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Proceedings of the Pacific regional peer review of a framework for identifying ecological conservation priorities for marine protected area (MPA) network design in the Northern Shelf Bioregion

November 22-24, 2016
Vancouver, British Columbia

Chairpersons: Miriam O and Russ Jones
Editor: Candice St. Germain

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Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

These Proceedings summarize the relevant discussions and key conclusions that resulted from a Fisheries and Oceans Canada (DFO), Canadian Science Advisory Secretariat (CSAS) Regional Peer Review meeting from November 22-24, 2016 at the Morris J. Wosk Centre for Dialogue in Vancouver, B.C. One working paper was presented for peer-review and outlines a framework for identifying conservation priorities (CPs) and the application of this framework in the Northern Shelf Bioregion (NSB). CPs are features to be protected or prioritized during identification of potential sites contributing to the marine protected area (MPA) network.

In-person and web-based participation included Fisheries and Oceans Canada Science, Oceans, and Fisheries and Aquaculture Management Sectors staff, and external participants from First Nations organizations, the commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report providing advice to DFO Oceans Management Branch to inform the Marine Protected Area Technical Team's (MPATT) development of a network of MPAs in the NSB. The framework may also be appropriate for developing lists of CPs in support of other MPA network planning processes within Canada.

The Science Advisory Report and supporting Research Document will be made publicly available on the [Canadian Science Advisory Secretariat](#) website.

INTRODUCTION

A Fisheries and Oceans Canada (DFO) Canadian Science Advisory Secretariat (CSAS), Regional Peer Review (RPR) meeting was held from November 22-24, 2016 at the Morris J. Wosk Centre for Dialogue in Vancouver, B.C. In this meeting, participants reviewed a framework for identifying conservation priorities, the application of this framework in the Northern Shelf Bioregion (NSB), the list of conservation priorities produced by this application, the types of spatial information needed to represent conservation priorities (CPs), and the uncertainties, gaps, research needs, or limitations for further consideration in support of marine protected area (MPA) network design.

The Terms of Reference (TOR) for the science review (Appendix A) were developed in response to a request for advice from DFO Oceans Management Branch. Notifications of the science review and conditions for participation were sent to representatives with relevant expertise from First Nations, commercial and recreational fishing sectors, environmental non-governmental organizations, and academia.

The following working paper (WP) was prepared and made available to meeting participants prior to the meeting (working paper abstract provided in Appendix B):

A framework for identifying ecological conservation priorities for marine protected area (MPA) network design in the Northern Shelf Bioregion by Gale, K., Frid, A., Lee, L., McCarthy, J.B., Robb, C., Rubidge, E., Steele, J., and Curtis, J. CSAS Working Paper [*2015OCN05a*]

The meeting Chairs, Miriam O and Russ Jones, welcomed participants, reviewed the role of CSAS in the provision of peer-reviewed advice, and gave a general overview of the CSAS process. The Chairs discussed the role of participants, the purpose of the various RPR publications (Science Advisory Report, Proceedings, and Research Document), and the definition and process around achieving consensus decisions and advice. Everyone was invited to participate fully in the discussion and to contribute knowledge to the process, with the goal of delivering scientifically defensible conclusions and advice. It was confirmed with participants that all had received copies of the Terms of Reference, working paper, reviews of working paper, and agenda.

The Chairs reviewed the Agenda (Appendix C) and the Terms of Reference for the meeting, highlighting the objectives and identifying the Rapporteur for each review. The Chairs then reviewed the ground rules and process for exchange, reminding participants that the meeting was a science review and not a consultation. The room was equipped with microphones to allow remote participation by web-based attendees, and in-person attendees were reminded to address comments and questions so they could be heard by those online.

Members were reminded that everyone at the meeting had equal standing as participants and that they were expected to contribute to the review process if they had information or questions relevant to the paper being discussed. Candice St. Germain was identified as the Rapporteur for the meeting.

Participants were informed that Lucie Hannah and Rebecca Martone had been asked before the meeting to provide detailed written reviews for the working paper to assist the peer-review meeting. Similarly, Lucie Hannah and Rebecca Martone provided written reviews of the working paper. Participants were provided with copies of the written reviews (Appendix D).

The conclusions and advice resulting from this review will be provided in the form of a Science Advisory Report to DFO Oceans Management Branch to inform MPATT's development of a

network of MPAs in the NSB. The Science Advisory Report and supporting Research Document will be made publicly available on the [Canadian Science Advisory Secretariat](#) website.

REVIEW

Working Paper: A framework for identifying ecological conservation priorities for marine protected area (MPA) network design in the Northern Shelf Bioregion. [WP*2015OCN05a*]

Rapporteur: Candice St. Germain

Presenter(s): Hillary Ibey, Katie Gale, and Emily Rubidge

PRESENTATION OF WORKING PAPER

The following are brief outlines of the presentations given to summarize the working paper.

CONTEXT

Presenter: Hillary Ibey

- Outlined the foundational pieces for the framework:
    - Federal commitments, targets, and how the MPA network will fit into the bigger picture.
    - Canada-BC MPA network strategy document (2014) and how it helps to guide planning process.
    - Network planning process flow chart. The five major process steps and where they come from.
    - Governance using the tripartite arrangement and named governing parties.
    - Engagement as a key component involving many different groups. We are still developing a stakeholder engagement strategy.
    - Information gathering and data analysis. Over 500 data layers have been collected and we are working on a gap analysis and quality control assessment.
- Outlined the six network goals. This work focuses on goal one: "To protect and maintain marine biodiversity, ecological representation, and special natural features."
- Network objectives work together cohesively and were developed at the network scale.
- Network principles guide planning and site selection. These were very broad and needed to be more focused. A design guidelines draft is currently out for review.
- Conservation priorities (CPs) in context. CPs will feed into design strategies, which will feed into development of design scenarios. Here we focus on CPs that relate to goal one. We hope to have final network design by Spring 2019.

OVERVIEW OF WORKING PAPER

Presenter: Katie Gale

- Focusing on ecological CPs. Others CPS (such as socioeconomic) are identified through other processes.

- o Protecting known features will also help protect unidentified features.
- Scope as outlined in the bullets in the working paper.
- Outlined the structure of the framework.
  - o Built on previous work, using broad, general criteria.
  - o Criteria broken down into species- and area-based categories which speak to different network objectives.
- Overviewed species-based CP criteria.
  - o Developed systematic methodology for scoring and screening species.
  - o Mammals, fish, inverts, plants screened through six criteria, birds screened through two – all justifications in Appendix 3.
  - o Outlined spatial information recommendations.
- Overviewed recommended spatial features for area-based CPs.
  - o Scoring scheme not used (as in species-based).
  - o Covers four objectives (1.1, 1.3, 1.4, 1.6).
  - o Listed number of objectives covered by each area.
- Overviewed strengths and limitations.
  - o Systematic and transparent process that is repeatable and adaptive.
  - o Scores reflect existing knowledge, however, sometimes there is poor documentation.

SPECIES-BASED CONSERVATION PRIORITIES (CPS)

Presenter: Katie Gale

- Described how candidate species list was put together and the makeup of final list.
  - o Applied criteria (for objectives 1.1, 1.2, 1.5) to all species on CP list.
- General scoring reviewed, what different scores meant, and scoring considerations (e.g. scored on historical roles).
- Gave detail about different criteria used and scoring considerations for each:
  - o Conservation concern
  - o Intrinsic vulnerability
  - o Notes on rare species – characteristics incorporated into other criteria
  - o Ecologically significant species:
    - o Highly influential predators
    - o Key forage species
    - o Nutrient transporting species
    - o Habitat-forming species
- Presented framework overview diagram.

- o If species fit into any of the three criteria types (1.1, 1.2, 1.5) they were screened through.
  - o Birds screened through only two criteria.
- Presented score breakdown figures.

AREA-BASED CONSERVATION PRIORITIES (CPS)

Presenter: Emily Rubidge

- Unlike species-based CPs (two step process) some of objectives directly linked to areas from the beginning.
- Reviewed objectives (1.1, 1.3, 1.4, 1.6).
- Reviewed characteristics of area-based CPs.
- Reviewed Ecologically and Biologically Significant Areas (EBSAs) and how they feed into MPA network planning process.
- Reviewed significance of the different types of areas:
  - o Climate refugia
  - o Degraded areas
- Presented table with recommended types of features and which objectives they fulfill.
- Presented table on the classification systems recommended.
- Summarized next steps.

EUCLIDEAN DISTANCE ANALYSIS

Presenter: Katie Gale

- Euclidean distance analysis produced a spread of scores where there was a group of vulnerable, but not ecologically important species, a group of ecologically important, but not vulnerable species, and a group of overlap in the middle.
- Using Euclidean distance scores, the importance of double counted species (vulnerable and of conservation concern) was reduced and the importance of species with more ecological roles was increased.
- A reviewer clarified that this does not necessarily rank species but provides a way to separate them and tease out ecological roles, setting the stage for decisions with respect to targets. This analysis shows that some species are important for their ecological roles, some are important for vulnerability, and some for both. A Venn diagram would be a useful visual representation.

PRESENTATION OF WRITTEN REVIEWS

Formal reviews can be found in Appendix D: Working Paper Reviews. Discussions regarding formal reviews are included in the "General Discussion" section.

GENERAL DISCUSSION

The following is a summary of discussions regarding the working paper.

INTEGRATION WITH OTHER PROCESSES

Participants felt that the integration of this framework with other processes needed better description in the text. They stressed the importance that this document clearly shows how it aligns (or not) with other planning processes (government, First Nations, stakeholders, globally). How do goals two through six integrate? How do social considerations integrate with ecological, and is the scale the same? The chairs recommended that integration with other processes and the goals be better addressed in the context, but that the authors do not need to explain how all pieces fit together, just that they do fit together. The chairs stated that this does not need to be a large section, the authors should just expand on what is already there. One participant pointed out that there are many other documents developed by the planning team that the authors can reference in this section.

SCALE

In response to a reviewer comment regarding the scale of the analysis, the authors clarified that they identified and assessed species at a regional scale. They acknowledged that some species may be more or less important at a sub-regional scale, but they took a broad-scale approach. The reviewer stated that this is more of a consideration at the target phase in the next steps, rather than the species identification phase.

FRAMEWORK

In response to questions from the group regarding the difference in procedure for determining species-based CPs versus area based CPs, the authors acknowledged that the procedure was more complex for species-based CPs, but that there currently is not enough information to use the same approach for the area-based CPs. They pointed out that there is a concurrent process working to identify ecologically important areas right now. One reviewer recommended that the authors describe the process for determining area-based CPs better in the text, and that the figure they used for the presentation of this material would be helpful.

One reviewer wondered how much room there was for interpretation in the criteria. The authors stated that the criteria do leave room for special considerations, and that species may still be considered at a later stage if they don't make it on these preliminary lists, they just won't be used initially to drive site selection. Once scenarios have been developed, it is possible to assess for other species.

One participant pointed out that while the objectives are ecosystem-focused, most of the analysis and discussion are species-focused, and that some information may be lost by being too focused. The participant recommended that the authors state this upfront, and that there is not currently enough information to include ecosystem functions. The authors stated that this could be clearer and that they would revise and expand text regarding ecological roles. The chair recommended that they add some text to tie the species- and area-based CPs back to objectives which speak to ecosystem functions and communities.

One participant pointed out that MARXAN analysis had been mentioned a few times and asked whether this means that the CPs will be put through this analysis. The authors stated that the CPs will be used to drive site selection; each data layer will have targets set for it and these will go into MARXAN analysis. One participant pointed out that there are certain considerations

associated with MARXAN analysis. The authors stated that the framework was developed with MARXAN in mind, and that these considerations and features lists will come in the next steps.

SPECIES-BASED CONSERVATION PRIORITIES (CPS)

Vulnerability and conservation concern criteria

Participants expressed concern that the framework does not consider regional assessments, such as stock assessment data, to assess vulnerability, and that just because a species is vulnerable, does not mean the stock is in trouble. One participant pointed out that other meetings have put forward to include regional assessments to take a second-look consideration of the regional status of a species. The authors argued that global conservation status is important for how species are doing regionally but agreed to include stock assessment data. They clarified that they used a precautionary approach, where they took the higher vulnerability or conservation concern if the status differed regionally and internationally. The chair recommended that the authors add some text to clarify what was and was not included and why.

In response to a participant question about whether justifications can be given for species with no conservation concern scores, the authors said that they would consider combining the vulnerability and conservation concern criteria, given that several species had no conservation concern information.

One reviewer cautioned that the conservation concern criterion was biased and would be especially problematic if used as an essential criterion. The authors clarified that it was not used as an essential criterion but rather as an automatic pass, where if a species scored for conservation concern it was automatically screened through. If species did not score for conservation concern but scored high for other criteria they were screened though as well.

In response to a comment about overlap between criteria, the authors clarified that there is not full overlap between the conservation concern and vulnerability criteria, that more species scored for vulnerable than conservation concern, and that they included the vulnerability criterion to remove some of the bias that exists for the conservation concern criterion (heavily studied and/or socially important species have greater representation on conservation lists).

In response to a comment about the use of the Cheung (2005) method scores for vulnerability scoring, the authors stated that theses scores have been used in many processes to represent vulnerability and that they would include better text about how the scores were used.

One participant was unclear on why species that were already protected warranted high priority for choosing protected areas. The authors responded that whether a species is protected does not influence the decision to continue protection if it has an ecological role such that it warrants continued protection.

One participant noted that the framework should consider species that may depend on other species not marked as vulnerable. The authors responded that this may be more of a concern for birds, as fish are more generalist, but it is a valid concern.

One participant brought up the decline of sea urchins and sea stars and the scale of vulnerability. The authors pointed out that all species would be vulnerable to disease, but the main point is how quickly they recover once the stressor is removed. Sea urchins and sea stars should recover fast relative to longer-lived species such as glass sponges.

There was discussion about whether the vulnerability criterion would need to be adapted for birds, and the group decided that the criterion would be used as is with a column added for expert reviewer comments.

The chairs recommended that the document would benefit from a better definition of vulnerability in the context of this framework and how it differs from life history traits that may make different animals vulnerable.

Trophic level

There was much discussion regarding the definition and scoring of highly influential predators. The authors clarified that they used a mix of long-term studies and ecosystem studies and looked at how ecosystems recover after the removal of given predators. One participant wondered whether species were identified as predators before scoring for trophic level. The authors responded that, no, they developed the list and then scored for trophic level. One participant asked about small but mighty predators and how length was a good indicator of predator effectiveness. The authors responded that, as predators increase in size, they can eat larger and more prey and elicit stronger predator-prey reactions, so they tend to have a larger effect. This is well documented in the literature and this criterion was chosen intentionally. One participant pointed out that birds are highly influential predators, even though they do not meet the criteria for this. In a study that estimated removal of prey by birds within Canada's Exclusive Economic Zone (EEZ) birds were found to remove a significant amount.

There was also discussion about highly influential non-predators and how these might be included. One participant wondered how biomass is captured in terms of influence, for example, small-sized animals with high biomass (such as hake). The authors responded that hake was given a high score because of their high contribution. The authors also responded that ecosystem roles would become difficult to define if non-predators were included as highly influential species. They suggested that they could refine the definition to include only top predators, and that other highly influential species would be captured in other areas of the framework, such as under habitats. The group agreed with this suggestion and the consensus was to use the term "upper level predator".

One participant noted that the guidance for forage species was fish centric. The authors responded that the forage species definition was difficult because the literature was more focused on forage fish, and that they added shrimp to be more inclusive of invertebrates. In the literature, the concept of forage species was that they hold an important trophic role and may cause repercussions to multiple species and trophic levels. Consensus was that the authors would work with reviewers to adapt the guidance for forage species. One participant pointed out that mudflats and estuaries are key forage areas and the authors stated that these would be captured as area-based CPs.

The need to give clear guidance to experts for scoring and review was re-iterated.

Migratory or anadromous criterion

In response to comments and questions from the group the authors clarified that a positive score was given to species with documented evidence of nutrient import/export; anadromous species scored 2, and other migrators scored 1. There was concern about the focus on migratory or anadromous species, as some non-migrators import nutrients. The authors responded that they focused on migratory and anadromous species to constrain the analysis. Group consensus was that the authors would add more text to explain why they focused on the migratory and anadromous species and change the criterion name to nutrient transporting to better reflect the intent of the criterion.

Habitat forming species

Participants expressed concern that sub-surface species were not included in the scoring and suggested that this part of the criterion be removed. The authors responded that sub-surface species could be included in the future. After some discussion, the group decided to remove the sub-surface habitat-forming portion from the title, but keep it in the criterion description and to acknowledge that currently we may not have enough data to properly assess this criterion.

Candidate species list

In response to a reviewer comment about the candidate species list, the authors clarified that the candidate list was produced to narrow down the process. To produce the list, the authors reviewed Pacific North Coast Integrated Management Area (PNCIMA) and EBSA processes and included any species that were mentioned. They also included culturally important species to achieve a broader range of species. They then performed a literature review and added any missed species, trying to be as flexible as possible while constraining it to species with ecological importance. The reviewer recommended that the authors clarify this in the text.

Reviewers and participants expressed concern that the documents and lists used to produce the candidate species list were biased toward vertebrates and commercial species and may have missed species that should be considered. The authors acknowledged that the analysis was fish-heavy and pointed out that the objectives do tend to identify larger species and that some invertebrates were grouped so the invertebrate list appears shorter. In response to reviewer comment, the authors acknowledged that some species were non-native and said that they would be removed. One participant pointed out that much work went into the processes (PNCIMA etc.) that the candidate species list was built on. Another participant suggested the authors add species from the BC Conservation Data Center. The authors replied that this would not add many relevant species. Consensus from the group was that the original candidate species list would be reviewed by experts who would add any missing species and remove any inappropriate species before re-scoring. The authors clarified that missed species may be captured when looking at areas and that the candidate species list was meant to be a starting point and not exhaustive.

One participant expressed concern that because coastal species were not included in the list that estuarine stewardship species may be missed. The authors stated that they did include stewardship species and would add any species that may have been missed. Another participant suggested that there needs to be a specific process for the inclusion of non-DFO species. The chairs suggested that these go into the recommendations in the SAR, then the non-DFO people in the room should flag it for relevant people in their departments. The chairs also recommended that there be further clarification within the scope regarding the inclusion of marine versus coastal species.

In response to a reviewer recommendation to group species the authors responded that they had spent much time thinking of this but that it was difficult to break them into informative groups. They also re-iterated that just because a species had not been included did not mean that it would not be captured either at a later stage or within one of the included habitats.

Some participants suggested that it would be better to determine area-based CPs before species-based. There was some discussion about this, but the group consensus was that the current method was appropriate. The authors pointed out that in practice both lists inform each other.

One participant suggested that marsh plants be considered as habitats rather than species and the authors acknowledged that this may be better, or as a guild. There was discussion about

whether phytoplankton should be included on the candidate list. The authors pointed out that we likely do not have enough data to include individual phytoplankton species, but data on important areas for several phytoplankton species would be helpful. One participant thought that they should not be included on the list given that they are the base of the food chain and we cannot set a target to live with, for example, 10% of the phytoplankton. The authors stated that they included phytoplankton to acknowledge their important ecological role. Another participant pointed out that viruses should be included as well, given that they are also important. The group consensus was that experts would be asked to adjust species lists as needed.

Scoring

In response to reviewer comments regarding particular scores and pre-review of scores the authors acknowledged that they did have difficulty scoring some species and that they had wanted to include a pre-review of all scores but were limited by time. After much discussion, the group agreed that all scores would be reviewed by experts and that missing scores would be scored by experts. The group agreed that after expert review and scoring that the changes would be compiled and sent to the chairs, who would decide whether the changes warranted further review by the group.

The group agreed that guidance from a similar process, the national oil vulnerability framework (Thornborough et al. 2017 and Hannah et al. 2017), would be used for scoring invertebrates.

There were questions from the group as to why birds underwent a different assessment than other species. The authors stated that their intention was always to include birds completely but that they were time limited and birds are not under Fisheries and Oceans' mandate. However, they are part of the ecosystem, so the authors wanted to include them somehow. There was much discussion about whether the way they were currently included was acceptable, and the group decided that it was not. The group discussed removing the bird section altogether until it could be scored properly but eventually decided that experts would review and properly score the birds section for inclusion in this process. They decided that the criteria would not be adjusted but that an expert comments column would be added to the bird scoring table to include any special considerations.

The chair stressed the need to give guidance to experts for review and scoring.

Appropriateness of spatial management

There was much discussion about the fact that not all species would benefit from spatial management and how this should be reflected in the framework. Recommendations included adding a criterion to identify species that can be spatially managed, adding a final filter to identify whether species can be mapped, and/or adding a table to identify species that are currently under spatial management. The authors were open to these suggestions but pointed out that these species may benefit from other types of management and they would rather not limit the process at this stage.

One participant pointed out that there is a difference between what is used for design strategies and what may benefit from MPA protection. Species that have important habitat may be suitable for the design even if they are not suitable for spatial management. Another participant pointed out that large polygons are difficult in a spatial protection approach, and not to set targets on species that are difficult to map but to use them to check representation goals.

There was some discussion about the interpretation of Objective 1 from the TOR and whether the group needed to decide if the CPs were suitable for design strategies. If so, the group would need to decide on whether or how to include species that do not benefit from spatial

management. The authors clarified that the CPs were meant to inform design and not necessarily feed into design strategies. Also, that the design guidelines are another piece of work that will feed in and this is where other measures are considered when thinking about design. The design guidelines do already speak to this discussion. The group consensus was to leave these considerations for the next steps, where filters may be applied to remove CPs that do not benefit from spatial management. The chair recommended that this be explained in the scope and a future steps section of the document and included it as a recommendation in the SAR.

AREA-BASED CONSERVATION PRIORITIES (CPS)

Environmentally and biologically significant areas

One participant asked where the Northern Shelf Bioregion EBSA updating process (a concurrent process) currently stands. The authors responded that gaps are being filled using the proceedings from the Northern Shelf Bioregion EBSA meeting to guide the process. Also, other processes using existing empirical data to support expert input are being integrated. In most cases, the empirical data is highlighting smaller areas within the larger one. While this will not change any areas, it may highlight smaller areas.

Degraded areas

In response to reviewer comments about degraded areas the authors stated that they struggled with these as there was not much information in the literature about how to select them. They suggested that one way was to choose areas that have not been altered to the point that cannot revert back to the historic state or areas that have good potential for recovery once stressors have been removed. Consensus was that more discussion of degraded area parameters was needed.

There was discussion about what the ideal recovery state for degraded areas was and what "original" state they should be brought back to. Participants pointed out that there has already been environmental change, and there will be more moving forward, so it would likely not be possible to bring degraded areas back to a truly original state. The authors stated that there is no idealized state, that it is more about looking at a range for a given ecosystem and the point at which it becomes something new with further change. The authors stated that they would add more language about this in the document.

Refugia

One participant suggested that the authors include many habitats as marine refugia to ensure a robust array, as we are going to be facing much environmental change moving forward.

One participant stated that something missing from the refugia section was the identification of blue carbon sequestering areas which counter acidification. They suggested that this section have a reference to blue carbon and areas that are resilient to impacts, not just refugia and stated that this would align with the outcomes of a meeting that had happened in California at a conference on cold water habitats. The authors agreed that this was a good idea.

One participant pointed out that there are some species known to be immune or to thrive in acidification, and that it is not necessarily best to map acidified areas. They asked whether the authors looked at resilience to identify where organisms might thrive. Participants suggested that the authors look more at resilience than refugia and that the title for this section should change to something that reflects resilience, such as "Areas of climate resilience". The authors agreed and said that they would restructure the section to reflect this change.

Representative areas

In response to questions from meeting participants, the authors clarified that ecological units (Table 18) refer to units within existing classifications for the West coast. They also explained the different types of data that are being used to determine modelled or measured areas (Table 18) and that, at this point, models are still underway, so only the types of areas are included.

One participant pointed out that, as with species-based CPs, MARXAN analysis will prioritize area-based CPs. It will also work for areas with gradients (multiple features) and will feed into whatever classification is used. One participant expressed concern about using multiple classification systems, stating that the multiple categories would overlap in space and setting targets would be difficult. The participant suggested that the authors choose one classification system and use it to set targets, then use others to validate. Another participant stated that MARXAN can accommodate multiple classification systems with overlap; features can be prioritized at different levels and different targets can be set for each of the classifications within that system. This would highlight areas with increased diversity (areas where there are more classification systems overlapping). Participants agreed that these decisions were outside the scope of this document and would be decided in the next steps.

One participant suggested that the authors separate the areas of upwelling into shelf and slope, as these are used as different habitats for seabirds. The authors stated that they would also use smaller, coastal-scale upwelling and could further define this in the document. The participant pointed out that the more tangible features that can be mapped, the easier it will be to map other, less tangible things.

DISCUSSION

Participants pointed out that the discussion section was heavily weighted toward species-based CPs with little on area-based CPs. The chairs recommended that the authors increase discussion of area-based CPs. One participant suggested that perhaps this is where the ecosystem components could be captured. For example, "When combined, the species and area-based targets would capture the important components of the ecosystem."

One participant expressed concern that the focus was on species rather than biodiversity, and that ecosystem management was not a component of the framework. The authors responded that the species drive data collection, and representative habitats and ecological interactions will be taken into consideration when developing the network.

The chairs requested recognition from the group that not all the area-based or species-based CPs would be used for network design; it would depend on review of spatial information and spatial protection measures for each species etc. There was no objection from the group.

The chairs asked whether the discussion in the text was sufficient to recognize what types of data we are looking for (e.g. static, moving, etc.), and whether anything else needed to be added. There were no suggestions or objections from the group.

PRIORITIZATION

There was much discussion about prioritization of the CPs. Several participants felt that CPs should be prioritized, but all agreed that using additive scores would not be appropriate for prioritization. The authors responded that the intention was to first come up with a comprehensive list of CPs without any other considerations, then decide on prioritization in the next steps. One participant pointed out that MARXAN analysis would prioritize, so it is not necessary at this stage. Another argued that setting targets for 128 species in MARXAN would

be difficult. One participant suggested that target setting could be simplified by grouping species by type and setting targets for each species type.

A reviewer suggested that Euclidean distance analysis could be used to highlight important groups, and participants decided that the authors would perform this analysis overnight for review by the group the following day. Euclidean distance analysis showed a group of species that are important for their ecological roles, a group that are important for vulnerability, and a group that are important for both. The importance of double counted species (vulnerable and conservation concern) was reduced and the importance of species with more ecological roles was increased. A reviewer clarified that this does not necessarily rank species, but provides a way to separate them and tease out ecological roles, setting the stage for decisions with respect to targets, and that a Venn diagram would be a useful visual representation.

The final consensus was not to include prioritization but to include a Venn diagram to identify criteria that are driving inclusion into the process, with the figure mapping Euclidean distance scores onto the axes with colour-coding for major groups, and some text indicating that these scores are not rankings, but allow different roles to be teased out.

INCORPORATION OF TRADITIONAL ECOLOGICAL KNOWLEDGE (TEK)

One participant asked the authors if they had thought about how to use TEK to inform priorities specific to this component to make sure that it is relevant to all people using the information. The authors responded that they had incorporated some TEK reports. Also, as part of the reassessment of the EBSA work, they were developing a framework for how to incorporate TEK, which would go out to First Nations for review. One participant pointed out that TEK is also held by commercial fishermen and that this knowledge needs to be considered. The chair asked whether the terminology "traditional, local, and community knowledge" would be appropriate, and participants agreed. Consensus was that text would be added to the spatial data section regarding this discussion. There was some discussion about stakeholder engagement strategy and consensus was that this would be decided in the next steps.

REVIEW AND ACCEPTANCE OF TOR OBJECTIVES AND ACCEPTANCE OF PAPER

The chair read the objectives from the TOR and the group agreed that each objective had been met. The chair then gave an overview of the requested revisions and asked the group whether they accepted the paper with the recommended changes. The group accepted the paper with revisions.

CONCLUSIONS AND ADVICE

The document was accepted with revisions. Conclusions and advice from the meeting included:

- This framework is a scientifically defensible, transparent, and repeatable method to identify ecological CPs that meets the network objectives for the NSB. This evaluation framework can be used to assess additional species and can be adapted to other planning areas. The list of ecological CPs is expected to drive data collection for future steps in the NSB MPA network planning process.

- Two types of ecological CPs were identified: species-based and area-based. Species-based CPs are identified based on the characteristics of individual species or higher-level taxa, selecting those that are ecologically important, vulnerable, or of conservation concern. Area-based CPs include areas, spatial features, or habitats that directly support the network objectives under Goal 1 of the Canada-BC MPA Network Strategy.

- Species that were identified as of conservation concern and/or received high scores for either vulnerability or ecological significance were recommended as ecological CPs. The list of species includes 65 fishes and elasmobranchs, 23 marine mammals (including four Orca ecotypes), one sea turtle, 48 invertebrates, five plants and algae, and 55 marine bird species to be considered as ecological CPs for the NSB.

- Areas and habitats including areas of climate resilience, degraded areas, representative habitats, and EBSAs were recommended as ecological CPs. Seventeen types of area-based ecological CPs were recommended.

- The types of spatial features and information that should be collected in order to adequately represent species-based ecological CPs in the MPA network were recommended, including Important Areas, observed or modelled distributions and relative abundance, and areas of high or distinct genetic diversity.

- A review of ecological CPs is recommended for future work prior to the design strategies phase to determine which ecological CPs are amenable to spatial protection measures within the NSB.

- It was not possible to evaluate all criteria for all candidate species, in some cases due to a paucity of information or data. In particular, there was a lack of vulnerability data for invertebrate species in available literature and the selected criterion was not applicable to birds. Further review by subject matter experts was used to augment the available data from literature. The inclusion of expert evaluation of scoring outputs is an important step to ensure scores are both accurate and appropriate.

- It is recommended that the scores for ecological CPs NOT be used for ranking. Scores are additive and will be higher for species that have more data and meet multiple criteria. Comparing species' additive scores across criteria is inappropriate because some of the criteria are correlated.

- Development of accessible and comprehensive spatial databases is recommended as a next step to continue fostering collaboration among DFO programs, other agencies and organizations including governments, First Nations, and stakeholders engaged in marine spatial planning to avoid duplication of efforts and ensure efficiencies.

- It is recommended that future iterations or applications of this framework:

  o incorporate expert input at an early stage to develop criteria that apply generally across groups, classes, or phyla (e.g., invertebrates, fishes, marine birds, marine mammals) and provide expert pre-review of criteria evaluations to ensure applicability to all species and taxa;

  o define criteria to be applicable to all candidate species;

  o consider the context of the objectives in each MPA network area for the development of appropriate criteria; and,

  o develop or improve criteria assessment tools and metrics as new information becomes relevant.

ACKNOWLEDGEMENTS

Miriam O and Russ Jones as Chairs of the meeting and Candice St. Germain as the Rapporteur.

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Thornborough, K., Hannah, L., St. Germain, C., and O, M. 2017. A framework to assess vulnerability of biological components to ship-source oil spills in the marine environment. DFO Can. Sci. Advis. Sec. Res. Doc. 2017/038. vi + 24 p.

APPENDIX A: TERMS OF REFERENCE

FRAMEWORK FOR IDENTIFYING ECOLOGICAL CONSERVATION PRIORITIES FOR MARINE PROTECTED AREA (MPA) NETWORK DESIGN IN THE NORTHERN SHELF BIOREGION

Regional Peer Review Process – Pacific Region

November 22-24, 2016
Vancouver, BC

Chairpersons: Miriam O and Russ Jones

Context

As a signatory to the Convention on Biological Diversity agreement to "improve the status of biodiversity by safeguarding ecosystems, species, and genetic diversity", Canada has committed to conserving "at least …. 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services…through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures…" (DFO 2016) (Aichi Target 11 [COP/10/INF/12/Rev.1]). Through Canada's Oceans Act and Canada's Oceans Strategy, federal departments are directed to engage in multi-agency collaboration and coordination to identify areas of interest for marine protected areas (MPAs). Through its 2004 memorandum of understanding with the Province of British Columbia regarding implementation of Canada's Oceans Strategy, provincial and federal governments agreed to collaborate on understanding and protecting the marine environment on the Pacific Coast. The federal government also signed the 2008 *Memorandum of Understanding on Pacific North Coast Integrated Management Plan (PNCIMA) Collaborative Oceans Governance* and the 2012 *Letter of Intent to Collaborate on Marine Planning and other Fisheries Related Issues in the Pacific North Coast* with Coastal First Nations and the North Coast Skeena First Nations Stewardship Society. Additionally, the Province of BC and First Nations in British Columbia (BC) have developed Marine Use Plans for areas within the Northern Shelf Bioregion to be considered for candidate protected areas. Building on these commitments, Canada, the Province of BC, and First Nations have formed the Marine Protected Area Technical Team (MPATT) to collaborate on the development and implementation of a network of MPAs in the Northern Shelf Bioregion (NSB).

The development of Canada's MPA network is guided by the 2011 National Framework for Canada's Network of MPAs (Government of Canada 2011). The [2014 Canada – British Columbia Marine Protected Area Network Strategy](#) ("the Strategy") provides the primary guidance for the design, development, and implementation of MPA networks in Pacific Region. The Strategy outlines six ecological conservation, social, cultural, and economic goals to be achieved by the development of a network of MPAs. Goal 1 of the strategy was identified as primary importance and specifies the protection and maintenance of marine biodiversity, ecological representation and special natural features. Goal 2 of the strategy contributes to the conservation and protection of fishery resources and their habitats. The remaining four goals relate to protection and promotion of recreational, social, economic, cultural, and educational resources and opportunities and will form the basis of identification of cultural, social and economic conservation priorities through other processes. The strategy also outlines ecological network design principles to ensure that the full range of biodiversity is included; that ecologically and biologically significant areas are incorporated; that ecological linkages are considered in MPA siting; that the configuration (size, shape, and spacing) of individual MPAs

maximizes their contributions to the network, and that the benefits of the MPA network are protected over the long term.

The MPA network planning process requires the development of effective governance and stakeholder engagement, and a set of network objectives that align with the goals and principles outlined in the Strategy. The key steps to move from network objectives to implementation of an effective MPA network in the NSB are iterative and include: 1) identification of ecological conservation priorities; 2) development of design strategies, including targets; 3) gathering and analysing data; 4) designing, assessing and implementing the network; and 5) monitoring and adapting the network to ensure that goals and objectives are being met effectively. The ecological aspects of Step 1 will be the focus of this review.

Ecological conservation priorities are identified as part of systematic conservation planning processes, such as MPA network design, to focus analyses on the most important attributes within a planning area, and to serve as the basis for monitoring and managing MPA network effectiveness. This review will focus on ecological conservation priorities, which could be any subset of species, habitats, communities, and/or other features identified as important to conserve with the MPA network. Coupled with design strategies, the full set of conservation priorities will be used to develop one or more network scenarios for further consideration. As such, the selection of conservation priorities has the potential to strongly influence the outcome of analyses, planning scenarios, spatial configuration, and management of MPAs within the network. As noted, other processes will review conservation priorities for the purpose of achieving cultural, social and economic goals as identified in the Strategy.

Fisheries and Oceans Canada (DFO) Science has provided general guidance regarding the design of MPA networks (DFO 2010), considerations for how to achieve representativity in the design of MPA networks, guidance on formulation of ecological conservation objectives for individual MPAs (DFO 2008, 2013) and conservation priorities for large ocean management areas (DFO 2007, 2012, 2014, Murray et al. 2016). However, ecological conservation priorities for MPA network design have not yet been developed for MPA network design in Pacific Region. Guidance on conservation priority identification is available from literature based on MPA network design processes from within BC and other jurisdictions (e.g., Burt et al., 2014; Airamé et al. 2003; California Department of Fish and Game 2008, Howson et al. 2012).

DFO Oceans Management Branch requested that Science Branch develop a framework and criteria for identifying ecological conservation priorities, and apply the framework to identify ecological conservation priorities in Northern Shelf Bioregion (NSB). The assessment and advice arising from this Canadian Science Advisory Secretariat Regional Peer Review will be used to inform MPATT's development of a network of MPAs in the NSB and the framework may be appropriate for developing lists of conservation priorities in support of other MPA network planning processes within Canada.

Objectives

Participants will review the following working paper, and will use the information from the working paper to provide advice on the specific objectives outlined below:

Gale, K., Robb, C., McCarthy, J., Lee, L., Frid, A., Steele, J., Curtis, J.M.R., Rubidge, E. 2016. A framework for identification of ecological conservation priorities for marine protected area (MPA) network design in the Northern Shelf Bioregion. CSAS Working Paper 2015OCN05a.

The specific objectives of this review are to:

1. Review the evaluation criteria for identifying ecological conservation priorities for MPA network design with respect to network goals, principles and objectives.

2. Evaluate the application of these criteria to ecological attributes (e.g. species, habitats, communities, areas, natural features) to produce a list of conservation priorities for the NSB.

3. Identify the types of spatial information needed to represent conservation priorities in subsequent systematic site selection analyses to achieve MPA network goals and objectives.

4. Discuss uncertainties, gaps, research needs, or limitations for further consideration when identifying conservation priorities for MPA network design in NSB or other bioregions within Canada.

Expected Publications

- Science Advisory Report

- Proceedings

- Research Document

Expected Participation

- Canada-British Columbia-First Nations Marine Protected Area Technical Team (MPATT)

- Fisheries and Oceans Canada (Ecosystems and Oceans Science, Ecosystems and Fisheries Management, Science)

- Parks Canada Agency

- Environment and Climate Change Canada

- Transport Canada

- Natural Resources Canada

- Province of British Columbia

- First Nations

- Academia

- Industry representatives

- Environmental non-government organizations

References

Airamé, S., Dugan, J.E., Lafferty, K.D., Leslie, H., McArdle, D.A., and Warner, R.R. 2003. Applying ecological criteria to marine reserve design: A case study from the California Channel Islands. Ecological Applications.13(1) Supplement: S170–S184.

Burt, J.M., Akins, P., Lathem, E. Beck, M., Salomon, A.K., Ban, N.C. 2014. Marine protected area network design features that support resilient human-ocean systems - Applications for British Columbia, Canada. Simon Fraser University. British Columbia, Canada. 159 pp.

California Department of Fish and Game. 2008. Master Plan for Marine Protected Areas, Revised Draft.

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DFO. 2007. [Guidance Document on Identifying Conservation Priorities and Phrasing Conservation Objectives for Large Ocean Management Areas](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/010.

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DFO. 2010. [Science Guidance on the Development of Networks of Marine Protected Areas (MPAs)](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/061.

DFO. 2012. [Risk-based Assessment Framework to Identify Priorities for Ecosystem-based Oceans Management in the Pacific Region](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/044.

DFO. 2013. [Guidance on the Formulation of Conservation Objectives and Identification of Indicators, Monitoring Protocols and Strategies for Bioregional Marine Protected Area Networks](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2012/081.

DFO. 2014. [Pilot application of an ecological risk assessment framework to inform ecosystem-based management in the Pacific North Coast Integrated Management Area](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2014/026.

DFO. 2016. [Guidance on Identifying "Other Effective Area-Based Conservation Measures" in Canadian Coastal and Marine Waters](). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2016/002.

Government of Canada. 2011. [National Framework for Canada's Network of Marine Protected Areas](). Fisheries and Oceans Canada, Ottawa. 31 pp.

Howson, C. M., Steel. L., Carruthers, M. & Gillham, K. 2012. Identification of Priority Marine Features in Scottish territorial waters. *Scottish Natural Heritage Commissioned Report No. 388*.

Murray, C.C., Mach, M.E., and O, M. 2016. [Pilot ecosystem risk assessment to assess cumulative risk to species in the Pacific North Coast Integrated Management Area (PNCIMA)](). DFO Can. Sci. Advis. Sec. Res. Doc. 2016/049. vii + 59 p.

APPENDIX B: WORKING PAPER ABSTRACT

Conservation priorities (CPs) have been identified as part of systematic conservation planning processes, including Marine Protected Area (MPA) network design, to focus analyses on the most important features (species, habitats, and areas) within a planning area. In this paper, we develop and apply a framework to identify species- and area-based ecological CPs to inform the development of the MPA network in the Northern Shelf Bioregion (NSB) of British Columbia. We focus exclusively on Goal 1 of the Canada – BC Marine Protected Network Strategy (2014): "to protect and maintain marine biodiversity, ecological representation and special natural features". Species-based CPs were identified based on the characteristics of individual species or higher-level taxa, selecting those that are ecologically important, vulnerable, or of conservation concern. Area-based CPs include areas, spatial features, or habitats that directly support the network objectives under Goal 1. Criteria for identifying ecological CPs were developed based on global best practices and were nested under the network objectives associated with Goal 1, then applied to areas and a candidate list of species found in the NSB. Criteria were applied and evaluated using information from the literature then vetted and augmented by expert opinion. Species that were identified as of conservation concern and those that received high scores for either vulnerability or ecological significance were recommended as ecological CPs. The list of 195 species to be considered as ecological CPs for the NSB includes 65 bony fishes and elasmobranchs, 23 marine mammals (including four Orca ecotypes), one sea turtle, 46 invertebrates, five plants and algae, and 55 marine birds. A total of 17 area-based ecological CPs were recommended, including areas and habitats including areas of climate resilience, degraded areas, representative habitats, and features associated with Ecologically and Biologically Significant Areas (EBSAs; e.g., areas of high productivity or diversity). Several types of spatial features were recommended, including Important Areas, to represent species-based CPs in site selection analyses for the MPA network. Ecological CPs identified from this framework will inform subsequent MPA planning steps, including the development of design strategies and design scenarios.

APPENDIX C: AGENDA

Regional Peer Review Meeting (RPR)

Evaluation of a framework for identification of ecological conservation priorities for marine protected area (MPA) network design and its application in the Northern Shelf Bioregion

November 22-24, 2016

Vancouver, British Columbia

Chairs: Russ Jones and Miriam O

Morris J Wosk Centre for Dialogue, 580 W Hastings St, Vancouver, BC V6B 1L6

DAY 1 - Tuesday, November 22

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping CSAS Overview and Procedures	Chairs
1000	Review Terms of Reference	Chairs
1015	Presentation of Context: Network Planning Process • *MPATT* • *Goals and objectives* • *Conservation priorities & design strategies* • *Scope of working paper* • *How will this advice be used in the process?* • *Where else do people get involved in MPA network planning?*	Oceans Manager: Hilary Ibey
1030	*Break*	
1045	Presentation of Working Paper: Overview • *Questions of clarification*	Author: Katie Gale
1130	Reviewer comments: overview	Reviewers & Authors
1200	*Lunch Break (not provided)*	
1330	Identification of key issues	RPR Participants
1400	Presentation of Working Paper: Part 1 Species-based Conservation Priorities • *Questions of clarification*	Author: Katie Gale
1430	*Break*	
1445	Reviewer comments: Species-based Conservation Priorities	Reviewers & Authors
1500	Identification of key issues related to Speciesbased Conservation Priorities	RPR Participants

Time	Subject	Presenter
1530	Discussion on Species-based Conservation Priorities: *Evaluation criteria*	RPR Participants
1615	Check in on progress and confirmation of topics for discussion on Day 2	Chairs
1630	***End of Day 1***	

DAY 2 - Wednesday, November 23

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping Re-cap of Day 1	Chairs
0930	Discussion on Species-based Conservation Priorities: *Scoring methods*	RPR Participants
1030	***Break***	
1045	Discussion on Species-based Conservation Priorities: *Review of results and recommended spatial features*	RPR Participants
1200	***Lunch Break (not provided)***	
1330	*Presentation* of Working Paper: Part 2 Area-based Conservation Priorities • *Questions of clarification*	Author: Emily Rubidge
1345	Reviewer comments: Area-based Conservation Priorities	Reviewers & Authors
1400	Discussion and Identification of key issues	RPR Participants
1445	***Break***	
1500	Discussion and Identification of key issues (cont'd)	RPR Participants
1530	Check in on progress and confirmation of topics for discussion on Day 3	Chairs
1600	***End of Day 2***	

DAY 3 - Thursday, November 24

Time	Subject	Presenter
0900	Introductions Review Agenda & Housekeeping Re-cap of Days 1 and 2	Chairs
0930	Continue outstanding discussion from Day 2 (if needed)	Chairs
1000	Review Terms of Reference • *Have all objectives been addressed?* • *Is working paper accepted?*	Chairs +RPR Participants
1030	*Break*	
1045	*Science Advisory Report (SAR)* Develop consensus on the following for inclusion: • *Sources of Uncertainty* • *Results & Conclusions* • *Additional advice to Management (as warranted)*	Chairs +RPR Participants
1200	*Lunch Break (not provided)*	
1330	*Science Advisory Report (SAR)* (cont'd)	RPR Participants
1430	*Break*	
1445	*Science Advisory Report (SAR)* (cont'd)	RPR Participants
1545	Next Steps – Chairs to review • *SAR review/approval process and timelines* • *Research Document & Proceedings timelines* • *Other follow-up or commitments (as necessary)*	Chairs
1600	***Adjourn Meeting***	

APPENDIX D: WORKING PAPER REVIEWS

REVIEWER: LUCIE HANNAH, FISHERIES AND OCEANS CANADA

General overview review

Thank you for the opportunity to review this paper, the authors have done a great job with this document. I think overall the approach is sound; the paper is thorough, clear and well written and is well supported with citations and justifications.

I focused on reviewing the species criteria / scoring section of the paper (Species based Conservation Priorities), due to my experience in this area and previous work on similar criteria-based frameworks.

Based on the planned agenda, I have divided my comments into a broad overview, followed by more specific points on the species based CP section

Overview

- The authors clearly state the background and purpose. The clarity of the paper would be improved with the inclusion of a summary of how all the components in the paper fit together and feed into each other. This could be achieved through inclusion of a framework diagram/ figure.

- The paper would also be improved with a more fleshed out scope section to lay out exactly what this paper does and does not address. Should include more about what only considering the ecological objectives means (and state clearly that socio-economic/fishery aspects are not included). Should also be clearly stated why this new process is needed, and how it differs / fits in with the PNCIMA/ESS process (as these areas and objectives do appear overlap).

- Overall, the methods and descriptive text used to identify and score species CPs was clear and well justified with citations. However I found it to be overly focused on fishes/birds – needs more guidance to interpret the scoring criteria for other biological groups in the assessment, in particular marine invertebrates and plants.

- I found the method and descriptive text for how the initial candidate species list was selected to be less clear. Are there any potential implications of using this approach to assemble the initial species list, such as bias, or potential missing species? I noticed that several non-native species ended up on the candidate list (e.g. ascidians – all of the species of ascidians assessed were non-native). Also there was a reduction in the number of candidate species from the initial 316 to 217 and it was not clearly explained how this was done. More transparency on this section would be helpful, particularly where species have been removed for reasons other than the use of the criteria.

- The framework uses conservation status as an important factor in screening in a few places (screening of initial species lists, and appears to be used as an 'essential' criterion for selection). Emphasizing this one criterion could have drawbacks: (i) some are global indices and not from the area of interest (e.g. IUCN) – was that considered?; (ii) different indices may use different measures to assess the conservation concern that are not comparable (not always population decline, could be rarity); (iii) Certain groups are under-represented or not assessed by these indices. The results show many species received no score for this criterion due to have not been assessed, problematic if this is used as an 'essential' criterion for screening. Other approaches for assessing population decline could be considered (e.g.

stock assessment, literature review) to capture examples such as the recent declines in sea star populations.

- Analysis of gaps could be more distinct in the document, in particular where scoring was hindered by lack of knowledge.

- More description and justification of the testing of the different screening/ranking methods and to support the method selected.

- Though the authors did not present a list of ranked species, this should be considered for inclusion to help evaluate the conclusions.

- Are the selected species planned to be considered as 'umbrella' species for those not selected or assessed? If so this is important to discuss in the document, and whether the range of species selected is broad enough to act in this role (perhaps with examples to compare screened out species and how they may be captured under other species that were included)

- The scores would benefit from receiving expert review to provide validation and support for the outputs.

- Overall I can see that a great deal of thought and effort has gone into developing this framework

More detailed comments on the selection of species based CPs

Method for assembling the initial list of species to be assessed

- As an ecological approach, this approach should try to consider all species in some way at the onset, clearly this is a challenge as identified in the paper due to the large numbers of species. The way that the candidate species were selected to put into this assessment at is important.

- As I understand it, the approach taken to assemble the list of 316 candidate species was to collate all species listed in three documents based on work done for PNCIMA, a list of culturally significant species and species obtained by searching in the BCCDC database for species and selecting only those with a conservation status. The authors should consider the potential implications of applying criteria to a list of species that is made up of those that (I assume) have been already been assessed by other criteria in the PNCIMA process. Were there factors/criteria/screening used in the PNCIMA papers to select these species, and would these introduce any bias/ other issues, and how do they compare to the criteria in this paper (I assume there was some screening in these documents otherwise there would be many more species). Table 2 does a great job of illustrating the different criteria used in some of the conservation planning processes does it include the criteria used in these 3 PNCIMA documents? The concern is that some species may have been missed in particular marine invertebrates. The authors could include some text on the PNCIMA species selection method/criteria and outlining any limitations/concerns.

- I noticed the inclusion of a number of non-native/invasive species in the species candidate list that was assessed, how do these fit into this process? I wonder how they ended up in there (as they are not listed in conservation indices and unlikely to be in the PNCIMA process), of particular note – all of the ascidian species listed are non-native species.

- The authors should clarify why a list of culturally significant species was included, though it is important that these are included in the process at some stage, the scope clearly states

that it looks at ecology not cultural factors for this specific work. The other species entering the assessment have been pre-screened in some way already.

- The document also has another reference to screening "*A pre-screening assessment at the group and species levels excluded groups or species that did not require in-depth reviews, based on the traits of the species, the authors' knowledge of the species' biology and ecology, and an early pilot analysis of ecologically significant species*". Is this the screening that reduced the candidate list from 316-217? I think the authors need to clearly state at which stage this occurred and what this entailed to make this transparent. Did this remove species, or just mean that this pre-screening allowed them to assign scores without needing extensive justifications, rather than removal of species?

- The authors could consider a more consistent approach to structuring these species/groups, particularly if they are considering these as umbrella species. Perhaps future work could group them by similar ecological traits? For the Annelid worm example, the initial species list contains one species, another approach could be to instead select at least one Annelid species representing different ecological types, such as infaunal Annelids, tube dwelling Annelids, and errant Annelids. This may make it easier to incorporate how other species of those types could be captured under those representative 'umbrella' species based on similar ecological traits.

Background text and scoring guidance should be appropriate for all marine biota assessed

- The methods used and the descriptive text seem to be overly focused on marine fishes (perhaps due to the greater amount of knowledge/research on marine fishes) and would benefit from being expanded to increase the representation of all marine biota being assessed. The marine invertebrates and plants need more attention and more text describing how they were incorporated and scored. For example, the interpretation of forage species worked for some marine invertebrates but not for others which would seem to fulfil this criterion, for example mussels are important forage species for other species such as stars, worms for fish.

- More guidance is needed for how to score some criteria where it is not clear if all requirements must be met to score, or just one.

Criteria

- Some criteria are likely to be biased towards some groups (e.g. migratory / anadromous favours mobile species) – any potential influence on the final species list? How do they balance out?

Vulnerability to disturbance and/or slow to recovery

- Table 4 includes a mix of factors, might be helpful to separate out the recovery factors (e.g. fecundity) from the vulnerability to disturbance factors (e.g. aggregation, range)

- Guidance and table seems focused on fishes mainly - It is not clear how this table is used for other biota?

- For those not listed on SeaLifeBase/Fish Base– did these species receive no score?

Highly influential predator

- Need more guidance on how 'judgement' is used for biota other than fishes. The table should be broken down for each biological group with guidance for each and some examples in the text.

Key forage species

- Need to include guidance text on how this works for other biota, with examples. For example mussels can be key forage species for sea stars.

Migratory/anadromous

- What about other non-migratory nutrient importers such as bioturbators?

- Scoring – how do you determine if a species is transporting limiting nutrients or not (difference between scoring 1 and 2)? Presumably they are feeding and emitting waste all the time?

Species is declining / under threat of decline regionally, nationally or globally

- This is an important criterion as if I understand correctly it is an 'essential' criterion that must be met for a species to be included.

- Table 10 is an excellent summary of the conservation indices and how they compare; did a species have to be listed in just one index to be scored in?

- This framework uses conservation status as an important factor in several places (screening of initial species lists, as an 'essential' criterion for selection. This can have drawbacks: (i) some are global indices and not from the area of interest (e.g. IUCN) – was that considered?; (ii) different indices may use different measures to assess the conservation concern that are not comparable; (iii) Certain groups are under-represented or not assessed by these indices, are these removed or retained as a precaution? I think some more text on this would be useful.

- If the conservation criterion is 'essential' and must be met for a species to be retained, this may be problematic for the inclusion of species that have not been assessed by the conservation indices listed. If used this way, need to acknowledge that some biological groups are under represented in these indices and are mostly unassessed. There are alternatives for including unassessed species that may be in decline/reduced - through literature review/stock assessment/expert knowledge. For example, one stock of herring in the region may be in decline (based on a stock assessment report), but stable over the whole region so not listed in conservation indices. Another example might be the recent decline in the sea star population. This might be a way to reduce the number of 'insufficient information' scores (*). Did you try assessing the species without this being an essential criterion?

- Are species that are greatly reduced from historic included (but may be stable now at lower population levels)?

Rarity and range restriction

- This was not included as a criterion, with good supporting text for why rarity was excluded, range was one of the factors captured in the scoring guidance table for criterion 'vulnerability to disturbance/slow to recover' and endemism gets at a similar aspect. It seems like these would be captured under that criterion?

Results

- The comparison of different screening and ranking options in Table 12 is very helpful, but I think it needs a bit more explanation, and reasoning for the method selected. An approach for making the selection/screening method clearer could be to run through the process using an example species/group of species

- The number of species retained is out of 217, I am unclear where the 316 species at the start were reduced to 217? Was this through the pre- screening that went on at the start? Was this done by only selecting those with conservation concern?

- Seem like relatively few marine invertebrates and plants in the final list; presume it is made up of a lot of species that might be there mainly due to the conservation listing? Would expect to see echinoderms on the list. There were two criteria at least where a lot of marine invertebrates likely received no score due to not being included or not assessed.

- Very large number of 'insufficient information' (*) scores for conservation concern – if these species receive no score based only on those indices, this biases the assessment towards assessed species. This should be addressed – could use other ways to measure population decline, assign precautionary scores, or not make this criterion essential.

- Some of the groups in the final list (e.g. marsh plants) contain many species within the group – how is that going to be dealt with?

- Are there any further steps after the creation of the species list? Further screening of the list for the subsequent data part of this work?

Discussion

- Table 19 – if this table was divided up by biological group the reader would get a clearer picture of how the scores fall out between the different groups and for a better idea of gaps

REVIEWER: REBECCA G. MARTONE, CENTER FOR OCEAN SOLUTIONS, STANFORD UNIVERSITY

Thank you for the opportunity to review this document. I have restricted my comments to some overall observations and then some detailed thoughts about the proposed methodology. I did not comment on the scores or species descriptions in Appendix 3, as I am not an expert in conservation concern or biology of all species of interest. However, there may be value in carefully examining the scores themselves, as these are at the heart of the selection of Conservation Priorities (CPs). I expect that interaction with species and habitat experts will help to highlight any concerns about the selection of CPs.

I will evaluate the paper based on whether it has met its stated purpose and scope, the application of the approach, and how the selection of CPs can be further refined for use in the MPA network planning process. I have structured my review with a summary of general observations, and then give thoughts section-by-section.

General Observations

- The authors provide a transparent, repeatable approach based on ecological expertise and the scientific literature for selecting ecological CPs.

- Species-based scoring is fine for overall inclusion in the list, but there is a lack of guidance on how to prioritize the list you provided. This will be key for moving forward with setting design strategies and targets. Additive scores are not necessarily appropriate, given the correlation among criteria and bias toward data-rich, large-bodied mobile predators. One way forward is to reconsider which criteria get included in the overall additive score and use those to rank the species importance. For example, you could drop the mobility criterion and modify the "predator" criterion to consider other important foraging roles (e.g., detritivores/herbivores). Another option is to only emphasize Conservation Concern scores and Choose the most important ecological role, and apply a Euclidean Distance approach to

allow for visual representation of species scores. This would greatly reduce variability among the species however and you would lose some information. You could also consider additional screening criteria, including the influence of a species in a given habitat/ecosystem, umbrella species; whether they have known foraging/spawning areas in BC waters, etc.

- Species based scoring is much more in depth than habitat or area-based approaches. Is there a reason you didn't score area-based features?

- Given the next phase of the process, it would be helpful to link species based CPs to area-based CPs. You start to do this in Table 15 but I think this could go a bit further.

- Overall, it is difficult to disentangle what identification and prioritization should be done in the selection of CPs phase and what can be done in the Design strategies phase. There seem to be some blurred lines. It would be good to clarify this.

Section 1. Introduction

- The authors do a good job stating the purpose and scope of the document and defining CPs - features to be protected or prioritized during identification of potential sites contributing to the MPA network

- The document is focusing on Goal 1 and its associated Objectives. However, there are aspects of Goal 2 that could be (and are somewhat) addressed in this document. See my specific comments later in the review.

Section 1.1.1 Conservation Priorities and Design Strategies

- The authors state that "To maximize the benefits of MPAs, need to identify CPs to focus spatial planning towards areas of high conservation value." I believe this is the aim of the approach taken here to identify ecological CPs and should be the touchstone of the process.

- The objectives under each goal are an important consideration when thinking about how to prioritize CPs.

- I have provided some comments in Table 1 related to each Objective and am tryig :

- Objective 1.1: Suggests that climate change and other threats need to be considered at some part of the phase.

- While many of the issues like size, spacing and replication will be addressed in the Design Strategies phase of the MPA planning process, there may be additional prioritization of CPs during this phase that could help inform the Design Strategies phase.

Section 1.2.

- The authors state that CPs are at the scale of the NSB and that subregional priorities are not identified here. However, MPAs may be applied at the subregional scale. Thus, how will the subregional priorities be identified and how will they be integrated into this process?

Section 2. Framework

- Good to have transparent, systematic, repeatable process founded in ecological principles.

- Excellent review of the literature and processes around the world.

- Good to link broad criteria to the objectives (Table 2) but also the species-based and area-based CPs.

- In the processes listed in Table 2, the authors note that some processes used expert judgment and others data to select CPs; Might be helpful to add a row to identify which processes used expert judgment, which data and which a combination? Possibly not relevant but might be good for future use or for going back to these processes for additional guidance.

Section 3. Identification of Conservation Priorities.

- It doesn't seem that the section header matches what you are describing. Perhaps something like, "Linking Objectives to CP Identification".

- You need to better describe how you refined the broad identification criteria. Was this based on the previous processes? Did you have a particular process you pulled from? Describe your approach.

- Also, you state that Objective 1.1 and 1.7 contain broad suite of concepts and that Objective 1.1 will be achieved when Objectives 1.2-1.7 are fulfilled. However, you then go on to score whether Objective 1.1 is met using a vulnerability criterion.

- Objective 1.5 isn't mentioned here. Is there a reason or was it oversight?

- Similarly, you mention that to meet Objective 1.7, Important Areas can be used to spatially represent the species identified under the other objectives. But under the other objectives in Table 15 you describe the need to collect data at the scale of the entire distribution of the species within the NSB. It is a little bit contradictory. You might want to clarify here.

Section 4. Species-Based Conservation Priorities

- Citations for each criterion would be helpful in Table 3.

- Criterion 1.1: What about Umbrella Species (species whose protection will result in the protection of other species) (Roff and Taylor 2000)?

- Criterion 1.1.S1. I know this is the "Species" section but there is also the concept of protecting biodiversity through community or landscape properties. This implies the important thing to consider is the interaction among species and habitats, with trophic organization and overall diversity of components as the objective to be attained. Do you have suggestions for how to achieve this or is this what you meant by "Objective 1.1" will be met if all of the other Objectives are met?

- Criterion 1.2.S.1 how is "highly influential" defined? Sometimes you say "top predator" but this is a specific role in the food web and isn't the same as a mid-level predator that might be "highly influential". For example, rockfishes (Sebastes sp.) might be highly influential predators in rocky reef ecosystems but aren't necessarily "top predators" as they may be eaten by marine mammals or other fishes like Lingcod. Also, shouldn't this include other influential foraging strategies. For example, although Katherina tunicata and Strongylocentrotus sp. are not "predators" they are highly influential herbivores that may influence community structure. This may be an important consideration.

- Criterion 1.2.S.2. – Forage species should also be applied to invertebrates. For example, clams and amphipods are important forage species for gray whales and seabirds, respectively. Are these considered here?

- Criterion 1.2.S.3 – are you equating migratory or anadromous species with nutrient import/export? Some species that aren't anadromous or migratory can be important for import/export (e.g., kelps; non-migratory birds). Migratory may also influence range and

habitat use, suggesting that these species may be less supported by a network of MPAs, unless they are in areas that are important for reproduction/foraging/etc. For example, did you score Elephant seals as 2 for 1.2.S.1 because they are "top predators" but also in 1.2.S.3 as 2 for migratory, suggesting they are high in nutrient import/export? Is this assumed or known? This needs to be clarified. Also, see my comments about bias elsewhere in this review. You might need to reconsider this particular criterion.

- You could also consider additional screening criteria, including the influence of a species in a given habitat/ecosystem (using centrality or linkage strength or expert opinion); umbrella species; whether they have known foraging/spawning areas in BC waters, etc.

Section 4.1 Identification of Candidate Species

- Good use of previous sources

- Might want to include the full list of candidate species, indicating which species were dropped from the list in an additional appendix?

Section 4.2 Scoring Methodology

- When you say that candidate species were grouped based on their taxonomy and ecological and functional roles and then assessed does this mean that you didn't have to evaluate each species/group for each criterion? In other words, if you know that species are not habitat creators, you just automatically assigned a zero and didn't apply the analysis any further? It isn't quite clear. Might want to clarify. Ah I see now. It might be good to emphasize this here.

- While assignation of 0,1,2 is appropriate, there is a challenge using this approach to then further rank species. If you use overall score, this leads to much higher weights for large-bodied migratory mammals and bony fishes over any other species, especially as vulnerability and CC is typically unknown for many invertebrate species and few play a strong predatory role

- It is clear how – differs from 0, and I think this is an important distinction.

- How are * being addressed? Any emphasis on filling data gaps?

- I agree that you might want to modify criteria for bird species, although there may be some additional aspects of prioritizing birds that can help (e.g., top species within a given habitat type; species whose distribution or reproduction is limited to BC).

- The overall set of criteria are not necessarily independent of one another. Larger bodied predators and highly migratory species tend to be more vulnerable than other species. Plus criteria for Objective 1.1 is vulnerability but so are the criteria for Objective 1.5. If the "additive" score is going to be used at all (which I'm not sure it should) then this correlation should be considered.

- While the authors do not recommend using the total score to rank species CPs, they do provide the scores and the option for using this to further sort the species CPs. But, using the overall scores from this approach leads to some illogical outcomes. For example, Northern Elephant Seals are ranked as one of the top species CPs in the region. However, Northern Elephant Seals are not known to breed in BC and their influence as predators is not well-documented. Contrast this with sea otters, which are known to be highly influential predators in nearshore rocky reef ecosystems, are threatened, and breed and forage in BC waters, thus are more likely to benefit from a network of MPAs. As such, there should be additional screening criteria or advice on how to use the scores.

- One way to do this is to link the species to their habitats (across life histories) and score them by how influential they are. For example, sea otters are important in nearshore rocky reef and sandy habitats but do not spend time in pelagic waters. Some forage species are important in mid-water while others are in shallow sandy bottoms. This will allow for ranking species in certain areas and will help in the target-setting phase of MPA network design.

Section 4.3 Criteria

Objective 1.1

- Other stressors that influence vulnerability to climate change include nutrient inputs and other land-based stressors (Strong et al. 2014; Mach et al in review)

- I think the choice of 0,1,2 is fine but am curious why the authors chose to use it, particularly for vulnerability ranking, as many vulnerability frameworks use a 0-3 scoring process? Did you do this so that your values matched the other criteria? That is an important consideration but I wonder if it would be worth adding an additional level – none, low (1), moderate (2), high (3) here and possibly for all criteria. This would allow for more nuanced separation of CPs. Perhaps it is not feasible for all criteria?

- In Table 4, are these both for fish (in FishBase) and other species (SeaLifeBase)? Are all life history characteristics applied in all cases? If not, indicate which are applied to all species and which are applied to fish only. Also, for some characteristics (e.g., Geographic range) there are only high and very high vulnerabilities. Is this a threshold dynamic? It isn't clear if you assigned 0,1,2 to each characteristic and then calculated the formula using Cheung et al 2005 methods or if the outputs from the Cheung et al methods would have given a categorical vulnerability rating (e.g., moderate or very high) and that is how you would then assign your values. I assume the latter but it should be described more clearly here.

Objective 1.2

- Good that the authors describe the caveat that assigning functional importance can be challenging and is scale-dependent. However, as the authors are doing here, there are several examples of where processes are doing this with ESSs.

- Use of Highly Influential Predators in the overview paragraphs but then switch to top predators, apex predators, upper level predators in section 1.2.S1. I think it is important to be consistent or be clear in how you are defining highly influential vs. top vs. upper level vs. apex predators.

1.2.S1. Highly Influential Predators

- As I mentioned above, I think this ends up biasing upper level, large-bodied species and overlooks other important functional roles, including herbivores and detritivores. It might be worth considering these under this category. You could score the importance of the particular foraging strategy, rather than just predatory foraging strategies? This would allow for higher scores for other well-known strongly-interacting species (e.g., sea urchins, black chitons).

- I think the last sentence on page 12 is particularly important and is especially relevant to your scoring approach.

- The Scoring Approach is not really described anywhere. You discuss the relevance of size and trophic level in the above paragraphs. It would be good to have a description of how these sizes and trophic levels were chosen for fish and perhaps whose judgment was used for other species.

- What if a species uses multiple habitats or areas but is only functionally important in some? E.g. migratory species may only forage in certain habitats. Suggests that need to link species CPs to

- area/habitat CPs

- Again Table 5 says "Top Predators" is this "Top" or "Highly Influential"? Consider changing to highly influential predator/herbivore/detritivore, etc.

1.2.S2 Forage Species

- What about squid? Other invertebrates like clams, amphipods?

- Give an example or two of fishes that might be classified as forage fish in the juvenile stage (e.g., rockfishes).

- As in previous paragraph, you don't describe the scoring approach but you do explain in Table 7. However, you don't refer to Table 7, which does describe the scoring approach. Might be a typo?

1.2.S3. Migratory/anadromous species

- It seems that you are using migratory/anadromous as a proxy for nutrient export/import. But there are some species that are also important for nutrient transfer that aren't migratory and wouldn't be considered diel migrators either (e.g., kelps). Be explicit that you are using migratory/anadromous as a proxy and also considering non-migratory species that provide nutrient subsidies.

- I think it is worth discussing whether species that link the benthic-pelagic realms should be overlooked under this criterion. These species may be critically important for ecosystem processes. However, if diel migration is highly correlated with forage species (which is likely), then I think it is probably a good idea to not include this biological process under this criterion.

- As you say, migratory species also fulfill Objective 1.7, so be clear that this is why you chose them.

- I think the authors might considered dropping this criterion out of the overall score as it is highly correlated with body size and predators. It might be useful to help identify and link species to the areabased features.

1.2.S4. EpiBenthic or sub-surface habitat

- You don't really describe how or why you chose the criteria in this section.

- I don't think 1 and 1* are sufficiently different or clearly defined in the scoring rubric.

- You say see species profile for more information – does this mean, in order to understand why you chose to assign a 1* will be different for each species or the species profiles better define this criterion?

Objective 1.5 Contribute to protection of rare/unique/threatened and/or endangered species and their habitats

- I'm wondering if you are double counting if you have vulnerable species in Objective 1.1 and species of conservation concern here? If species with higher scores are considered higher priority (when considering design strategies), then this is putting a higher weight on vulnerable species. If that is the intention, then it needs to be clearly stated somewhere.

- Also, you don't describe the assignation of scores here. It seems that if a species is considered a 2 at any scale, it is considered a 2. Your choice here should be explained (e.g., precautionary).

  Other considerations: Rarity and Range Restrictions

- I agree that using rarity is untenable, given the difficulty in measuring it.

- However, while rarity is difficult to measure, there is a possibility of considering range restriction as a criteria. The Scottish MPA process used a criterion they call "proportional importance" that could be used here. However, it seems as if the authors have already pre-screened species for this by removing any accidental or vagrant migrators in the initial selection process, so it may be done implicitly.

- As the authors state, species at the edge of their range could indeed adapt their behaviours and move into the region as a result of climate change. If there is some indication of such a shift in range already occurring, it could be incorporated into planning scenarios. Note my comments under climate refugia. There are climate envelope models (e.g., Pinsky et al 2013) and risk assessment approaches (Samhouri et al 2013) that can be used to help identify potential shifts or vulnerabilities.

- Note also that while rarity is hard to identify, if it is used, it should be sub-divided according to naturally rare versus rare due to human-induced disturbance. These different types of rarity suggest different management actions. In the case of rare species that are naturally rare, high protection of existing occurrences is important; if due to human disturbance, recovery plans are likely to be necessary, and may involve protecting areas that no longer maintain the features in question, but where they were known to historically occur. This may also be in line with protecting degraded areas. It might be worth including a criterion that identifies different types of rarity and even if you cannot assign scores, identify this as a data gap that needs addressing.

4.3.1 Birds

- Good use of previous work and clear description of criteria and assignation of scores.

4.4. Results: Species-based conservation priorities.

- The authors clearly define how they chose their final list of CPs. I think the approach is fine for providing a long-list of 128 non-bird species and 59 birds. However, there is a lack of guidance for how to use this list in meeting the objectives of the network. They authors indicate that they don't think additive scores should be used necessarily be used to rank species and CPs. While I agree, I do think there needs to be additional recommendations for how to rank or add weighting for CPs in the process.

- One challenge is dealing with the potential correlations among your criteria. You have chosen to emphasize forage species, predators, migratory species, vulnerable species, and species of conservation concern. There are correlations among many of these variables, making the use of the total additive score to rank CPs inappropriate.

- One way forward is to drop the migratory criterion in the additive score and recalculate. I have done this and to me it makes more sense biologically. For example, several species that are on the list are migratory species. While these may be important CPs, several do not have clear breeding areas in BC, or the features that are linked to their foraging patterns may be dynamic. These species may not necessarily benefit from static MPAs. You could still maintain the migratory status scores to help identify the area-based priorities. See my comments re: table 15.

- Another possible way forward is to choose additional criteria to help assign weights for species-based conservation priorities. For example, species that could be considered "umbrella" species for others might rank higher (in a given habitat)?

- I tried shifting away from an additive approach and used a Euclidean distance and sum of squares approach. The rank scores are the same and the interpretation is a bit more challenging. However, with Euclidean distance you could plot Conservation Concern and score for primary ecological role or vulnerability and see how species fall out in a visual way to help prioritize the list. This would give you species that have high CC and important ecological role vs. species with just high CC or important ecological role and those that are somewhere in between.

4.5 Recommended spatial features for species-based conservation priorities

- This section is helpful guidance for future data collection. It would be helpful to link the species list to the categories here (i.e., which species are considered mobile, which are fisheries, which are habitat species, etc.). You could add a column to Table 13 or Table 20. This would help link area-based CPs to species CPs as mentioned in Section 3.

- Regarding Observed or modelled distribution and relative abundance of species, we know that there are major data gaps for many species in BC. Rather than use species distribution and abundance data to design MPAs, it is recognized that protection based on Ecological/habitat classification can address many species priorities and overall biodiversity. As such, how would you recommend that this type of information be used in the design strategies phase?

Section 5. Area-Based Conservation Priorities

5.1 EBSAs (linked to Objectives 1.1, 1.3, 1.6)

- Might want to better link this to Table 17. How are the EBSAs informing your selection? Perhaps add a paragraph that states how you did this.

5.1.1 Climate refugia (linked to Objective 1.1, 1.6)

- As above, better describe how this informed your selection of area-based conservation priorities in Table 17.

- Is it possible to provide additional guidance on how species will respond to Climate Change and whether that can be incorporated into area-based MPAs? Do we have this information for BC? If not, is there any effort towards taking a climate envelope modelling approach (see Pinsky et al 2013; Cheung et al 2009) or a risk-based approach (Samhouri et al 2013 – CCIEA)?

5.2 Representative Areas (linked to Objective 1.4, 1.1, 1.3)

- I agree with the authors that multiple classification systems can be used to achieve Objective 1.4. The authors state that there are a number of ecological classifications in the Pacific Region. Perhaps make reference to Table 18 that lists them.

- Another classification to consider was recently described and applied to the NBS by Gregr et al (2016) that uses disturbance-adversity to find areas of high biodiversity. It should also be considered in this list in Table 18 (perhaps this could be included under modeled areas of high benthic species abundance?).

- Even though representativity will be addressed in the Design Strategies phase, it will be helpful to provide some guidance around which ecological classifications to use and how to

prioritize them and the EBSAs. For example, are all habitats created equal or do you consider habitats and areas that protect the greatest biodiversity? Are habitats/area-based CPs that are important for priority species CPs weighted more heavily? A recent paper in EcoSphere (Cabral et al 2016) indicates the importance of habitat quality and extent to the metapopulation benefits of MPAs. Maybe this is a consideration in the Design Strategies phase.

- What about habitat vulnerability (Objective 1.1)? There are several approaches in the peer-reviewed literature that indicate how to address habitat vulnerability to a suite of stressors.

Section 6. Discussion

Section 6.1.1 Distribution of Scores

- One issue is that invertebrates are relatively data-poor compared to other species, and thus 38 invertebrate species received no scores, indicating a big data gap in this group in BC. The authors might want to consider whether/how these species could be addressed in the habitat or area-based CPs. There are other vulnerability processes in the literature that could help fill this gap. For example, PSA approaches have been applied to invertebrates in other peer-reviewed literature (Micheli et al 2014 Biol Conservation) that could be adapted or applied here.

- Are the 51 species with no scores distributed across a number of habitat types or concentrated in a few? Perhaps it would be helpful to connect the species CPs to the habitats identified through ecological classification approaches.

- How do you plan to address the 118 species that have no scores for conservation concern? This seems to be an important factor when considering possible approaches for ranking species CPs.

- I agree with the authors that scale influences the selection of CPs. In this case, aggregating species into broader taxonomic categories and choosing to ignore species that are habitat-forming at very fine scales is appropriate. It is good that the authors acknowledge this. However, I think that the choice of ecological classification and application of representativity in the Design Strategies phase will have to address this issue of scale.

Section 6.3 Potential rankings of species

- I think the authors need to explore this in more detail and provide some potential approaches that could help in the next phase of MPA planning. I have given some suggestions above and feel that this is a critical piece to this paper that has been under-explored.

Section 6.4 Uncertainty in Scoring

- Regarding the role of protecting vulnerable and at-risk species as umbrella species, while this may be true, it will depend on the size and spacing requirements for protecting these species. Often umbrella species are those that have larger ranges or whose important areas overlap with other species. Per my earlier comments, if umbrella species could be identified, this might be an additional criterion that could help with weighting the CPs that have been recommended for inclusion here.

- The discussion of representativity and ecological classifications with an emphasis on the PMECS classification system is helpful. Do the authors have additional suggestions on how to prioritize some of the area-based and habitat CPs? For example, should the overlap with

multiple objectives be a criterion that is considered when selecting ecological classifications and setting targets?

Section 7. Next Steps

Section 7.1 Spatial Data Availability

- Should data availability be an additional criterion to rank the species or area-based CPs in the next phase?

- The authors' inclusion of species that scored a 2 in any of the criteria reduced bias towards well studied groups, but (as discussed in the previous section) the list is already biased towards well studied groups. Invertebrates and algae in particular are likely under-represented. I agree with the authors that using additive scores can bias species that are well-known. In order to reduce this bias, it might be important to emphasize areas/habitats/umbrella species that are good proxies for protecting other species and biodiversity more generally.

Section 7.2 Non-Ecological Conservation Priorities

- It is important to emphasize that other non-ecological CPs will be identified elsewhere in this process. However, regarding the CPs under Goal 2, the authors do include fisheries species in Table 15 when identifying the data types that would be useful to consider for each set of ecological CPs. It will also be necessary to cross-reference the list of ecological CPs here with those that are also potential CPs under Goal 2 (i.e. current fisheries' targets). The authors could include which species are potential fisheries' CPs that could then be taken into the next phase of the process.

Section 7.3 Design Strategies

- Again, I want to emphasize the importance of prioritizing the list of species CPs and area- and habitat-based CPs. The authors suggest that this will happen in the Design Strategies phase of the project. I think that is fine but I do believe that there is a possibility that the scoring applied here could be mis-applied in that phase of the project if the authors do not give a set of recommendations on how to prioritize the list as it is now. They offer up a couple of ideas here but additional approaches could be identified (see my earlier suggestions).

Section 7.4 Future Applications

- Also it would be worth mentioning the changing status of species regarding vulnerability or conservation concern and the importance of filling gaps where there is a lack of data sufficient to score many species under the proposed framework.