that I have used and reviewed over my entire career.

I do not have extensive experience with estuarine ecology or the Puget Sound and Hood Canal environments.

IV. Summary of Findings

My findings are summarized here, categorized in subsections 1-3 by the three Terms of Reference (TOR) provided in the PWS. Findings that apply to more than one TOR are presented in the most-applicable category. I also provide a few editorial comments in subsection 4 and miscellaneous comments on non-science issues in subsection 5.

1. Analytically sound process

a) Overall approach

This TOR addresses whether the Model uses appropriate variables and mechanisms, and whether its functional relationships could be strengthened.

The most fundamental question of this review is whether habitat equivalency analysis is an appropriate type of model for its purpose. The Model's purpose is regulating and mitigating impacts of numerous and diverse small disturbances, in a large system, on fish that spend only a small part of their life cycle in the environment. To meet this purposes, a model also needs to be relatively simple and easy to use by agency field staff and consultants but credible enough to support regulatory decisions.

Alternative types of models include traditional population models and complex individual-based simulation models of the type I develop and use. Those alternatives could have the advantage of producing results such as expected numbers of successful outmigrants that have clearer management meaning than the DSAYs produced by the habitat equivalency approach. Individual-based models can have the advantage of explicitly representing the many mechanisms through which habitat affects fish that are considered in the nearshore model. But I do not think these alternatives would work for the nearshore management purpose: the predicted effects of each small development would be too small to distinguish from stochastic "noise" and other uncertainties. Population-level modeling does not seem like a viable alternative.

Another alternative approach is resource selection modeling; the traditional instream flow model PHABSIM is an (extremely outdated) example. Resource selection models also weight areas of affected habitat by their value to target species, but the weighting is based on empirical relations between habitat characteristics (e.g., depth, vegetation cover) and fish occupancy or density. This approach has the advantages of being able to evaluate habitat alterations too small to have strong effects on populations and being based on empirical observations and (sometimes) rigorous analysis methods. However, as the Report authors point out, the fish of interest are often sparse and vary seasonally in abundance and size, which would make empirical resource selection observations very difficult to produce and highly uncertain.

While habitat equivalence analysis is not a widely used approach to ecological modeling, to me it does seem appropriate for the nearshore habitat management purpose. The approach used in the Calculator and Model seems to combine the advantages of mechanistic individual-based models and resource selection models. It meets its purpose of evaluating individual small habitat alterations in ways that allow development and mitigation to be traded off, while using our mechanistic understanding of how such alterations could affect fish to make the evaluation process scientific and relatively rigorous. The Calculator makes the Model relatively easy for routine use by people other than its developers.

A second fundamental question is whether the Model has sufficient credibility for its purpose. In my opinion it does, for two general reasons. First is its explicit basis in specific biological mechanisms explained throughout Sect. 3 of the Report. Basing model assumptions and parameters on specific mechanisms, even when the mechanisms are mostly hypothesized, provides scientific justification and reduces the potential for ad hoc or biased assumptions; anyone challenging the model would have to provide scientific evidence or reasoning. The second reason for the Model's credibility is the detailed software and guidance for using it: the Calculator and User Guide not only make the Model easier to use but reduces the chances of errors or misuse.

I have only one suggestion on the Model's analytical approach, which is based on my experience with PHABSIM. PHABSIM weights habitat area using "suitability curves" that lack any specific ecological meaning, making the whole model vulnerable to *ad hoc* and non-credible approaches for evaluating "suitability". A clearer meaning of the measures used to weight area could make it easier to think about model assumptions and select meaningful ones. "DSAYs" are described (Sect. 2.4 of the Report) as a unitless currency of "service value". Given the diversity of habitat types and impacts the Model addresses, it may not be possible to provide a clearer definition of service value, but I suggest at least trying. I found it useful to think of the Model's output in this way: if we added up the DSAYs over the entire Puget Sound area, they should reflect the fraction of juvenile salmon that survive from migration into the area to the open ocean. The benefits of growth and survival are both represented in this conceptual measure because (a) fish must grow big enough to smolt to get to the ocean and (b) tradeoff behaviors relate growth and risk, e.g., abundant food can reduce the need for fish to forage in riskier places or times.

b) Specific comments

I found the first and second full paragraphs of p. 14 of the Report particularly unclear. First, the assumption that impact value must equal compensatory services seems like a regulatory requirement, not an assumption of the analysis. Second, I find the concept of habitat being "limiting" particularly not useful because (a) it is very hard to define what is or isn't limiting and (b) increasing some resources such as food and predator escape cover always benefit a population no matter how abundant they are[1]. (I prefer to talk about how strongly resources affect populations than how "limiting" they are, but I realize that the "limiting factors" concept pervades fisheries ecology.) Here, I would talk about the potential for some habitat resources to be so critical and scarce that their loss can only be compensated for with the same resources. These paragraphs also especially need editing for errors and clarity.

Water quality indicators: The use surrogates for water quality seems appropriate and practical.

Building in and explaining analyses for common applications is good (Report Sect. 4)—it increases reproducibility and consistency, and reduces effort and opportunities for error or misuse.

The adjustment factors explained in Report Sect. 5 seem appropriate and well-documented. They add the flexibility to identify and protect especially valuable habitat.

2. Scientifically sound process

This TOR addresses whether the Model uses the best available information and makes valid interpretations. My ability to comment on this TOR is somewhat limited by my lack of familiarity with estuarine ecology and Puget Sound, but I offer the following specific comments. Unless otherwise noted, section and page numbers refer to the Report.

"Annual Discount Rate", p. 12: This description does not say whether the statement "habitat today is worth more than habitat in the future" refers to worth for salmon population viability or to monetary worth as in the cost of providing population viability. I think it could refer to both.

Sect. 3.2, Riparian Zone, p. 18: The riparian zone width of 40 m seems high to me, though I lack experience to support a different value. The risk of a lower value is not capturing effects of large trees far from the water, while the risk of a high value is the potential to offset impacts close to shore with vegetation etc. too far from water to have much benefit.

Sect. 3.3, sentence spanning pages 21-22: It is uncontroversial that vegetation can provide escape and concealment cover to reduce predation risk, but the claim that reduced turbidity would reduce risk is likely to be debated. The paper by Phillips et al. (2021) cited here found a positive effect of turbidity on predation by seabirds in the Columbia River's ocean plume and explained that the birds are attracted to such plumes, while also citing conflicting results for other habitat types. Sections 9.18.4 and 9.19.3 of Railsback et al. (2023. InSTREAM 7 user manual: model description, software guide, and application guide. PSW-GTR-276, USDA Forest Service, Pacific Southwest Research Station, Albany, California. https://doi.org/10.2737/PSW-GTR-276)

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[1] Railsback, S. F. and B. C. Harvey. 2011. Importance of fish behaviour in modelling conservation problems: food limitation as an example. Journal of Fish Biology **79**:1648–1662.

discuss the question and evidence. I would simply delete reference to turbidity effects here as they are likely to be minor.

Sect. 3.3, p. 23, pp on DSZ: I think this pp. would be clearer and more useful if it provided a more mechanistic understanding of how salmonids use deep water. The concepts we use in our models are that small juveniles are most vulnerable to fish predators and of less and visibility interest to birds, so they are safest in shallow water; but as they grow, they become more vulnerable to birds and less vulnerable to at least some fish predators. Therefore, they tend to use deeper water as they get bigger (but perhaps not at night when low light offers protection from birds). Those concepts imply that they need both shallow and deep water, but I agree that shallow is likely more important.

Sect. 3.4.2.1.1: This sect. discusses avoidance of shaded areas by juvenile salmon. To me, this makes sense for small juveniles vulnerable to fish predators that use dark places to conceal themselves from prey and from predators like birds. If the authors agree with this mechanistic interpretation for why small juveniles avoid shade, consider including it in the document. (River fish biologists are used to fish avoiding well-lit habitat due to risk by terrestrial predators such as birds.) However, larger juveniles may be more vulnerable to birds and less to fish, so it seems possible that they could prefer shade; is there any evidence of that? Overall this section makes a convincing case for effects of structures on migration.

Sect. 3.4.2.1.3, metrics for migratory corridor obstruction: The metric for shaded area seems reasonable; the more shading, the less able a fish is to see what's there. However, here and elsewhere the term "amount of shading" is a bit ambiguous because it sounds like an area or volume; something like "degree of shading" better reflects how the metric is calculated as the fraction of light blocked.

Sect. 3.4.2.1.3: It is a little confusing that the shading metric is described as a weighting factor independent of area, while the boat ramp metric includes area.

Sect. 3.4.2.1.1 discusses pinniped predation, but pinnipeds receive very little attention in the rest of the Report or Calculator. Are they simply assumed part of the risk associated with overhead structures?

Sect. 3.4.3: The term "cover" is commonly used by fish biologists as if it is one habitat feature, while they acknowledge that cover has multiple distinctly different benefits. In our salmonid models, we explicitly refer to "velocity shelter" (cover that reduces swimming speeds when feeding in flowing water), "escape cover" (to which fish can flee when a predator is detected), and "concealment cover" (where fish can hide for extended periods when not feeding). In streams, we assume that woody debris provides escape cover but that concealment cover is provided mainly by crevices in large substrate. It would make this discussion conceptually clearer to distinguish types and uses of cover in a similar way.

Sect. 3.4.3: The discussion of sediment would be stronger if it described general sediment types in the study area, how typical development actions affect them, and their relative food production (and perhaps cover) values. This section identifies sediment quality as an indicator but says nothing about how it is evaluated. It also appears to identify “sediment-associated benthic invertebrate production” but that metric does not appear in Fig. 3-8 or Table 3-3.

Figure 3-9: The caption and axis label refers to “median percent cover”, which is not explained in the text. The caption needs editing as well.

Table 3-7: Is the metric really length of shoreline (in what units?), or percentage of affected shoreline, etc.?

Sect. 3.4.4.1.3: The discussion of piers and floats and boat ramps says they cause an “increase/decrease” in effect—presumably, adding a pier reduces the metric by one level? Why is adding piles assumed to increase the metric?

Sect. 3.4.5.1.3 and Table 3-11 are particularly confusing. The first pp. mentions just one metric, “vegetation type and amount”, without defining it precisely. But following paragraphs discuss four other metrics (that appear in the table) without specifically identifying them as such.

Sec. 3.5: What is a “drift cell”? In the middle pp. of p. 61, what is “this approach”?

Sect. 3.5: This section is overall straightforward and relatively clear, but in places it seems to confuse area and distance. I think this is because it focuses on the extent of impacts in the direction perpendicular to shore and implicitly assumes that the extent parallel to shore is clear enough it doesn’t need explanation. Examples from Sect. 3.5.4 include its first pp. (e.g., “the likely affected area waterward of hard armoring to be limited to 20 feet on average”, which equates an area with a distance) and the first pp. on p. 65.

Sect. 3.6: These duration times seem generally reasonable, well-supported, and straightforward to apply.

Sect. 4.1, 3rd pp.: Should “for the design life of the structure” be “for the design life of the new structure”?

Sect. 4.3, last full pp. of p. 73: Is “fences” a more common and general term than “palisades”?

Sect. 4.4, last bullet on p. 79: Should “1 ton of creosote” really be “1 ton of creosote-treated wood”? Also, the text on p. 89 should be clear about what “per one ton” refers to- per ton of treat wood, or also sediments?

Fig. 4-4: I don’t see how the toxicity function for “Response C” differs from “Response A”. This figure is not thoroughly explained in either the text or caption.

Sect. 4.4: This section (including figures) unnecessarily repeats fundamental concepts presented in Sect. 3. The repetition makes it much harder to identify and focus on the specifics of creosote removal.

Sect. 4.4.1 seems unnecessary and uncharacteristic of the rest of the Report. Important uncertainties can be discussed when each mechanism is discussed.

Sect. 4.6: Again, the separate sect. 4.6.1 for uncertainties seems unnecessary. It would be helpful for the first pp. of sect. 4.6 to state simply and clearly that the Nearshore Calculator does not address new dredging or disposal of dredged materials. (The statement "It is usually done when an existing overwater structure is located in a too shallow area..." is misleading as it does not make it clear that the problem is sediment deposition; I believe it should be something like "when sediment deposition reduces the usability of an existing structure".)

Sect. 4.6: The methods appear to implicitly assume that maintenance dredging will not change the long-term nature of the sediments, e.g., that SAV beds will revert to SAV and not to rock. That assumption seems reasonable for maintenance dredging, but perhaps should be stated explicitly so that users are more likely to notice and account for exceptions.

Sect. 4.6, Table 4-7 and the pp. explaining it: it was not clear to me what these calculations are used for. Does this explain how assumptions embedded in the MDredging tab were derived (as the text after the table implies)?

Sect. 4.7: Jetties, groins, and breakwaters seem like major structures with relatively widespread effects. The Calculator Excel file does not explicitly refer to groins, breakwaters, or piles (only jetties and boat ramps) so it is not clear how to assess them.

Sect. 4.7: The Calculator uses jetty width and length as input, but does not say what these dimensions refer to—I assume length is in the direction perpendicular to shore? It seems like this should make a difference in calculating effects of interrupted sediment drift?

Sect. 4.8: This section, like 4.7, seems brief and short on explanation of how the Calculator works.

Sect. 5.1: From its heading, I expected this section to provide and justify specific adjustment factors but it does not.

Sect. 5.1.1.1: A quick definition of "natal estuary" would be helpful at the start of this section.

Fig. 5-1: This figure doesn't seem to be cited in the text, and it's not clear what the "X"s in it mean. Is it intended to provide the factor values, or just show the situations in which factors apply?

3. Useful/realistic output

This TOR addresses whether model results are useful and well-supported, and whether they over- or under-estimate any development impacts.

My responses to these questions are largely captured in the preceding comments. The overall modeling approach appears to provide useful results for its purpose of evaluating shoreline development impacts and identifying sufficient mitigation. The Model provides an appropriate tradeoff between regulatory efficiency and usability vs. the ability to capture site-specific conditions and details.

With the few exceptions noted above, I found the model assumptions well justified by specific literature and explanation of mechanisms. The Calculator and User Guide lend rigor by implementing assumptions in specific software and by providing what is essentially a checklist of potential impact mechanisms.

4. Editorial comments

Overall I found the Report relatively well-written and understandable. There are occasional misspellings and particularly clumsy or confusing sentences. If this document is intended for widespread use, professional editing could reduce those problems and help by making much of the text shorter and clearer. As a random example, this sentence (p. 2): "The existing poor condition of the nearshore habitat in Puget Sound continues to be degraded by development action in the nearshore" could be "Puget Sound's poor nearshore habitat condition continues to be degraded by development."

Similarly, I found the User Guide generally well-written but with occasional minor usage errors etc. If the opportunity arises for professional editing, I recommend it because that document is specifically intended for widespread use.

The first PBF is called "Unobstructed migratory corridor". To me, "migratory" refers to something that migrates (a migratory bird), while the standard term for a corridor is "migration corridor".

Some specific comments:

Report footnote 4, p. 2: Especially in a model documentation report, I would use a term like "characteristics" instead of "parameters". "Parameter" has a specific definition used by modelers (equation coefficients that are likely to differ among but not within applications). The population characteristics listed here are measures of population status, very different from model parameters.

The first full pp. of Report p. 13 starts "Second,". It is not clear what was first.

Report Sect. 3.3, first sentence: "(0 -1)" should be "(0 – 1)".

Report Sect. 3.4, first pp.: Here the term "shoreline elevation band" is used instead of "elevation zone". To avoid user confusion, be very consistent with such terms. I noticed inconsistency with this and other critical terms throughout the report.

Report citations: The citations in the text and References section for Everett County have errors. I did not check whether other similar reports were also mis-cited.

Table 3.2, entry for "Indicator Effect Pathway" for "Forage": "results reduced invertebrate" should be "results in reduced invertebrate".

Table 3.3: There are several typos in the "Indicator Effect Pathway" column.

First full pp., Report p. 45: it is not clear why the 3 indicator effect pathways identified here are numbered 3-5.

Middle of Report p. 57: "bounded by" instead of "boarded by" ?

Report Fig. 3-14: Does "BH" stand for bulkhead?

Report Sect. 5.3: This section refers to the "size" of adjustment factors. "Value" is a more standard term, and "evaluating" instead of "sizing".

Report Sect. 5.3: Say at the start of this section that adjustment factor values are given in Table 5-1.

Report Table 5-1: This table is supposed to present the factor values but no columns are labeled as such. Is the adjustment factor value 1.0 plus the "Quantification Percent More Credit"??

Calculator tab "Overwater structures", cell B7: The text says to enter the dimensions, while col. E indicates that the area, not dimensions, are input. (I did not review the Excel files thoroughly for minor issues like this.)

Calculator ReadMe tab: The tab uses abbreviations I didn't know: VBA, OWS lookup tables. It also lists hidden tabs without explaining that they are hidden.

The Excel files have a number of editorial issues that careful proofreading could resolve. Examples include widespread typographical errors and inconsistent capitalization. In many places in the Model Excel file, the text describing numerical input says "percent" where it appears the input is actually a fraction (0.0 to 1.0); this kind of inconsistency could lead to errors. Proofreading should include making sure the Excel files and User Guide match each other as exactly as possible, and that guidance is provided (even if only cross-references to relevant sections of the User Guide or Report) for every entry field.

Calculator SAV Planting tab: This tab has inputs labeled "LSZ: Change in Submerged Aquatic Vegetation (SAV) scenario from before to after". I found no explanation for those inputs. The User Guide does not provide specific guidance on using this tab, nor does the Calculator's ReadMe page. Even the Report uses the term "SAV scenario" without defining it or how it is evaluated. I eventually found the definition by searching the User Guide and learned that it is a fairly fundamental concept.

5. Other comments

I know from our experience that developing comprehensive yet useful and coherent model documentation is a very difficult but important task, and requires different expertise than model development does. Documentation needs to include a complete model description and justification, plus a software user guide that explains how the implementation works, and model software that is relatively easy to use properly and difficult to misuse. Further, these three elements need to be carefully coordinated to ensure comprehensiveness, avoid redundancy (which makes use tedious and introduces the potential for confusion when something is updated in one place but not another), and ensure consistency in terms, variable names, etc. Comprehensive but concise and consistent documentation not only makes a model easier to use but makes maintenance (updating with improved assumptions, software revisions, etc.) easier and less error-prone.

The Puget Sound Report, User Guide, and Excel files currently seem quite usable, but their organization, comprehensiveness, conciseness, and consistency could all be significantly improved if NMFS found that worthwhile to facilitate its widespread use and maintainability. (I provide examples in the following paragraph.) The first step I would recommend is thorough editing by an experienced technical writer.

I found Report sect. 3.4 quite difficult and tedious to follow and review, yet it contains the most important information. The difficulty was in part because the habitat values model is quite complex and uses too many terms to keep in mind, but I'm sure the text could be simpler and easier to understand. Some changes that could increase understanding are:

- Be very consistent with terms and names of metrics. Currently it is difficult to follow exactly what the metrics are because terminology is not consistent. As examples, Sect. 3.4.3.3.1 starts by identifying "**planktonic production**" and "**benthic and epibenthic production associated with the sediments**" as important processes, then in the 2nd pp. refers to "**primary production**" and "**sediment-associated production**". Then in sect. 3.4.3.3.2 the indicators are identified as "**phytoplankton production**" and "**benthic production**". Different terms are used again in Table 3-8. In Sect. 5.2, "Landscape-scale adjustment factors" and "location adjustment factors" appear to be used for the same thing, while Fig. 2 of the User Guide uses "Crediting/Discounting Factors".
- Be consistent and careful with other terms like PBFs. For example, Table 3-5 has multiple rows for the same PBF, some labeled "Forage" and one "Forage and cover".
- Use bold-face type more judiciously to avoid confusion. Currently, the metric names are identified only via bold, but many other terms are also in bold. Numbering the metrics could also help identify them unambiguously.
- Put all the background on ecological processes in one place instead of mixing it throughout the discussion of indicator effect pathways, indicators, scoring, etc. That background could identify the effect pathways so they do not need to be addressed later. I think this background would be more concise and easier to follow if the background for all shore zones is presented together, for each PBF: first cover migration corridors for all zones, then forage and cover for all zones, etc.
- State each metric concisely but precisely. Without re-stating the background on why the metric was selected, say exactly how the metric is evaluated in the field and (as simply as possible) how it affects the final habitat value. Make sure this description includes how space is factored into the metric.

The Report's list of abbreviations and glossary are extremely useful and well-written. The glossary definitions are generally concise yet complete. Terms that were used in the report and not clear to me and not in the glossary are: float, drift cell, bulkhead. (The report uses several terms for common kinds of development, such as float and bulkhead, that may be well-understood by users but unfamiliar to me.)

The Report's Disclaimer makes it clear that revisions should be expected, and its suggested citation provides the publication year. However, the exact publication date is not on the report, and some but not all of the appendices are dated. (The User Guide, though, is dated.) On reports like this, I put a "Last revised" date on the cover page so that users can know exactly which revision they are using. For model documentation, I typically also include a revision log so users can see what changes were made when. (This log is simply a table after the cover page with rows documenting what changes were made to what report sections on what date.) Similar change logs could be in model software such as the calculator and model Excel files. Clearly documenting revisions seems especially important for regulatory decision models. (Software developers refer to this issue as "version control" and typically use elaborate methods such as repositories to address it; I prefer methods that are simple and easy but rigorously followed.)

I think the User Guide would be substantially easier to use if its sections were numbered, which would facilitate cross-references within the document and from the Excel files. Further, I expected the sections on each tab (starting on p. 24) to fully explain each entry field on each tab, but they do not. The Calculator would be easier to use and less vulnerable to errors if the User Guide provided guidance on each field, even if the guidance was a just cross-reference to full explanation elsewhere.

I congratulate the Report authors on coming very close to joining us (Railsback et al. 2009. InSTREAM: the individual-based stream trout research and environmental assessment model. PSW-GTR-218, USDA Forest Service, Pacific Southwest Research Station) in citing references by authors from A to Z.

V. Conclusions and Recommendations

My summary conclusions are that the Nearshore Calculator and Habitat Values Model:

- Is an analytically sound process, with an overall design appropriate for its purpose and well-supported choice of variables and mechanisms;
- Provides a scientifically sound process that can, and appears to, use the best available information to make valid interpretations, by applying specific mechanisms to predict effects of actions that individually would have impacts too small to observe; and
- Produces useful results that are reasonably well-supported while being relatively easy and straightforward to apply.

I therefore see no reason why the Calculator should not continue to be used for its intended purpose in assessing and mitigating effects of nearshore development.

My only substantial recommendation for improving the Calculator and Model are, if future applications justify the effort, to continue efforts to improve the comprehensiveness, conciseness, and consistency of model documentation.

VI. Appendices

1. Bibliography of materials provided for review

I was provided with the following materials for review:

Ehinger, S. I.,1 Paul Cereghino, Josh Chamberlin. 2023. The Puget Sound Nearshore Habitat Conservation Calculator (`Puget Sound Nearshore Habitat Conservation Calculator Final 7 23 23.pdf`).

Nearshore Calculator Excel file (`Nearshore Calculator 2023 V1.5b annotated 7 13 23.xlsm`).

Nearshore Habitat Values Model Excel file (`Nearshore habitat values model July 13 2023.xlsx`).

Ehinger, S. I., L. Abernathy, M. Bhuthimethee, L. Corum, N. Rudh, D. Price, J. Lim, M. O'Connor, S. Smith, J. Quan. 2023. Puget Sound Nearshore Habitat Calculator User Guide V1.5. NOAA, editor (`calculator-user-guide-v1.5.pdf`).

Nearshore Calculator appendices (`Puget Sound Nearshore Habitat Conservation Calculator Appendices Final.docx.pdf`).

Cereghino, P., J. Ory, P. Pope, S. Ehinger, M. Bhuthimethee, K. Wykoff, and J. Chamberlin. 2023. Estimation of Typical High Intertidal Beach-Face Slope in Puget Sound. U.S. Department of Commerce, NOAA Processed Report NMFS-NWFSC-PR-2023-03 (`Cereghino et al 2023.pdf`).

Ehinger, S.I.1, J. P. Fisher, R. McIntosh, D. Molenaar and J. Walters. 2015. Working Draft, April 2015: Use of The Puget Sound Nearshore Habitat Values Model with Habitat Equivalency Analysis for Characterizing Impacts and Avoidance Measures for Projects that Adversely Affect Critical Habitat of ESA-Listed Chinook and Chum Salmon (`Docum for NHV & HEA Model WorkingDraft 2015.pdf`).

Max R. Lambert and Joshua Chamberlin. Beach nourishment in Puget Sound: status, use, and habitat impacts (`Lambert and Chamberlin 2023.pdf`).

Salish Sea Nearshore Programmatic Biological Opinion (`2022_06-29_SSNP_WCRO-2019-04086.pdf`).

2. CIE Performance Work Statement

Performance Work Statement (PWS)
National Oceanic and Atmospheric Administration (NOAA)
National Marine Fisheries Service (NMFS)
Center for Independent Experts (CIE) Program
External Independent Peer Review
Under Contract #1305M219DNFFK0025

CIE Desk Review of the Puget Sound Nearshore Conservation Calculator and the integral Puget Sound Nearshore Habitat Values Model

Background

The National Marine Fisheries Service (NMFS) is mandated by the Magnuson-Stevens Fishery Conservation and Management Act, Endangered Species Act, and Marine Mammal Protection Act to conserve, protect, and manage our nation's marine living resources based upon the best scientific information available (BSIA). NMFS science products, including scientific advice, are often controversial and may require timely scientific peer reviews that are strictly independent of all outside influences. A formal external process for independent expert reviews of the agency's scientific products and programs ensures their credibility. Therefore, external scientific peer reviews have been and continue to be essential to strengthening scientific quality assurance for fishery conservation and management actions.

Scientific peer review is defined as the organized review process where one or more qualified experts review scientific information to ensure quality and credibility. These expert(s) must conduct their peer review impartially, objectively, and without conflicts of interest. Each reviewer must also be independent from the development of the science, without influence from any position that the agency or constituent groups may have. Furthermore, the Office of Management and Budget (OMB), authorized by the Information Quality Act, requires all federal agencies to conduct peer reviews of highly influential and controversial science before dissemination, and that peer reviewers must be deemed qualified based on the OMB Peer Review Bulletin standards[2].

Scope

NMFS is requesting peer review of the Puget Sound Nearshore Conservation Calculator (Nearshore Calculator) and the integral Puget Sound Nearshore Habitat Values Model to

[2] https://www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/memoranda/2005/m05-03.pdf

strengthen the quality and credibility of the agency's science, and improve stakeholder's trust that the agency is basing policy decisions on the best scientific information available.

NMFS designated critical habitat for Puget Sound (PS) salmonids in 2005 (70 FR 52629, Sept. 2, 2005). NMFS's designation of salmonid critical habitat describes which physical and biological features (PBFs) support the specific conservation roles of habitat. For estuarine and nearshore marine areas, essential PBFs of habitat for PS Chinook and Hood Canal Summer Run (HCSR) chum salmon include (1) unobstructed rearing and migration corridors; (2) forage including aquatic invertebrates and fish, supporting growth and maturation; (3) natural cover such as submerged aquatic vegetation and large wood;[3] and (4) water quality supporting juvenile and adult physiological transitions. NMFS used these PBFs as a framework for developing the Puget Nearshore Calculator, consistent with how NMFS evaluates effects on critical habitat under ESA section 7.

NMFS West Coast Region (WCR) developed the Nearshore Calculator to assist in analyzing the impact of proposed local development action in nearshore marine habitats within Puget Sound, Washington. The Nearshore Calculator is based on Habitat Equivalency Analysis (HEA) (Described in section 3 of Ehinger et al. 2023). The Nearshore Calculator is an easy-to-use interface for the Nearshore Habitat Values Model (NHVM). NMFS WCR designed the NHVM to consistently determine habitat service values to be used as input parameters in HEA.

For use as an analysis tool for ESA consultations, the Nearshore Calculator is based on evaluation of the PBFs and the conservation roles of those features - survival, growth, and maturation – and likely effects of proposed actions on population level viability (abundance, productivity, spatial structure, and diversity, or "VSP"[4]) for salmonids. The Nearshore Calculator quantifies changes to PBFs of listed salmonid habitat and considers how these changes likely affect salmonid growth, development, and VSP and as a corollary, the relative conservation value of an area of habitat. The formal structure and science-based quantitative assessment results in a more predictable quantification of the impacts of actions during an ESA consultation, which is valuable because it improves consistency, efficiency, and transparency. Finally, the Nearshore Calculator is amenable to revision based on new science.

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[3] The description of the estuarine PBFs further outlines "These features are essential to conservation because without them juveniles cannot reach the ocean in a timely manner and use the variety of habitats that allow them to avoid predators, compete successfully, and complete the behavioral and physiological changes needed for life in the ocean." ." https://www.federalregister.gov/d/05-16391

[4] The process NMFS typically uses to evaluate impacts on listed salmonids uses the viable salmonid population (VSP) concept (McElhany et al. 2000). McElhany et al. (2000) identified four parameters to evaluate the viability of a population: abundance, population growth rate, population spatial structure, and diversity. When analyzing the effects of actions on listed species as part of an ESA section 7 consultation, NMFS usually analyzes the effects on each of these parameters.

NMFS requests that the CIE reviewers conduct a peer review of the scientific information and framework of the Nearshore Calculator based on the Terms of Reference (TORs) referenced below.

The specified format and contents of the individual peer review reports are found in Annex 1. The Terms of Reference (TORs) of the peer review are listed in Annex 2.

Requirements

NMFS requests five (5) reviewers to conduct an impartial and independent peer review in accordance with the performance work statement (PWS) and the TORs below. Each reviewer should have working knowledge and recent experience in a minimum of three of the following areas:

(1) Salmon ecology;
(2) Marine nearshore ecology and/or conservation biology;
(3) Development of models preferably in the context of making decisions to avoid, minimize, or mitigate potential impacts;
(4) Science of valuing habitat for fishes based on ecological functions and services;
(5) Quantifying effects of physical changes (like the installation of shoreline armoring) on habitat conditions and functions;
(6) Quantifying effects of changes in habitat condition (structure & functions including vegetation, prey productions, water quality) on fish (preferably salmon) growth and survival.

In addition, knowledge and experience with Habitat Equivalency Analysis is helpful, though not required. Each CIE reviewer's duties shall not exceed a maximum of 10 days to complete all work tasks of the peer review described herein.

Tasks for Reviewers

Each CIE reviewer shall complete the following tasks in accordance with the PWS and Schedule of Milestones and Deliverables herein.

1. Pre-review Background Documents: Two weeks before the peer review, the NMFS Project Contact will send by electronic mail or make available at an FTP site to the CIE reviewer all necessary background information and reports for the peer review. In the case where the documents need to be mailed, the NMFS Project Contact will consult with the CIE on where to send documents. The CIE reviewer shall read all documents in preparation for the peer review:

Main Documents:

- Nearshore Calculator Scientific rationale (central document providing background and information for quantifications developed for Nearshore Calculator) 145 pages + appendices (Ehinger et al. 2023)
- Nearshore Calculator – Excel Spreadsheet, available on NOAAs web page.

- Annotated and updated Excel Nearshore Habitat Values Model.

Background Documents:

- User Guide (provides instruction on how to populate fields and get impact/benefit results from calculator) – available on NOAAs web page at: https://www.fisheries.noaa.gov/resource/tool-app/puget-sound-nearshore-conservation-calculator, 60 pages.
- Cereghino et al. 2023 – (describes GIS layers developed to identify Highest Astronomical Tide (HAT) lines in Puget Sound) 45 pages.
- Historic document Ehinger et al. 2015 on previous model version.
- Lambert and Chamberlin. 2023. Beach nourishment in Puget Sound: status, use, and habitat impacts - in final review by authors.
- Salish Sea Nearshore Programmatic (SSNP) Biological Opinion

2. Webinar: Approximately two weeks after the CIE reviewers receive the pre-review documents, they will participate in a webinar with the NMFS Project Contact and Nearshore Calculator team members to address any clarifications that the reviewers may need regarding the TORs or the review process. The NMFS Project Contact will provide the information for the arrangements for this webinar.

3. Desk Review: Each CIE reviewer shall conduct the independent peer review in accordance with the PWS and TORs, and shall not serve in any other role unless specified herein. Modifications to the PWS and TORs cannot be made during the peer review, and any PWS or TORs modifications prior to the peer review shall be approved by the Contracting Officer's Representative (COR) and the CIE contractor.

4. Contract Deliverables - Independent CIE Peer Review Reports: Each CIE reviewer shall complete an independent peer review report in accordance with the PWS. Each CIE reviewer shall complete the independent peer review according to required format and content as described in **Annex 1**. Each CIE reviewer shall complete the independent peer review addressing each TOR as described in **Annex 2**.

Place of Performance

Each CIE reviewer shall conduct an independent peer review as a desk review, therefore no travel is required.

Period of Performance

The period of performance shall be from the time of award through September 2023. The CIE reviewers' duties shall not exceed 10 days to complete all required tasks.

Schedule of Milestones and Deliverables

The contractor shall complete the tasks and deliverables in accordance with the following schedule.

Within two weeks of award	Contractor selects and confirms reviewers
No later than two weeks prior to the review	Contractor provides the pre-review documents to the reviewers
September 2023	Each reviewer conducts an independent peer review as a desk review
Within two weeks after review	Reviewers submit draft peer-review reports to the contractor for quality assurance and review
Within three weeks of receiving draft reports	Contractor submits five (5) final independent Peer-Review reports to the Government

Applicable Performance Standards
The acceptance of the contract deliverables shall be based on three performance standards: (1) The reports shall be completed in accordance with the required formatting and content; (2) The reports shall address each TOR as specified; and (3) The reports shall be delivered as specified in the schedule of milestones and deliverables.

Travel
Since this is a desk review travel is neither required nor authorized for this contract.

Restricted or Limited Use of Data
The contractors may be required to sign and adhere to a non-disclosure agreement.

Project Contact:
Kim Kratz
kim.kratz@noaa.gov
NMFS, West Coast Region
1201 NE Lloyd Blvd, Suite 1100, Portland, OR 97232

Annex 1: Peer Review Report Requirements

1. The report must be prefaced with an Executive Summary providing a concise summary of the findings and recommendations, and specifically whether the Nearshore Calculator represents the best available science and if not, what specific improvements you recommend.
2. The main body of the reviewer report shall consist of a Background, Description of the Individual Reviewer's Role in the Review Activities, Summary of Findings for each TOR in which the weaknesses and strengths are described, and Conclusions and Recommendations in accordance with the TORs.
3. The reviewer report shall include the following appendices:
    1. Appendix 1: Bibliography of materials provided for review
    2. Appendix 2: A copy of the CIE Performance Work Statement

Annex 2: Terms of Reference (TOR) for the Peer Review

The reviewers will provide input on the following questions. During your evaluation, please keep in mind that the Nearshore Calculator must use the best available science, Endangered Species Act consultations cannot be delayed until better science becomes available, and the Nearshore Calculator can be modified over time as additional science becomes available.

1) **Analytically sound process:**
    a) Are the underlying relationships that Nearshore Calculator and the NHVM are built upon (e.g. duration of aquatic access, functional pathways, indicators/metrics) sufficient and well-founded for evaluating effects of changes to nearshore habitat conditions on salmonids, given the stated goals and objectives? Is the analytical approach based on a valid list of habitat attributes (physical and biological functions)?
    b) Are there ways to strengthen the functional relationships the Nearshore Calculator is based on?
    c) Include in your findings a description of strengths and weaknesses.
    d) For weaknesses, please outline possible solutions considering the stated goals and the data availability, and if possible, provide references.
2) **Scientifically sound process:**
    a) Does the Nearshore Calculator systematically and appropriately incorporate and interpret the highest priority and best available scientific information given the stated goals and objectives?
    b) Indicate if and what relevant information is missing, provide references.
    c) Indicate if interpretations need to be refined, and if possible, provide references.
3) **Useful/realistic output:**
    a) Does the Nearshore Calculator generate reasonable and well-supported quantifications of the impacts (positive, negative, neutral) to nearshore habitats and salmon?
    b) If warranted, include in your findings a description of where the Nearshore Calculator likely over- or under-estimates impacts or benefits to salmon and their habitat.
    c) If warranted, outline possible solutions for better supported quantifications and if possible, provide references.

Objectives for the Nearshore Calculator

In summary, the Nearshore Calculator is designed to be:

- Rapid and Efficient – quantify habitat services using data typically provided as part of ESA-consultation packages.
- Accessible – invite use by biological consultants, agency personnel, and applicants.
- Transparent – allow users to review every element of an assessment.
- Consistent – produce repeatable results through the use of objective indicators and criteria. Expert opinion is thoroughly developed and reviewed and then frontloaded into the Nearshore Calculator rather than applied by individual biologists.
- ESA-based – references PBFs of critical habitat and effects on the survival, abundance, and productivity of listed salmonids.
- Duration-sensitive – consider the duration of impacts and benefits.
- Scaled to level of effects – evaluate the small difference in common project types, for example, the changes in shading caused by the size of overwater structures and the use of grating.
- Adaptable – allow for the incorporation of new science or best available information.